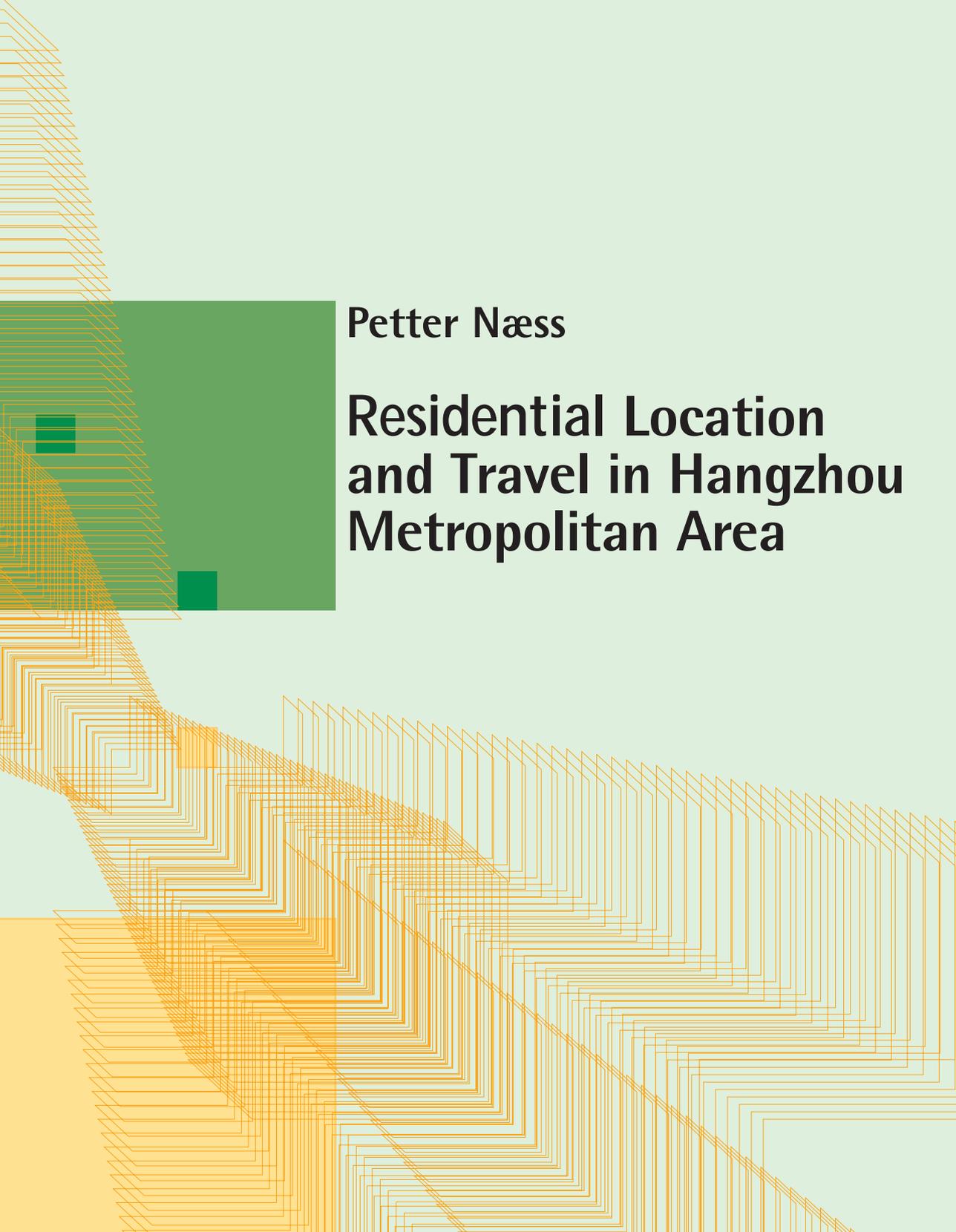


Petter Næss

Residential Location and Travel in Hangzhou Metropolitan Area



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Preface

This report presents the results of a study of influences of residential location on travel behavior in Hangzhou Metropolitan Area, China. The study was funded by Volvo Research and Educational Foundation and has been carried out in cooperation with Zhejiang University.

The report has been written by Professor, Dr. Ing. Petter Næss. The author would like to thank the Chinese members of the research team: Professor Yin Wenyao, Yan Hui, Ma Weihong, Yao Yinmei and Li Fen. Especially thanks to Yan Hui who carried out, transcribed and translated the qualitative interviews into English and played a key role in carrying out the questionnaire survey. Thanks also to members of the planning agencies of the Municipality of Hangzhou and the regional authorities for helpful assistance during the data collection.

Oslo, February 2007

Berit Nordahl
Research Director

Innhold

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Summary

Petter Næss

Residential location and travel in Hangzhou Metropolitan Area

NIBR Report 2007:1

The theme of this report is how spatial planning in urban areas can be used to influence the amount of travel and the proportions carried out by different modes of conveyance. The report is based on a pioneering study of residential location and travel in an affluent Chinese urban region, viz. the Hangzhou Metropolitan Area in the province of Zhejiang. Until now, there has been lack of valid and reliable knowledge about the influence of residential location on travel in East Asian cities. If Chinese cities are to follow the path that North American and many European cities has followed in their urban development and transport policies during the latest half of the 20th century, a very strong increase in urban motoring must be expected, with associated problems related to oil consumption, air pollution, health, traffic accidents, and reduced accessibility to facilities for people who do not possess a private car. It is therefore of a high policy relevance to identify possible strategies for urban development that may reduce car dependency and provide a high accessibility for the inhabitants to workplaces, service facilities and other urban functions without having to rely on a high level of individual motorized transport.

In important ways the Hangzhou Metropolitan Area study goes beyond the scope of most previous investigations into the relationships between urban land use and travel. The traditional quantitative travel survey approach has been combined with qualitative interviews in order to identify the more detailed mechanisms through which urban structure affects travel behavior. Rationales for activity participation, location of activities, modal choice and route choice make up important links in these mechanisms. The statistical analyses include a broad range of urban structural, socioeconomic and attitudinal variables. Differences between

population groups in the way urban structure affects travel behavior have also been investigated.

The Hangzhou Metropolitan Area study shows that residential location affects travel behavior, also when taking into consideration socioeconomic and attitudinal differences among the inhabitants. Although the specific influences of urban structure vary between population groups, the location of the residence in the urban structure of the Hangzhou metropolitan area affects travel behavior within all our investigated subgroups.

Overall, our analyses show that the location of the dwelling relative to the center structure of Hangzhou Metropolitan Area has a considerable influence on the travel behavior of the respondents. On average for all our respondents, living close to downtown Hangzhou contributes to less travel, a lower share of car driving and more trips by bike or on foot. Conversely, living in the peripheral parts of the metropolitan area contributes to a higher amount of transport and a lower share of travel by non-motorized modes. In particular, the length and travel mode of journeys to work are influenced by the location of the dwelling relative to the city center of Hangzhou. In general, the strong concentration of service and leisure facilities in the inner and central parts of the metropolitan area also implies shorter average trip distances for non-work purposes the closer to downtown Hangzhou the residence is located. The location of the dwelling relative to the closest second-order and third-order center also influence travel behavior, but not to the same extent as the location of the residence relative to the city center of Hangzhou.

Our data indicate that a residential location close to the city center of Hangzhou contributes to:

- shorter overall traveling distances on weekdays as well as in the weekend
- considerably higher likelihood of using non-motorized modes during the weekdays as well as in the weekend, but somewhat shorter traveling distances by foot and bike than the average among users of these modes
- lower likelihood of traveling by bus both during the weekdays and in the weekend, and shorter traveling distances by bus than the average among users of this mode
- lower likelihood of using car or taxi during the weekdays and to some extent also in the weekend, and shorter traveling distances by car and taxi than the average among users of these modes

- lower likelihood of using electric bike, especially in the weekend but also during the weekdays
- considerably higher proportion of the total traveling distance carried out by non-motorized modes during the weekdays as well as in the weekend
- considerably shorter commuting distances

Residential location close to any of the two second-order centers (Xiaoshan and Yuhang) appears to contribute to:

- higher likelihood of using non-motorized modes during the weekdays as well as in the weekend
- lower likelihood of traveling by bus in the weekend and to some extent also during the weekdays
- slightly higher likelihood of using electric bike during the weekdays
- higher proportion of the total traveling distance during the weekend carried out by non-motorized modes
- somewhat shorter commuting distances

Residential location close to any of the six third-order centers appears to contribute to:

- slightly longer overall traveling distances on weekdays
- somewhat higher likelihood of using non-motorized modes during the weekdays as well as in the weekend
- shorter traveling distances by foot and bike than the average among users of these modes on weekdays, but somewhat longer in the weekend
- lower likelihood of traveling by bus during the weekend
- lower likelihood of traveling by car or taxi during the weekend, and slightly shorter traveling distances by car and taxi than the average among users of these modes
- slightly higher likelihood of traveling by electronic bike during the weekend
- somewhat higher proportion of the total traveling distance during the weekend carried out by non-motorized modes
- longer commuting distances

Most of these tendencies are in line with what could be expected from theoretical considerations and are also in line with the mechanisms and rationales identified in the qualitative interviews (see below). There are, however, some effects that may appear surprising, notably

the tendencies to longer commuting distances and overall traveling distances on weekdays when living close to a third-order center. Better accessibility to job opportunities outside the local area when living close to the public transport connections usually available in a third-order center might be an explanation. In particular, such a tendency appears to exist among women. More research is still needed in order to uncover the reasons for the tendencies found towards a higher amount of travel on weekdays when living close to a third-order center.

Our material does not show any tendency to “compensatory travel” in the form of longer traveling distances in the weekend among respondents living at locations making it possible to manage on a low amount of travel on weekdays. In Europe, a hypothesis of compensatory travel has gained much attention, and in our investigation in Copenhagen Metropolitan Area, certain indications of such travel could be found among residents of dense urban districts. In Hangzhou Metropolitan Area, there is even in the weekend a fairly strong and certain tendency to longer traveling distances the further away the respondents live from downtown Hangzhou.

Our interviewees' *rationales* for location of activities, choice of transport modes and route choice make up important links in the mechanisms by which urban structures influence travel behavior. The rationales are partially interwoven. Usually, the choice of an individual is not based on one single rationale, but on a combination of (and a trade-off between) several rationales. Most of the rationales identified either contribute actively to strengthen the relationships between residential location and travel, or are neutral as regards these relationships. A few of the rationales form the base of "compensatory" mechanisms, which may contribute to weaken the relationships mentioned.

Our interviewees' choices of locations for daily activities are made as a compromise between two different concerns: a wish to limit travel distances and a wish for the best facility. For most travel purposes, our interviewees emphasize the possibility to choose among facilities rather than proximity. This means that the amount of travel is influenced to a higher extent by the location of the residence in relation to *concentrations* of facilities, rather than the distance to the *closest single facility* within a category. In particular, this is the case for workplaces and places of higher education, but also for cultural and entertainment facilities, specialized stores and, to some extent, also grocery stores. For leisure activities, the "atmosphere" and the esthetic qualities at the destination may also play a role, contributing

to strengthen the attraction of Hangzhou's central parts, in particular the areas bordering the West Lake.

The longer traveling distances among outer-area than among inner-area residents are mainly a result of longer commuting distances. The given configuration of residences and workplaces results in a shortage of suitable jobs within a moderate commuting distance when living in the outer parts of the metropolitan area. Outer-area residents therefore tend to make longer commutes, partly because local job opportunities often do not exist, and partly because jobs outside the local area are considered more attractive. Although the distances to shops are usually also longer when living in the suburbs, the outer-area interviewees often compensate for this by buying daily necessities along the route home from work. In this way, the rationale of distance limitation and the rationale of choosing the best facility can be combined for shopping trips and certain other errands.

Our interviewees' rationales for choosing modes of transportation usually contribute to a more extensive use of cars in the suburbs and a higher use of non-motorized modes in the inner city. The rationales for route choice imply that the interviewees are not apt to make long detours from the shortest route to daily-life destinations, and thus provide general support to the activity-based approach to transport analyses.

Our interviews indicate that people's activity patterns are to some extent adapted to the availability of facilities in the proximity of the dwelling. The interviewees still rarely give up activities completely as a result of moving to a different urban structural situation. According to our survey data, "distance decay" in the form of reduced activity participation when living far away from relevant facilities is not very pronounced among our respondents. In general, the relationships between residential location and the frequencies of activity participation are relatively weak.

Traveling distances are influenced by residential location to a higher extent among men than among women. Men's traveling distances tend to increase considerably when living far away from the city center of Hangzhou, while women's amount of travel is also influenced by the location of the dwelling relative to the closest third-order center, where proximity to such a center tends to increase their traveling distances. This difference between men and women is to a high extent attributable to male suburbanites' choices of workplaces within a wider geographical area than among their female counterparts. Traveling distances also seem to be influenced to a lesser extent

among childless households with two or more adults (a group including many pensioners) than among the remaining respondents. Moreover, we find somewhat stronger influences of residential location on traveling distances among respondents with a low education level and income than among those with a high education or income.

There are certain differences in the likelihood of using car or taxi according to age, household type and education level, where the likelihood of being a car or taxi user does not appear to be influenced by residential location at all among the younger half of the respondents, single persons and respondents with education level above the median. Among respondents above the median age, respondents belonging to households with at least two adult members, and respondents with education level at the median or below, tendencies to lower likelihood of being a user of car or taxi are found among respondents living close to the city center of Hangzhou, and among the older half of the respondents also when living close to a third-order center.

There are only small differences between the investigated population groups in the influences of residential location on the shares of non-motorized travel.

The results of the Hangzhou Metropolitan Area are highly consistent with the findings of a similar study carried out in Copenhagen Metropolitan Area, Denmark. Both in Hangzhou Metropolitan Area and in Copenhagen Metropolitan Area, living in the central parts of the region contributes to shorter overall traveling distances, shorter commuting distances and a higher share of non-motorized travel. In particular, the location of the dwelling relative to the main center of the region appears to influence traveling distances and modes in very similar ways. The rationales on which the interviewees of the two studies base their travel behavior are also very similar across national contexts. There are also considerable similarities between the Hangzhou and Copenhagen study in the different ways that residential location influences travel among different population groups. In particular, this applies to gender differences.

- However, residents of Hangzhou Metropolitan Area travel in general only a small fraction of the distance traveled by Copenhagen Metropolitan Area residents. Although outer-area residents in both metropolitan areas travel longer than their inner-city counterparts do, the difference between the Chinese and Danish respondents is considerably larger than the average

differences between respondents living in different parts of each metropolitan area. These differences across national contexts reflect the far higher car ownership rates in Denmark than in China.

1 Why is knowledge about urban form and travel needed?

1.1 Introduction

The theme of this report is how spatial planning in urban areas can be used to influence the amount of travel and the proportions carried out by different modes of conveyance. Against a background of increasing concerns about the environmental consequences of urban transport, a growing number of research studies have addressed the relationship between the physical/spatial characteristics of cities and the inhabitants travel behavior. However, few, if any of these studies have investigated these relationships in-depth in an Asian context. The present report is based on a pioneering study of residential location and travel in an affluent Chinese urban region, viz. the Hangzhou Metropolitan Area in the province of Zhejiang. By combining qualitative and quantitative research methods, this study was carried out with the aim of digging a pit deeper into the causal mechanisms between urban structure and travel than what has been the case in most previous studies.

Until now, there has been lack of valid and reliable knowledge about the influence of residential location on travel in East Asian cities. Such knowledge will be invaluable in an urban planning aiming to reduce car dependency and energy use for transport. China's rapid economic growth has entailed a high increase in the consumption of floor space for residential as well as other purposes, with a tripling of the average residential floor space per capita since 1980. At present, nearly one half of the world's construction of buildings (measured in floor area) takes place in China. In particular, the pace of construction is very high in the cities along the eastern coast, where a rapid

population increase due to in-migration from surrounding rural areas and western provinces add to the demand for more housing space resulting from increased purchasing power among the inhabitants. Car ownership rates are still low in China, also in the affluent cities. However, the numbers of cars is growing at an unprecedented rate, currently with approximately a doubling each five years.

If Chinese cities are to follow the path that North American and many European cities has followed in their urban development and transport policies during the latest half of the 20th century, a very strong increase in urban motoring must be expected, with associated problems related to oil consumption, air pollution, health, traffic accidents, and reduced accessibility to facilities for people who do not possess a private car. It is therefore of a high policy relevance to identify possible strategies for urban development that may reduce car dependency and provide a high accessibility for the inhabitants to workplaces, service facilities and other urban functions without having to rely on a high level of individual motorized transport.

Previous studies in a number of European, American and Australian cities have shown that residents living close to the city center travel less than their outer-area counterparts and carry out a higher proportion of their travel by bike or by foot. These relationships make up an important part of the foundation for the policies of planning authorities in several European countries aiming at a more compact and concentrated urban development. However, very few studies of land use and travel have been carried out in an Asian context. Moreover, many earlier studies into this issue have been criticized for failing to control for other possible sources of influence and for not being able to establish whether a *causal* relationship exists between urban structure and travel behavior.

In important ways the Hangzhou Metropolitan Area study goes beyond the scope of most previous investigations into the relationships between urban land use and travel. The traditional quantitative travel survey approach has been combined with qualitative interviews in order to identify the more detailed mechanisms through which urban structure affects travel behavior. Rationales for activity participation, location of activities, modal choice and route choice make up important links in these mechanisms. The statistical analyses include a broad range of urban structural, socioeconomic and attitudinal variables. Differences between population groups in the way urban structure affects travel behavior have also been investigated.

The results will be compared with a recent, comprehensive research study in Copenhagen Metropolitan Area (Næss, 2005, 2006a). Being based on a methodology similar to the Hangzhou Metropolitan Area investigation, the Copenhagen area study has significantly improved the status of knowledge about the influence of urban structure on travel behavior. Topics of particular interest for comparison are the extent to which similar rationales for activity location, travel mode choice and route choice as in Denmark are also present in the Chinese context, and the influence of the considerably lower car ownership rates in Hangzhou than in Copenhagen on the forms of relationships between residential location and travel.

The focus of the Hangzhou Metropolitan Area study is the transport consequences of the location of the residence within the spatial/functional urban structure. In this context, the spatial/functional urban structure applies to:

- The geographical distribution and fabric of the building stock (the pattern of development)
- The mutual location of different functions (residences, workplaces, public institutions and service) within the building stock (the pattern of location)
- The transport system (road network, public transport provision, and parking conditions)
- Water, sewage and energy supply and telecommunications systems
- The urban green and blue structures (more or less natural areas within and close to the city, and lakes, rivers and creeks)

1.2 Relevance to environmental policy

Reducing the consumption of fossil fuels (oil, coal and gas) is a key issue in the efforts to promote a *sustainable development*, as conceived by the UN World Commission on Environment and Development (the Brundtland Commission) in its report “Our Common Future” (WCED, 1987). Motor transport in China is almost entirely based on fossil fuels, either directly through the use of gasoline or auto diesel (and in a few cases gas) to fuel the motors of the vehicles, or indirectly through the combustion of coal, oil or gas in power plants producing the energy for electricity-driven means of conveyance. Combustion of fossil fuels pollutes the air and contributes indirectly to soil and water pollution as well, among others

through acid rain. The impacts on the natural environment have their effects on a local, regional as well as an international scale.

During recent years, attention has increasingly been directed towards the accumulation in the atmosphere of so-called greenhouse gases, notably carbon dioxide, caused by combustion of fossil fuels. According the latest report of the United Nation panel on climate change (IPCC, 2007), it can now be stated with more than 90% certainty that human-made emissions of greenhouse gases are causing global climate changes. Unless the consumption of fossil fuels is reduced, present concentrations of greenhouse gases in the atmosphere will be doubled or tripled within the next 100 years. Most likely, this will result in temperature increases in the range between 1.8 and 4 degrees centigrade within the end of this century. In addition, changes in the patterns of precipitation, wind and ocean currents could be expected, with a generally more frequent occurrence of extreme weather like hurricanes, draughts and floods. Moreover, environmental problems arise both from extraction and transportation of fossil fuels (among others, oil spills in the sea). Besides, oil, coal and gas are non-renewable energy sources. The present high and increasing consumption of these limited resources contributes to increase the risk of wars and international conflicts.

The United Nations Climate Panel (IPCC) has suggested that the global-level carbon dioxide emissions should be reduced by at least 60 per cent as soon as possible. If at the same time an increase in the material standard of living is going to take place in developing countries, this will most likely imply substantial increases in the energy consumption of these countries. For such an increase to be possible within the frames of a total level of emissions that does not aggravate the greenhouse effect, industrial countries must reduce their emissions by considerably more than the 60 per cent suggested by the UN Climate Panel for the planet as a whole (cf. also WCED, 1987:171).

The transport sector is probably one of the sectors where a reduction of greenhouse gas emissions will be most demanding and conflict-ridden. Road transportation is one of the sector showing the steepest increase in carbon dioxide emissions in China (Cai et al., 2006), thus the need for policies in order to “break the curve” is strong within this sector.

Transportation in urban areas has a number of other negative environmental and social impacts too, including local air pollution, noise, loss of valuable buildings and recreational areas due to road

construction, replacement of public urban space by parked cars, the barrier effects of major roads, and traffic accidents. Pollution and noise from traffic has severe consequences to human health, particularly in the urban districts most exposed. Moreover, the number of traffic fatalities in China is high compared to the amount of traffic and is rapidly rising, following the general increase in traffic.

For the time being, the political willingness to reduce the energy use and emissions of the transportation sector appear to be modest in China. Nevertheless, research into the ways measures within different sectors of society influence the development of transport and transport-related environmental problems is of a high relevance for society. Given the current Chinese transport policy, energy use and CO₂ emissions from transportation will increase substantially in the years to come. At the same time, the scientific uncertainty as to whether greenhouse gas emissions really affect the climate has been steadily reduced. Along with the increases in global greenhouse gas emissions there is reason to expect that the consequences of global climate change will become gradually more evident. Should the international society succeed in arriving at future climate agreements with more ambitious and binding goals than the Kyoto agreement, there will be an increasing pressure on the transportation sector to reduce its emissions. As the least conflict-ridden possibilities to reduce emissions within other sectors of society gradually become implemented, and further reductions accordingly are perceived as difficult to realize, there is reason to expect that these sectors will to a decreasing extent accept that transportation be exempted from the requirement for reduced emissions.

A number of imaginable measures exist in order to influence the amount of transport, the modal split between different means of conveyance, and the energy use and related emissions from transportation. Improving the energy efficiency of vehicles could bring about considerable reduction of the emissions from the transportation sector, but unfortunately, increased weight and motor power have so far tended to outweigh what is gained by “lean-burn” motors. A shift to electric cars would solve many of the local pollution problems of car traffic, but in terms of greenhouse gases an electrification of the car fleet would only move the emissions from the streets to the power plant. If the electricity is produced from renewable energy sources (notably solar, wind or hydroelectric), shifting from combustion-driven cars to electric cars will be beneficial not only for the local environment, but also in terms of greenhouse gas emissions. However, a massive increase in the production capacity of electricity based on renewable sources is not environmentally

unproblematic. Converting agricultural or natural areas into areas for production of bio-fuels would, for example, reduce the capacity for food production and/or cause impacts on biodiversity. Most likely, electricity based on renewable sources will not be ample, but rather a scarce resource where unlimited increase in the consumption within one sector will reduce the amount of renewable energy available in other sectors.

Other measures (e.g., radical increases in gasoline fees, road pricing with restrictively high rates per kilometer, or the establishment of maximum quota for each person's purchase of fuel) could potentially change transportation patterns significantly in the course of a short time. However, experience from Western countries show that it has proved to be extremely difficult to gain political backing for such measures. Part of the reason for this is probably the fact that the very mobility that has given most people in Western societies increased freedom to reach a wide range of destinations and activities, has also contributed to the development of societies where a high mobility has increasingly become a requirement. The location of built-up areas and activities in urban regions is an obvious example. During the last half of the 20th century, it became not only possible, but also necessary for people in American, European and Australian urban regions to transport themselves considerably longer distances to reach daily and weekly activities.

Among the employees who start working at a new workplace, or residents who move into new dwellings, the location of new residential or commercial development may already in a short term influence the need for travel considerably. However, for the city as a whole, the transport consequences of changing urban structure through spatial planning will mainly manifest themselves in a long-term perspective. Usually, it takes many years to change the existing building stock of a city to an extent sufficient to change overall traveling patterns significantly. However, precisely because it takes a long time to change the built environment it is important to avoid creating a future pattern of development dependent on ample supply of cheap energy. Such a structure will be highly vulnerable to any future limitations on energy use, e.g. resulting from international quotas for or taxes on carbon dioxide emissions.

It is not reasonable to expect any single instrument to be able in itself to induce the necessary reduction of emissions. If the reductions of transportation's environmental loads necessary to make a difference in relation to the global climatic challenges are ever to be possible, there will probably be a need to combine both more energy-efficient

vehicles, fuel taxes, road pricing, improved public transport in cities, and a spatial planning limiting the needs for transport.

1.3 Relevance to the accessibility of facilities and activity opportunities

Along with the environmental policy relevancy of research into relationships between urban structure and travel, the topic has of course also an important welfare dimension. An urban structure with large built-in needs for transport makes it necessary for the inhabitants to spend much time and/or money on daily travel. Those population groups who are able to pay for a high mobility (in the form of private motoring) may reduce their travel times and thereby have a less stressed daily-life schedule. However, those who do not have a car at their disposal – and this group includes both households who do not at all have a car, and persons who cannot themselves use the household's car because it is occupied by another household member – will either need to spend a long time on daily traveling, or confine their options for job opportunities and service facilities to a limited part of the urban area.

If any economical measures against the growth in car traffic are to work according to their purpose, the share of inhabitants who accept more time-consuming trips or reduced options for workplaces and service facilities must increase, while the proportion who choose to surmount the *friction of distance* (cf. chapter 2.2) by buying themselves a high mobility must be reduced. The more transport-requiring the spatial structure of the city, the higher losses of welfare will be the consequences of such changes in travel behavior. On the other hand, the proportion who do not consider themselves able to limit their transport but instead accept to pay more in order to be able maintain or increase their mobility will probably be higher, the higher dependence on (car) travel is built-in in the location of urban facilities. For the latter group of households, road pricing or other economic instruments to limit urban motoring will be an additional economic burden. This also illustrates an important relationship between economical and urban planning measures: the more transport-requiring the urban structure, the higher taxes will be necessary in order to change travel behavior among the households causing the heaviest environmental load through their daily traveling. At the same time, taxes of a magnitude sufficient to result in the desired environmental benefits will have higher negative welfare and

distributional consequences the higher "structural compulsion" is built-in in the physical and spatial urban structures.

A high amount of transportation necessitates substantial investments in the construction of high-capacity roads and public transport systems. Neither is the necessary energy to drive the vehicles free. Moreover, according to the cost-benefit models usually employed within the transportation sector, the time spent for transport might alternatively be spent on economically more profitable activities. A transport-demanding urban structure thus contributes to increase important entries in an economic account, even when omitting the "externalities" in the form of transportation's environmental impacts and the distributional effect of making accessibility to urban functions and facilities dependent on a high mobility.

1.4 The structure of the report

In the next chapter (chapter 2), a theoretical perspective of the influence of urban structure on travel will be offered, including a discussion of epistemological and ontological aspects of research into this issue. Chapter 3 presents the geographical context of Hangzhou Metropolitan Area and the research methods of our study in this urban region.

In chapter 4, a first picture of typical mobility patterns among residents living in different parts of the metropolitan area is outlined. In chapter 5 we try to find explanations of these geographical variations by means of material from qualitative interviews, searching for the causal mechanisms by which urban structure influences travel behavior in the contexts of individual households. Special attention is given to the interviewees' rationales for location of activities and choices of travel modes, and how these rationales, together with urban structural conditions, produce certain characteristic traveling patterns varying with the location of the dwelling. Chapter 6 looks again at the aggregate-level patterns of travel behavior, presenting the results of statistical analyses of the influences of urban structural, demographic, socioeconomic and attitudinal factors on travel behavior. The analyses focus on the respondents' travel by different modes during the weekdays, in the weekend and over the week as a whole, as well as on the commuting trips of workforce participants. Distinct from chapter 4, where only the immediately apparent geographical variations in traveling patterns were shown, chapter 6 seeks to identify the separate effects of urban structural conditions on travel behavior, i.e. the

relationships still present when the effects of the investigated demographic, socioeconomic and attitudinal factors have been 'subtracted'.

Chapter 7 investigates further into the relationships between residential location and the frequency of activity participation, location of activities and trip lengths for non-work trips, thus seeking to contribute to a more detailed and nuanced understanding of the relationship between residential location and daily-life travel. In chapter 8, the attention is drawn towards differences between population groups (e. g. male and female respondents, and different demographic and socioeconomic subgroups) in the ways that the urban structural situation of the residence influences travel behavior. Chapter 9 draws the attention towards certain indirect effects of urban structure on travel behavior via, among others, car ownership and transport attitudes. When controlling for variables whose relationship with residential location is two-way rather than unidirectional, we should at the same time take such indirect effects into consideration.

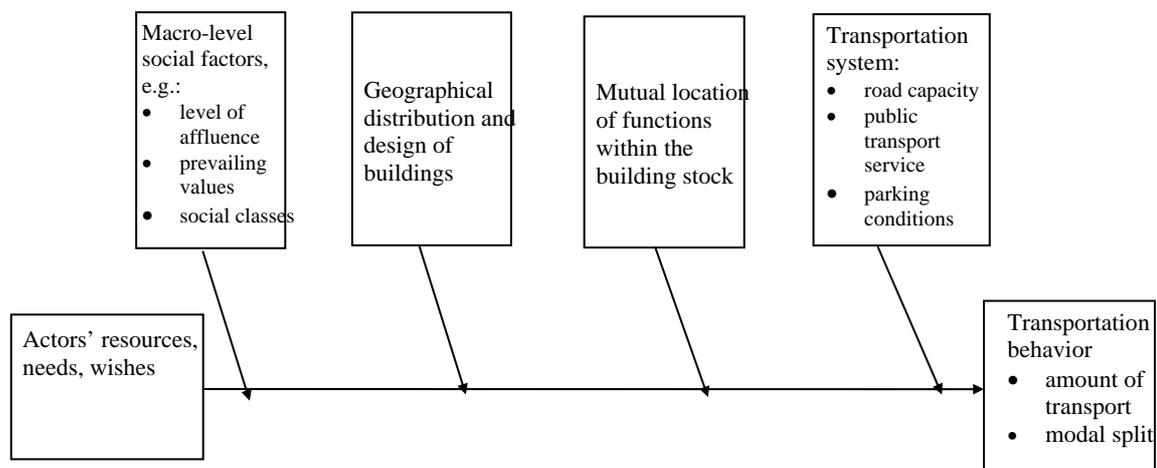
Chapter 10 draws together the threads from the previous chapters and compares the results of the Hangzhou Metropolitan Area study with the findings of other research studies into the relationships between residential location and travel, notably the earlier mentioned study in Copenhagen Metropolitan Area.

2 Urban structures as contributory causes of travel behavior – a theoretical perspective

2.1 A multi-causal situation

According to theories of transport geography and transport economics, the travel between different destinations is influenced on the one hand by the reasons people may have for going to a particular place, and on the other hand by the discomfort involved when traveling to this location (Beinborn, 1979; Jones, 1978). Or, in other words, by the attractiveness of the locations and the friction of distance, respectively. The concept of friction of distance refers to the impediment which occurs because places, objects or people are spatially separate: movement involves a cost (Lloyd and Dicken, 1977). By creating proximity or distance between activities, and by facilitating different modes of traveling, the urban structure makes up a set of incentives facilitating some kinds of travel behavior and discouraging other types of travel behavior. Still, *people* travel, not buildings or geographical distributions of urban facilities. The causes of travel behavior of course also include individual characteristics of the travelers, such as age, gender, income, professional status, as well as their values, norms, lifestyles and acquaintances. The emerging travel habits are a result of people's resources, needs, and wishes, modified by the constraints and opportunities given by the structural conditions of society (see Figure 2.1). Among the structural conditions the spatial and physical urban structures of course make up only a few out of several categories, but for urban planning these very structures are of particular interest.

Figure 2.1 *Transportation behavior as a function of land use characteristics as well as individual characteristics of the travelers.*



Any study of the effects of urban structure on travel behavior assumes - at least implicitly - that structural conditions have a potential to influence human actions. Ontologically and epistemologically, our study of residential location and travel in Hangzhou Metropolitan Area is based in particular on the philosophy of science position called Critical Realism. Critical realism, as outlined by, among others, Sayer (1992), Outhwaite (1987), Bhaskar (1998), Archer (2000) and Danermark et al. (2001), offers a platform within philosophy of science which, more than many other such platform, appears to be relevant for research into the ways in which structural conditions (including land use, patterns of development and transport infrastructure) influence human actions (including travel behavior). According to critical realism, the world exists independently of our knowledge of it, and this knowledge is both fallible and theory-laden. On the one hand, critical realism conceives social phenomena such as actions, texts and institutions as concept-dependent. On the other hand, these by and large exist regardless of researcher's interpretations of them. Moreover, critical realism distinguishes between three different domains of reality: the empirical (consisting of what we experience directly or indirectly), the actual (where events occur whether or not we experience them) and the real (including both experiences, events and the causal powers producing the events) (Danermark et al., *ibid.*). Part of the reason for our orientation towards critical realism is that it – as distinct from, for example, positivism, hermeneutics or radical social constructivism – allows investigations

into the non-universal and non-deterministic, but still politically very important, influences of urban structure on human actions. Thus, in many ways, critical realism appears to offer a viable route between the trenches of philosophy of science, in opposition to naïve empiricism and positivism as well as to postmodern relativism.

The relationship between structures and agents is one of the most contested issues in social theory. According to Archer (2000:6), some theorists, notably economists, consider social structures as a mere epiphenomenon of the aggregate preferences of instrumentally rational actors. An opposite position, represented by, among others, certain discourse theorists as well as parts of the capital logic tradition, considers all human properties and powers, beyond those stemming from our biological constitution, as derivative from socio-cultural systems. A third position, represented by, among others, Giddens' (1984) structuration theory, claims that structure and agency are mutually constitutive and cannot be untied. This precludes any analysis of how structures and agents influence each other, as the specific properties and powers of neither the structures nor the agents can be identified.

Distinct from these three positions, our studies are based – in line with Critical Realism – on the assumption that both structures and agents have particular properties and causal powers (Archer 2000; Sayer 1992 and 2000; Danermark et al. 2001). Apart from our natural environment, the structures surrounding us are in various ways “socially constructed”. The “constructs” may be physical artifacts like buildings or roads, or more immaterial structures like property relations, economic conditions or prevailing belief systems and cultural traditions. Once created, the various types of structures hold emergent powers and properties different from and beyond the aggregate sum of agential powers by which they were created. Not the least, it appears as highly reasonable to assume that *material* structures exert influence on human actions. These structures (e.g. roads, buildings, the natural topography) often have a high permanence, for example, the street network of inner Hangzhou is still characterized by the street pattern established several hundred years ago.

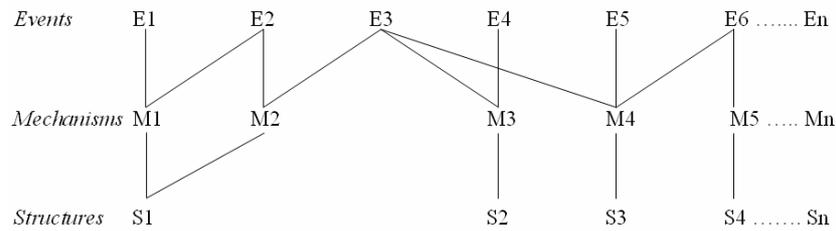
At the same time, the structures are being reproduced, modified and changed by human actions. Such changes most often occur gradually and slowly, but sometimes more dramatically and fast. The purpose of urban planning (as well as the knowledge production informing this planning, among others, the studies dealt with in this book) is

precisely to influence these transformation processes in a way that is more favorable for society.

Both in daily life and in science the term “cause” is used in very different senses, for example about a necessary condition and as a sufficient condition. Immediately, it seems clear that urban structural conditions cannot be attributed the status as a *sufficient* condition for a certain travel behavior. Obviously, a number of other circumstances will play a part, among others, the wishes and preferences of the traveler, the state of her/his health, obligations of being present at specific places, and access to means of transport. It appears more reasonable to attribute urban structural conditions, e.g. the location of the residence, the status of *contributory* (partial) causes of travel behavior, i.e. as one among several causes included in a causal relationship, but without the ability to produce the effect alone.

As already mentioned, our conception of urban structure as a contributory cause of travel behavior is to a high extent based on Critical Realist ontology. According to this position within theory of science, what happens in the world – in nature as well as in society – is a result of causal powers working via a number of mechanisms. Some of the mechanisms may amplify each other while others may neutralize or reduce each other’s influences. On the lowest level in Figure 2.2, borrowed from Sayer (1992:117), we find the causal powers and liabilities (termed by Sayer as “structures”¹). The latter include, for example, the political and economic structures of society and the material structures, but also the cognitive and physical abilities of individuals. Which causal powers and liabilities are relevant of course depend on which types of events we wish to explain. The causal powers and liabilities have a potential to influence observable phenomena (*events* in Critical Realist terminology) through a number of *mechanisms*. However, the mechanisms are only activated under certain conditions, dependent on the specific combination of influences from causal powers. Similarly, the events actually occurring (including the emerging state of things) depend on the combination of mechanisms at work in the particular situation.

Figure 2.2 *Critical Realism on structures, mechanisms and events, based on Sayer (1992:117).*



According to Critical Realist understanding of the concept of causality, causes do not always result in observable phenomena. Causality is not limited to monocausal relationships. Causes are rather seen as "tendencies" that may or may not be actualized, since other, simultaneously working causal powers may both neutralize, trigger or amplify a causal tendency, and may thus both prevent and induce an event.

This way of thinking matches the multiple cause situation a researcher is facing when trying to explain travel behavior. It also helps us understand why we can never expect to find the same kind of strong empirical regularities between causes and events in society as in some natural sciences. (For a more thorough account of the ontological and epistemological basis of our research into the relationship between land use and travel, see Næss & Jensen, 2002, and Næss, 2004; see also section 5.11 in this report).

In his article 'Causes and Conditions' the Australian philosopher John L. Mackie (1965) introduces the concept of an 'INUS condition' (an *insufficient* but *necessary* part of a condition which is itself *unnecessary* but *sufficient* for the result). In our view, the influences of urban structure on travel behavior should be considered as INUS conditions. For example, a resident of a peripheral residential area may choose to travel several kilometers by bus in the morning because this action, according to the person's opinions, is the best means to realize a wish to reach the workplace at the scheduled hour. Another person, living in the downtown area, may instead choose to make a short trip by bicycle in order to realize a similar wish. Thus, a common wish – to arrive at the workplace before the beginning of the working day – is realized by completely different means. Which means is the best to realize a wish will depend on the *conditions* under which the wish is to be realized.

Applying the concept of INUS condition to the above example: the long trip by bus from the outer-area dwelling to the workplace in the downtown area is the outcome, or result, of a number of contributory causes. This trip might have been carried out as a result of conditions other than the actual ones. Therefore, the conditions resulting in this specific trip are *unnecessary*, but *sufficient*. The distance between residence and workplace (*A*) was probably an INUS condition for the commuter's choice to travel a trip of that length by bus that morning (*P*). Given the circumstances (*X*), for example

- that she was employed in a company where the working hours started at 8 a.m.
- that the day in question was an ordinary workday
- that staying away from work would cut her wages and, if frequently repeated, would imply a danger of being fired, etc.

then it was a *necessary* and *sufficient* condition for the long trip that morning (*P*) that the distance from home to work (*A*) *either* had to exist in combination with the actual circumstances (*X*), *or* other conditions (*Y*) must be present that could make the person travel this distance at the given point of time.

In a similar way, the short distance between the home and workplace of a person living in the inner city area was arguably an INUS condition for her choice to ride a short trip by bicycle that morning in order to realize her wish to reach her workplace in time.

Mackie emphasizes that the results of INUS conditions are not only of the type *occurrence or non-occurrence* of an event or a situation. The results of INUS conditions are also of the type where the *magnitude* of an effect is influenced by a partial cause. The same applies to the partial causes, where the causal condition could be that a phenomenon is present to a higher or lower *extent*. The relationships between residential location and travel activity come within this category, termed by Mackie as cases of 'functional dependence' (Mackie, *ibid*: 260 – 261).

2.2 Facilities, activities and destinations

In this report the term of *facility* will often be used about the destinations visited by people. In urban planning terminology this concept refers to the activity possibilities or services, which the inhabitants and visitors of a city use and visit, for example stores, workplaces, public offices, cinemas and parks. *Destinations* are the

geographical locations toward which our trips are directed. Destinations are typically the facilities we visit in order to carry out our activities, e.g. workplace, store, kindergarten or restaurant.

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

The activity and traveling patterns could be considered as the results of planning processes at an individual level. In daily life, this planning is carried out only for a few activities, as many daily activities are routine actions (Vilhelmson, 1994:35). The fact that many trips are based on routines implies that the persons do not, in their daily praxis reflect on *whether* or *how* they are going to make these trips. Giddens (1979:56-59, quoted from Røe, 1999) distinguishes between three levels of consciousness for action: practical consciousness ("tacit knowledge", the approximately non-reflexive everyday praxis), discursive consciousness (implying reflection over one's actions), and an unconscious level of actions. Many of our daily-life travel activities are probably carried out through practical consciousness. However, this does not mean that people are never reflective over such trips. Routines have not always been there - they emerge at some time. When a routine is "born", different alternatives of action are usually considered within a discursive consciousness. Established routines can also be changed. Actions based on practical consciousness can sometimes be reconsidered because of changes in external, structural conditions, or changes in the individual's knowledge, attitudes or preferences, and thus be brought up at a discursive level (Røe, 1999). For example, the travel mode may be reconsidered when starting at a new workplace or school. In some cases even our place of residence may be reconsidered, resulting in a move (e.g. in order to come closer

to the workplace). Changes in life phase or family situation may also trigger such a re-evaluation.

Based on Vilhelmson (1999:181) trips can be classified into four categories, depending on how fixed or flexible they are in time and space. “Bounded trips” are trips in order to reach activities where both the time and geographical location are fixed and cannot freely be deviated from. Typical examples are journeys to work or school, and trips in order to bring or pick up children at kindergarten or school. “Non-bounded” trips are trips where the time of the activity is flexible and the location may vary. Many leisure activities belong to this category, e.g. visiting friends, jogging and outings. An intermediary group includes trips where the time of the activity is fixed but the location may vary, and trips where the location is fixed but the time may vary. An example of the former is the journeys to work of people working at different places (e.g. service mechanics), while visits to one’s parents may be an example of the latter. The “semi-bounded” trips also include a number of purposes where the destination may vary and the trip frequency is not fixed in any rigid way, but where the trips with the purpose in question must still be made relatively regularly. A typical example is grocery shopping.

According to Vilhelmson (ibid:181) 59 percent of the trips carried out by the Swedish population aged 20 - 64 years on weekdays in 1990-1991 could be classified as “bounded” trips where the spatial as well as the temporal location of the activities were fixed as routines. In the weekends, only 29 percent belonged to this category. For the week altogether the “bounded” trips made up 52 percent. Although the Swedish context is culturally, politically and economically different from the one of Hangzhou Metropolitan Area, the distributions between bounded and less bounded trips may still be relatively similar.

Urban structures could perhaps be expected to influence the amount of travel in a stronger and more direct way for “bounded” than for “non-bounded” trips, since some of the latter trips could simply be dropped if the relevant destinations are located too far away. Such ‘distance decay’ (cf. section 2.4) in the frequency of trips to distant destinations might then compensate for the increasing trip lengths when living far away from the relevant destinations of non-mandatory activities.

For some facility types, we almost always choose the closest facility, because the various facilities are more or less equal (e.g. post offices) or have regulated catchment areas (e.g. social security offices). But for other facilities, quality differences or symbolic differences within each

facility category may make people travel beyond the closest facility to a more attractive one. For cinemas and a number of other recreational facilities, many types of shops, and not the least workplaces, a number of other features than proximity are also important when choosing among facilities.

Moreover, even for the group of facilities where quality differences or symbolic differences are insignificant, the distance from the dwelling is not necessarily the most important criterion influencing people's choices among facilities. Because of the possibility of chaining different trip purposes, a facility located close to a destination already visited may be preferred. For example, if you need to visit the workplace each weekday, it may be more convenient to use a post office close to the workplace than the one located closest to the residence.

A person's radius of action during a given period depends on, among others, the speeds by which the person can travel through space. A person who has a car at his/her disposal may reach a higher number of destinations during the day than a person who is left to use non-motorized modes of transport. Yet, the spatial reach of a person is not determined by travel speeds alone, but also by the time available for traveling. (Economic costs and inconvenience caused by traveling comes in addition). Torsten Hägerstrand (1970) has developed the so-called time-geographical approach as a method to understand human activity patterns. Hägerstrand distinguishes between three types of restrictions: capability constraints, coupling constraints and authority/steering constraints. *Coupling constraints* are regulations requiring individuals, instruments, materials and signs to be coupled together into co-operating groups. (Cf. also Urry's (2003) concept *compulsion of co-presence*.) The necessity of being present at a workplace is a typical example of a coupling constraint (ibid: 21-22). The concept of *authority/steering constraints* includes spatial restrictions as to who is entitled to move through or stay in different places, as well as temporal restrictions, e.g. the length of the working hours and their location in time. The authority/steering constraints also include, among others, the layout and time schedule of public transport (ibid: 25-27).

Together the different types of restrictions imply a considerable limitation on people's use of time and the spatial distribution of their activities. In particular, this is the case for workforce participants and pupils on workdays and schooldays. The scope for "free" activities on weekdays far away from home is thus limited, in particular for those who do not have a private motor vehicle at their disposal. This

limitation implies that the “bounded trips” could be expected to account for a relatively high proportion of the amount of travel on weekdays among these population groups. The distance traveled on weekdays will then be quite closely related to the distances from the dwelling to the destinations of the fixed activities, in particular workplace or place of education. On the other hand, among car owners, the time possibly saved when living close to these destinations could be utilized by making more “non-bounded” trips, thus outweighing some of the travel-reducing effects of proximity.

For part-time workers or non-participants of the workforce, the time-geographical restrictions will often be less tight. (The same applies to students, who often determine themselves how often and when to be present at the place of education.) Often yet, people with reduced obligations in connection with wage labor have other commitments, for example child care, including regular bringing and picking up children at kindergarten or school. In practice, such obligations may imply a considerable limitation of the scope for “non-bounded” activities away from home.

In weekends, most people are less constrained by time-geographical restrictions than on weekdays. The amount of travel in the weekend could therefore be expected to be related less closely to the distance from the dwelling to a few, limited destinations. Regular leisure activities may yet imply that travel behavior in the weekend too is considerably constrained by time-geographical restrictions. Precisely because many other time-geographical restrictions are less tight in the weekend, many organized leisure activities take place on Saturday and/or Sunday, in particular activities involving trips to locations outside the local district (e.g. visits to summer cottages or sports meetings).

In a time-geographical perspective the location of the residence will arguably influence people’s need to own private motor vehicles. If you live far away from the destinations of the “bounded” trips and are compelled to walk, cycle or go by public transit, these trips will consume a high proportion of the time budget. The time allocated to the necessary travel in daily life may then easily replace other, desired activities, e.g. being with the children, organized leisure activities, or full-time workforce participation. By acquiring a car (or a second car) a higher speed of travel is obtained, leaving more time for other daily-life activities.

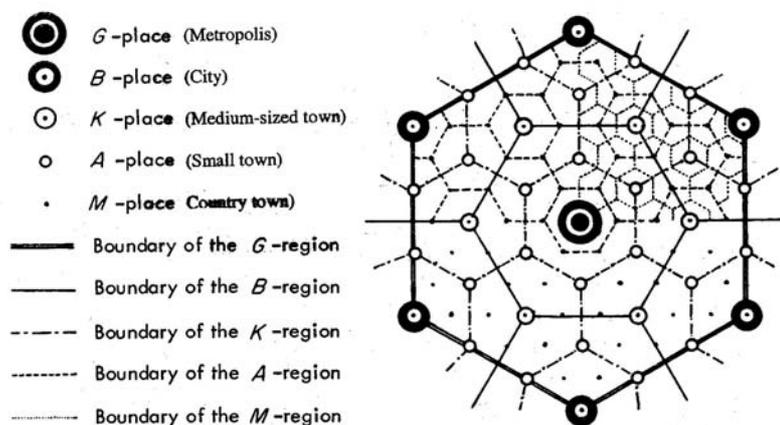
2.3 Center structures and accessibility to facilities

As mentioned in the introduction, the shorter traveling distances and lower proportion of car travel among inner-city dwellers found in many empirical studies have in particular been explained by the high concentration of workplaces, shops and other facilities traditionally found in the historical urban centers. There are several reasons for this concentration. The German geographer Walter Christaller's Central Place Theory (1933/1996) offers one of the explanations. This theory has had a considerable influence on urban and regional planning in a number of countries (Berry and Parr, 1988).

The size of the population base necessary for retail and services to run profitably varies between different types of services and commodities. A generalist doctor does not need as large a population base as a brain surgeon, since the proportion of the population treated by an ordinary physician during a year is far higher than the fraction that have their brains operated on. Functions like retail, health services, education, cultural activities, entertainment etc. may therefore be graded according to the size of the geographical area usually covered by each facility. The different sizes of catchment areas form the basis for the development of a hierarchy of centers. The largest centers include both highly specialized functions and functions requiring a smaller population base, whereas the lower-level centers include only those types of functions that can survive with a small population base. (Christaller, 1933/1966:49-70; Brown, 1995).

Figure 2.3 shows the main ideas of the Christaller's Central Place Theory. While Christaller's original theory dealt with the geographical distribution of cities within a larger region, Berry and Garrison (1958a, 1958 b, quoted from Brown, 1995) developed the theory further, applying central place principles to the internal spatial organization of cities. In cities, in particular the larger ones, there are usually several local centers in addition to the Central Business District, but these centers (ranging from street corner convenience cluster, neighborhood shopping center, community shopping center, and regional shopping center), typically offer a less varied provision of workplaces, shops and other service facilities than the historical urban core.

Figure 2.3 *Christaller's scheme of marketing regions in a system of central places.*



Source: Christaller (1933:66). Explanations added by the author of the present report

Within a city, the historical urban core will often approximate the geographical point of gravity of the city's stock of dwellings. This implies that stores will obtain the largest population base within a given distance by locating in the middle of the city (see, among others, Nielsen, 2002). Besides, the geographical point of gravity of the suburban workplaces and service facilities is also often situated not far from the downtown area. Downtown is also usually the major node for the public transport lines. Trips from a residence in one suburb to a random destination in another suburb will thus often on average be longer, the further away from downtown the residence is located (Nielsen, *ibid.*).

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

flights, express buses). The central parts of large cities are also usually well served by local/regional public transport. Businesses in the region center thus have better opportunities for contact to local as well as non-local partners.

Employees of the workplaces in the urban core contribute to increase the customer base of central-city stores, insofar as they do shopping in the lunch break or on the way home from work. The concentration of facilities in the downtown area also increases the possibility for visitors to carry out several errands within a small geographic area, which in itself increases the competitiveness of the urban core as a location for retail and other services (Christaller, 1933/1966:43, 105).

However, the residents of a city do not visit the downtown area only for functional reasons. The city center is also the arena of a host of recreational and entertainment activities evolving around what Pløger (2002:246-247) calls “the Dionysian² urban life”. According to Pløger (ibid:129), modern city dwellers increasingly emphasize the ethnic and multicultural qualities typical for the inner city (notably restaurants, cafés, and stores), along with the “traditional” urban qualities such as cultural facilities and a multitude of recreational opportunities. In many cities, the downtown area thus has an attractive “atmosphere”. Frequently, the downtown area is the part of the city visited by the highest number of tourists, among others because it usually includes a higher presence of historical buildings, and because the city center may be an important point of orientation and have a symbolic meaning (Albertsen, 1999; Rypkema, 2003). The customer base made up by tourists adds to the benefit for shopkeepers and other service providers of being located in the urban core. This is the location where many cultural and entertainment activities take place, both in cinemas, concert halls, in parks and on the streets. Sidewalk restaurants also add life to the downtown area.

As mentioned above, cities (at least those above a certain size) usually have several lower-order centers in addition to their main center. These centers are often located at nodes in the urban transportation system, and the areas close to such centers are often more densely built than the urban districts in-between. In urban areas, there is a mutual interdependence between density and centrality: Land values are often higher in central areas, thus making up an incitement for more intensive utilization of building sites. At the same time, a higher density of residences or workplaces in the local area increases the population base for various types of local service facilities Christaller, 1933/1966:45, 53).

In most cities, the inner parts are usually more densely developed than its outer parts. In particular, there is often a steeply decreasing density gradient from the center to the outskirts of American and Australian cities, but also in European cities densities are generally considerably higher in inner districts than in the suburbs. Usually, there is neither tradition nor demand for the same densities in peripheral parts of a city as in the inner and central areas (Mogridge, 1985:482-484; Holsen, 1995). This implies that the location of a residence within an urban area also affects the likelihood of being surrounded by either a high-density or low-density local community. Due to the influence of local density on the provision of local service facilities (cf. above), the average distance from residences to local service will normally also be shorter in the inner districts of a city than in the outer suburbs.

In Chinese cities, there is probably a less steep density gradient from the central parts to the outskirts, at least as long as we are dealing with the continuously built-up urban area. Compared to e.g. European and American cities, where suburban residential areas are often dominated by one-storey single-family houses, the outer districts of Chinese cities are usually considerably denser, with apartment buildings dominating. Nevertheless, cities like Hangzhou too generally have a higher population and workplace densities in the inner parts than in the outer parts of the city, and considerably higher in the continuously built-up urban area than in the surrounding villages.

Seen together, the conditions mentioned in the previous paragraphs imply that the inner and central parts of a metropolitan area usually include the largest supply of work opportunities, the broadest range of commodities in the shops, as well as the highest diversity of service facilities. In particular, this applies to public offices, various consultants, cultural facilities, restaurants, entertainment and specialized shops. For residents in the inner and central parts of the city the distances to this concentration of facilities will be short. Inner-city residents could thus be expected on average to make shorter daily trips than their outer-area counterparts both to local and more specialized facilities.

For most people, the use of non-motorized modes of transport is highly sensitive to trip lengths (Vejdirektoratet, 1999). Therefore, the proportion of non-motorized travel could be expected to be higher among people who live close to downtown and/or local centers, since the number of potential trip destinations accessible within a short distance is higher than in districts located further away from such centers. In particular, a higher proportion of non-motorized travel could be expected among dwellers of the inner city, where the

availability of job opportunities within walking or biking distances is higher while congested streets and scarce parking opportunities make up a deterrent against traveling by car for short trips.

Some debaters also call attention to the fact that inner-city districts are often characterized by grid-shaped street patterns providing higher local-scale connectivity. In particular, this has been emphasized by American researchers. Compared to the curvilinear streets with frequent cul-de-sacs typical of many suburban areas (in particular in the USA), the inner-city street patterns often imply more direct travel routes, thus contributing to reduce local travel distances and enhancing non-motorized modes (Cervero, 2003; Frank, 2003).

Distinct from the distance traveled, there is little reason to believe that the use of public transport will be significantly higher among inner-city residents than the average among those living in the outer areas. Of course, the provision of public transport services is likely to be higher in the downtown area, which is the main node of the public transport network in most cities. But because so many of the destinations of inner-city dwellers are within walking or biking distance, non-motorized transport will often be faster than going by transit. For short distances, the time it takes to walk to and from the transit stops and waiting for the bus or train to appear will often be long, compared to the time saved during the transit ride itself by choosing public instead of non-motorized transport. Public transport also lacks the flexibility characterizing both the car and the non-motorized modes of transport. In particular in areas with a low frequency of departures, the “hidden waiting time” resulting from the need to adapt the times of departure and arrival to the route timetable reduces the attractiveness of the public transport mode.

A weakened role for city centers?

Admittedly, in many cities the historical urban core has lost some of its dominant position. In America, a pronounced weakening of the Central Business Districts has taken place at least since World War II (Allpass et al., 1968). In Europe, a similar, but less dramatic development has occurred, mainly during the recent 30 or 40 years (Sieverts, 1999; Omland, 2002; Hansen, 2003). In Chinese metropolitan areas too, the location of “economic and technical development zones” in the outer districts has contributed in a similar direction. Partly, the reduced role of downtown is a result of urban planning strategies aiming to reduce the pressure against the historical cores by establishing extra-urban relief centers (Kjærdsdam 1995:128-133), but tendencies in the property market have also moved

development outwards. Due to higher mobility and car ownership rates, the demand for workplace and service locations close to highway ramps in the outer areas has increased, in particular in the USA, where the phenomenon of “edge cities” was first described (Garreau, 1991; Knox, 1994:138-139). This tendency is evident in Europe too (Dasgupta, 1994; UN/ECE, 1998), and in recent years also in China.

The mobility changes during the more than 70 years that have passed since Christaller published his central place theory imply a general increase in the geographical catchment areas of most facilities and services. Moreover, as a consequence of mass car ownership and highway development, locations close to motorways may sometimes have a more “central” location, measured in travel time by car, than the historical urban cores (cf. above). Current urban center structures thus differ considerably from the ones described by Christaller on the basis of his studies in Southern Germany in the 1920s and early 1930s. Yet, in spite of considerable criticism raised against central place theory³, in particular in the 1970s and 1980s, it is today widely accepted as a partial explanation of center formations (Sayer, 1992:217; Brown, 1995).

Most cities – in Europe as well as in China – still have a higher concentration of workplaces, retail, public agencies, cultural events and leisure facilities in the historical urban center and its immediate surroundings than in the peripheral parts of the urban area (cf., among others, Newman and Kenworthy, 1999:94-95; Yuanyuan, 2004). This also applies to the Hangzhou metropolitan area. Being the capital of the Zhejiang province, Hangzhou has a number of functions and facilities not available in the lower-order centers of the province. A high number of these facilities are located in the inner and central parts of the city of Hangzhou.

In America, the role of the downtown area is often weaker than in European cities, in particular in the southern and western “sun belt”. However, far from every urban facility is directed primarily towards customers or users arriving by car. Among those using public or non-motorized means of transport the urban center will still be the location that can be reached most easily by the highest number of persons.

The present concentration of workplaces and service facilities in city centers is partially a result of the location preferences of previous periods. Except for raw material processing factories, enterprises and institutions established 100 or 200 years ago were to a higher extent than today compelled to choose a central location, because they would

otherwise be too difficult to access for the population groups making up the market of their products or services, or from which employees could be recruited. Moreover, a couple of hundred years ago, the geographical extent of many cities was hardly any more than what today makes up the downtown area. This can in itself explain why downtown often has a concentration of historical buildings, institutions and parks. In many cases, important symbolic value is attached to these assets, contributing to increase the prestige of adjacent areas. This has probably worked as an incentive for the enterprises and institutions residing close to such amenities to stay in their premises rather than moving to other locations.

The established, material structures thus represent an inertia tending to sustain the importance of downtown, also in the present situation where mass automobility has reduced the need to locate workplaces and services at locations easily accessible by public or non-motorized modes of transport.

2.4 Compensatory mechanisms?

Although the location of the residence influences the distances to different types of facilities, and the spatial location of most of these facilities suggests that average travel distances will be shortest among inner-city residents, this pattern might be counteracted by certain *compensatory mechanisms*. For example, high accessibility may create increased demands. A high accessibility may be utilized by opting between a wider range of jobs, shops and leisure activities, rather than reducing the amount of transport.

Several authors have pointed to the fact that trip frequencies may increase if the distances to the relevant destinations are short (e.g. Crane, 1996). Conversely, if the distance from the residence to the facilities is very long, many people will find it too time-consuming, cumbersome and expensive to visit these locations regularly. Therefore, there will be "distance decay" in the attractiveness of a large center (Maddison et al., 1996). The range of attraction will vary with the type of facility, cf. above. Beyond that range, most people will orient themselves to smaller, more local centers, even if the job opportunities and selection of service facilities are narrower than in the big city. This might form a basis for the development of more local lifestyles and activity patterns among people living in the peripheral parts of a region. The phenomenon of distance decay may thus act as a compensatory mechanism, tending to reduce some of the

differences between residents of outer and inner parts of the urban region in overall traveling distances. For example, because the distances to a number of leisure facilities are shorter from dwellings in the inner city, residents of the central districts could be expected to use such facilities more frequently than their outer-area counterparts (Crane, *ibid*). However, this increased trip frequency could hardly be expected to balance the difference in trip distances to these facilities.

Moreover, the urban structural characteristics of residential areas could be imagined to influence people's social pattern of contact (see, e.g., Putnam, 2000: 204-215 about the possible negative impacts of urban sprawl on the social ties between people). Apart from the consequences this might have to people's well-being, such an effect might also influence the amount of travel indirectly, for example if more locally based circles of acquaintances in certain areas reduce the number of visits to friends in other districts of the city.

2.5 Lifestyle and travel

As mentioned above, people's daily-life transport activity depends not only on the location of the residence relative to various facilities. The destinations we choose or need to visit depend to a high extent on our individual resources, obligations and interests within a number of fields. Also the travel modes of course depend on a number of individual characteristics of the travelers, and not only by urban structural features. Age, sex, economy, household composition, and workforce participation may influence both people's radius of action in daily life and their choices of transport modes. The possibility as well as the need for car ownership is also unevenly distributed among the population.

In addition to the above-mentioned socioeconomic factors, people may have various *attitudes* towards different travel modes and destinations. These attitudes may result from different importance being attached to factors like travel speed, comfort and flexibility, as well as the symbolic image attached to various means of transportation or districts of the city. The individual characteristics influencing how people attach different importance to such aspects of traveling, are often referred to as "lifestyle factors" (see closer discussion below). Such factors may influence people's choice of facility within a number of facility categories, especially regarding leisure journeys, but also for example regarding shopping trips. Choices of travel modes and travel destinations are examples of

situations where individuals may seek to indicate their belonging to a certain status group, or to signal their own individuality. Some individuals may also act as “political consumers” (Lassen, 2002) within the field of transport, seeking to promote certain values through their choices of transport activities, e.g. the protection of nature and the environment (Tanner, 1999).

The term of *lifestyle* is generally used in order to describe various social and cultural aspects regarding the ways people lead their lives (Berge and Nondal 1994). In classical sociological theory, the lifestyle concept is connected to consumption in a wide sense (Veblen, 1899/1976; Weber, 1922/1971). The theories on lifestyle have been developed further by the Bourdieu (1984), who regards lifestyle as a set of dispositions for actions, based on a taste code determined by the symbolic and cultural capital of each individual. These are, to a large extent, a result of hereditary dispositions (class affiliation), deciding the footing of the individual and making probable certain action patterns or sets of dispositions (*habitus*). Giddens (1991) defines lifestyle as a more or less integrated set of practices maintained by an individual.

In our context it is, however, necessary to narrow down the lifestyle concept to something relevant to and possible to deal with in relation to the research questions of the study. Vilhelmson (1994:32) offers a conceptual model matching the activity-based approach to transport studies, cf. section 2.2. This lifestyle concept takes the individual agent as its point of origin, but does not regard the individual in isolation from his or her social and physical context. Along the first of its two dimensions, Vilhelmson’s model spans from the conditions for the actions of individuals to their actual actions. The second dimension spans from the internal properties of the individuals to the outer conditions. The lifestyle is characterized as the interplay between individual motivations (needs, values, preferences, etc.), individual resources and the structure of the surroundings, combined with the actual actions carried out by the individual. Transport activity is itself a part of these actions and is thus included in Vilhelmson’s lifestyle concept. Since our aim is to find the causes of these very actions, it is problematic to include the same actions in the lifestyle concept used - together with other factors of influence - in order to explain travel behavior. This necessitates a further narrowing of the lifestyle features used as explanatory factors in our analyses. Apart from a number of socioeconomic and demographic characteristics, the lifestyle features included in our analyses will be limited to a number of attitudinal and preference variables, along with some information concerning the adolescence of the respondents/interviewees (cf.

Bourdieu's concept of *habitus*). The attitudes and preferences focused on are attitudes to means of transport and transport policy issues, attitudes to environmental issues, and preferences for leisure activities.

The above-mentioned conceptualization of lifestyle and subsequent operationalization of the concept in empirical analyses was originally made with reference to a European (Danish) context. This of course implies that it should not be taken for granted that the same conceptualization will be appropriate in an East Asian context. However, we believe that contemporary lifestyles in affluent Chinese regions like Hangzhou Metropolitan Area have been exposed to international influences and have adopted "globalized" worldviews and attitudes to an extent making it defensible to borrow concepts from European theorists like Bourdieu and Vilhelmson in our analyses.

2.6 A behavioral model

Table 2.1 provides an overview of some of the key concepts used in the previous sections. Based on the theoretical considerations of the previous sections, Figure 2.4 shows a simplified behavioral model of the ways in which individual, urban structural and other social conditions are assumed to influence daily-life traveling distances through accessibility to facilities, rationales for activity participation and location of activities, frequencies of activity participation and actual location of activities⁴. The location of the residence relative to various centers and facilities, combined with the transport infrastructure on the relevant stretches, determines how accessible these centers and facilities are from the dwelling. Accessibility will be higher the lower is the *friction of distance* (cf. chapter 2.1), where the latter is a function of the time consumption, economic expenses and inconvenience involved when traveling from one place to another. Other things equal, the accessibility will of course be highest for the closest facilities. However, what is the easiest accessible location varies with travel modes, depending on, among others, the layout of the public transport network, the driving conditions along the road network, and the conditions for walking and biking.

The residents' individual resources, motives and social environments influence their rationales for activity participation (including their tradeoff between motivation for participation and friction of distance) and location of activities (notably their balancing between proximity and choice). Combined with the accessibility of various facilities,

these rationales influence the frequency of activity participation as well as the actual locations chosen for the various activities. The total distance traveled is a consequence of the geographical locations chosen for the activities in which the resident participates, the distance along the transport infrastructure network from the residence to these locations, and the frequencies at which the various activities are carried out⁵.

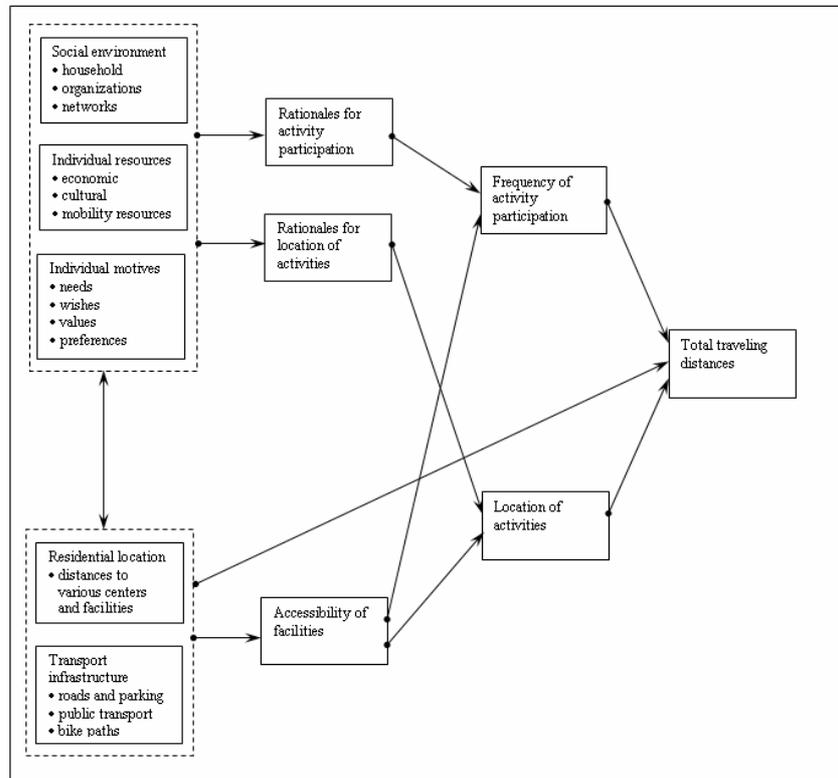
There are also mutual influences between the urban structural situation of the dwelling (location relative to various centers and facilities, and local transport infrastructure) and the individual and household characteristics. The possibility of an over-representation in certain geographical locations of respondents with a priori socioeconomic characteristics and attitudes predisposing them for a certain type of travel behavior (e.g. a preference for local facilities and travel by bike) necessitates multivariate control for such characteristics in order to assess the influences of urban structural variables⁶. On the other hand, certain socioeconomic characteristics and attitudes (e.g. car ownership and transport attitudes) may themselves be influenced by the urban structural situation of the dwelling. This implies that urban structure, in addition to its direct effects, may influence activity participation and travel behavior indirectly via car ownership, transport attitudes and some other variables.

Table 2.1 *Overview of some of the key concepts used in this chapter*

<i>Concept</i>	<i>The meaning of the term as used in this book</i>
structures	Sets of internally related objects and practices
causal power	Properties (of human individuals, society or nature) that can trigger, enforce or counteract events, usually in combination with other causal powers
INUS condition	A contributory (partial) cause of an event, defined as an <i>insufficient</i> but <i>necessary</i> part of a condition which is itself <i>unnecessary</i> but <i>sufficient</i> for the result
facility	Activity possibility or service, which the inhabitants and visitors of an area can use and visit
activities	Doings carried out by individuals at different places in order to fulfill physiological needs, institutional needs, personal obligations or personal preferences

bounded trips	Trips in order to reach activities where – due to preceding long- or medium-term decisions and commitments – both the time and geographical location are fixed and cannot freely be deviated from
time-geographical constraints	Capability constraints, coupling constraints and authority/steering constraints making limitations on people's use of time and the spatial distribution of their activities
center hierarchy	Centers can be ranked into higher-order and lower-order centers, where higher-order centers contain more specialized and a broader range of services than lower-order centers
friction of distance	The impediment which occurs because places, objects or people are spatially separate: movement involves a cost
accessibility	The ease by which a given location can be reached, depending on its proximity, the transport infrastructure leading to it, and the visitors' individual mobility resources
distance decay	The tendency for the use of a service or facility to decrease with the distance from its location
mobility	The <i>potential</i> of movement as well as the volume of <i>actual</i> movements of persons and goods. In our use, the concept is limited to physical movement in the form of transport
amount of travel	The aggregate movement of an individual or a group of persons within a given period, measured in passenger kilometers
modal split	The distribution of the amount of travel of a given individual or population between different modes of travel
lifestyle	The interplay between individual motivations, individual resources and the structure of the surroundings, combined with the actual actions carried out by the individual
compensatory travel	Additional 'non-bounded' trips (in particular leisure trips) made possible due to time and money saved when distances to daily destinations are short, as well as leisure trips made in order to compensate for deficits in residential environments where distances to the destinations of 'bounded trips' are usually short

Figure 2.4 *Behavior model showing the assumed links between urban structural, individual and social conditions, accessibility to facilities, rationales for activity participation and location of activities, actual activity participation and location of activities, and total traveling distances.*



Due to their wide radius of action and their specialized work qualifications, the most mobile and educated parts of the population are likely to emphasize choice rather than proximity. The amount of travel will then be influenced to a higher extent by the location of the residence in relation to concentrations of facilities, rather than the distance to the closest single facility within a category. Thus, among people who emphasize the opportunity of choosing among several work opportunities, shops and recreational facilities, people living close to the central parts of the region center city could be expected to travel less than those who live in more remote parts of the region. In particular, this could be expected to be the case among two-income households, since it is more difficult for couples than for single breadwinners to combine peripheral residences with suitable local jobs

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

2.7 The need for empirical inquiry

Although theories of transport geography suggest that the location of residences relative to the center structure of an urban region may exert an important influence on travel patterns, it is not possible from theoretical considerations alone to conclude with certainty about the nature of this relationship. Many different mechanisms are at work, and it is not possible a priori to state what their net result will be. For example, how strong and common are the possible compensatory mechanisms, compared to the mechanisms contributing to a higher amount of travel among outer-area residents? And what does proximity to local centers mean to travel patterns, compared to the distance from the dwelling to the Central Business District?

Traditionally, urban planners and architects have tended to look at the physical surroundings as the crucial conditions determining residents' well-being and activity possibilities. Within the physically oriented urban planning tradition, this "architectural deterministic" view (see, e.g. Chermayeff, 1982) has led planners to neglect the importance of socioeconomic and lifestyle properties of those who live in and use the physical structures. On the other hand, within influential parts of social science, in particular research based on sociological or economic theories, there has been a tradition for denial of the importance of the physical/spatial surroundings to human behavior (see Dunlap and Catton, 1983, for a discussion). The different disciplinary traditions are therefore likely to offer "incompatible" answers to the questions of whether, how and to what extent the physical and spatial structures of cities influence the travel patterns of the inhabitants. Theoretical analyses alone are therefore unable to answer our research questions in a satisfactory way. In order to "shift sun and wind" between the various hypotheses derived from different theoretical perspectives, empirical inquiry is necessary.

As mentioned in the introduction, investigations in a number of cities have shown that those living in the outer parts travel considerably longer by motorized means of transportation, compared to the residents of inner and central parts of the city. The same main pattern has been found in cities as different as Paris (Mogridge 1985,

Fouchier, 1998), London (Mogridge, *ibid.*), New York and Melbourne (Newman and Kenworthy, 1989), San Francisco (Schipper *et al.*, 1994), the Danish cities of Aalborg (Nielsen, 2002), Frederikshavn (Næss & Jensen, 2004) and Copenhagen Metropolitan Area (Næss 2005, 2006a), as well as the Norwegian cities of Greater Oslo (Næss, Røe & Larsen, 1995; Røe, 1999), Bergen (Duun, 1994), and Trondheim (Synnes, 1990). Although some of these studies have not controlled for the influence from socioeconomic factors, this has been done in other investigations (e.g. Næss, Røe & Larsen, *ibid.*, Røe, *ibid.*, Nielsen, *ibid.*; Næss & Jensen, *ibid.*; Næss, *ibid.*) and some of the latter have also taken the attitudes and subjective lifestyles of residents into consideration.

In spite of this evidence, it is still common among debaters on sustainability and urban form to question whether density and other urban structural factors really have any influence worth mentioning on transportation's energy use and emissions, cf. chapter 1. Many of the early empirical studies demonstrating correlations between urban structure and travel behavior have been criticized for not taking into consideration socioeconomic factors and/or disregarding the influence of the travelers' attitudes and lifestyles. Because, among other things, the income levels, household structures, age and leisure interests of the inhabitants often vary between inner and outer parts of the city, there is a risk that differences in the transportation pattern actually caused by such factors are being explained with differences in the location. In some studies, attempts have been made to meet these points of criticism by including socioeconomic variables in the analyses (e.g. Næss *et al.*, 1995), and in a few studies also indicators of the travelers' attitudes and lifestyles (e.g. Kitamura *et al.*, 1997; Røe, 2001; Næss & Jensen, 2004, Næss, 2005 and 2006a). Still, some critics call attention to the fact that statistical correlations, even with multivariate control, can never establish whether a causal relationship exists between urban structure and travel behavior (Handy, 1996; Røe, 1999).

The above-mentioned doubts and points of criticism have also influenced the opinions among urban planners and policy-makers. It has been common to say that we know too little about the links between urban form and travel to base urban developmental policies on such uncertain relationships. A relatively recently published book on sustainable urban development (Frey, 1999) concludes that no unambiguous data exist to indicate whether a compact or a more spread-out urban structure contributes to a higher or lower energy consumption. Similarly, the editors of an anthology on sustainable

urban form (Williams et al., 2000) write as follows in the concluding chapter:

“Simmonds and Coombe found that a strategy of compaction from the Bristol area would have only a minor effect on traffic. There are a number of reasons for this, including the fact that proximity to a desired facility is only a weak indicator of people’s choice of travel mode. More attention should also be paid to the relationship between proximity and mode of travel. Most authors assert that people will make more trips on foot or by bicycle, yet other research evidence counters this.”

“The findings that socioeconomic characteristics may explain more of the differentiation in travel distances than land uses do, also reveals much about the different policy options in reducing car travel.” (Williams et al., 2000: *Achieving Sustainable Urban Form: Conclusions*).

Earlier studies have also been criticized for ignoring possible differences among population groups in the way urban structure affects their travel. Moreover, some observers claim that in an era where leisure trips appear to replace trips to the fixed activities of daily life as the most important travel purposes, the proximity or distance between the different facilities of an urban area is no longer important to the amount of travel.

Frequently, however, such conclusions stem from model simulations where the results may simply reflect that the assumptions of the model do not capture the actual influence of the urban structure on travel behavior (see, e.g., Dasgupta, 1994; Simmonds and Coombe, 2000). In other cases, the lack of relationship between urban form and transport is the outcome of studies not including the variables that, from theoretical considerations, could be expected to exert the strongest influence on each other. For example, some studies have focused on trip frequency (among others, Kitamura et al., 1997; Boarnet and Sarmiento, 1998) or travel time (Gordon and Richardson, 1997; Snellen et al., 1998) as transportation activity variables, without investigating the influence of urban structure on travel distances or modal split. In some other studies, including Breheny (1995), conclusions are made about an absent or insignificant relationship between urban structure and travel, based on a comparison of travel survey data from cities of varying population size. However, the number of inhabitants is hardly a good indicator in order to test whether urban structure affects travel behavior.

In America, research into land use and transport relationships during recent years has in particular been directed towards the influence of local-scale urban structural conditions on travel behavior, comparing traditional suburban residential areas with areas developed according to the so-called “New Urbanism” or “Transit Oriented Development” principles (Cervero, 2003; Krizek, 2003). However, the location of the residential areas in relation to the center structure of the urban region does not seem to be given much attention in these studies⁷. Moreover, distinct from the European literature on the topic, several American papers on land use and travel are concerned about the so-called “self selection problem”. According to some authors (e.g. Kitamura et al., 1997; Krizek, *ibid.*), the possibility that people choose their residence based on their preference for a particular travel mode precludes any firm conclusions about the influence of residential location on travel.

Following a similar approach as our investigation in Copenhagen Metropolitan Area, the aim of the present study has been to dig a couple of yards deeper than what has been done in most previous studies of the relationship between urban land use and travel, taking into consideration a larger number of alternative explanatory factors and making stronger efforts to identify causal mechanisms through which residential location affects travel. In the next chapter, the methods of the Hangzhou Metropolitan Area study will be described.

3 The case of Hangzhou Metropolitan Area – context and research methods

3.1 Research questions

With the theoretical considerations outlined in the previous chapter as a background, the study in the Hangzhou metropolitan area has focused on the following research questions, of which the first could be characterized as the main one and the four next as secondary questions:

- Which relationships exist between the location of the residence within the urban structure and travel behavior (amount of transport and modal split), when taking into consideration demographic, socioeconomic as well as attitudinal factors?
- Does the location of the residence within the urban structure influence the range and frequency of activities in which people engage?
- On which rationales do people base their choices of activity locations and travel modes?
- Are the relationships between residential location and travel behavior different among different subgroups of the population?
- Is the effect of a residential situation where the need for weekday transportation is low, offset by a tendency to compensate this by traveling more during weekends?

3.2 Linking research questions with data

In principle, both time-series investigations (comparison of the same persons' travel behavior before and after moving from one residential address to a different one) and cross-sectional studies (comparison of travel activity among different residents living in different geographical areas) are possible strategies in order to elucidate these issues empirically. In practice, recruiting participants of time-series investigations within this field has proved difficult, in particular due to the problems of identifying the participants and registering their travel behavior *before* they move from the old to the new residence. Through retrospective questions it is still possible to obtain some information about possible changes in travel behavior and activity patterns after moving from one residential location to another.

Table 3.1 provides an overview of the types of information considered necessary in order to answer each of the research questions of our study. The table also shows the data sources used in order to acquire the desired information.

In order to answer the main research question of the study, information was needed about the location of the residence and its distances to various facilities, the travel activities of the residents during a period, demographic and socioeconomic characteristics of the residents, as well as their attitudes to relevant issues. This information also provided a base for analyzing whether the relationships between residential location and transport are different among different subgroups of the population. In order to answer the question of whether the urban structural situation of the residence influences the sorts of activities in which people engage, and the frequency of these activities, information was needed about the activity patterns of the residents and the location of these activities. The research question about rationales for activity location and choices of modes of travel required information about the location of activities, the use of different modes of transport, and the considerations behind these choices.

In addition to trying to uncover whether, and to what extent, urban structural conditions influence travel behavior, a main purpose of the study is to gain more detailed comprehension of *how* and *why* such influences occur in the context of a Chinese large city: which are the *mechanisms* through which residential location influences transportation? In order to uncover empirically *how* and *why* urban structural conditions influence the inhabitants' travel, qualitative research methods were necessary, in the form of field studies of urban

structural conditions and qualitative interviews of residents living in different urban structural situations. In particular, qualitative interviews were required to enable us to answer the questions concerning the residents' motivations and purposes for their ways of relating to their physical surroundings, notably the questions about rationales for activity location and modal choice. Also for the other four research questions, qualitative interviews could contribute with deepening and more complex information than what is possible to obtain through quantitative questionnaire surveys.

However, the qualitative approach does not remove the need for quantitative analyses. Besides identifying the various causal powers and liabilities that activate the mechanisms leading to certain events, e.g. transport activity, there was a need for knowledge about the form of combination and proportions of causal powers and mechanisms typical for these processes. While the empirical identification of mechanisms affecting travel behavior at the level of the individual could best be made by means of qualitative interviews, statistical analyses were needed in order to empirically identify the effects of urban structure on aggregate level travel patterns. Among the various mechanisms involved, some of which amplifying each other and some counteracting each other's effects, we expected some mechanisms to be stronger and more common than other mechanisms. Our hypotheses and assumptions about the ways in which urban structure affects travel behavior concern *degrees* and *strengths* of relationships. In order to identify such tendencies and differences of degree, quantifiable information about the travel activity of a relatively high number of residents was necessary. The respondents also had to be recruited from areas reflecting the variation in the urban structural factors, the effects of which we wanted to investigate. (See Næss, 2004 for a more thorough discussion.)

Table 3.1 *Research questions, information required and data sources*

Research questions	Types of information required	Methods/sources for acquiring the information
Which relationships exist between the location of the residence within the urban structure and travel behavior (amount of transport and modal split), when taking into consideration demographic, socioeconomic as well as attitudinal factors?	<ul style="list-style-type: none"> • The location of the residence and its distances from various facilities • The residents' travel activity during a period • Socioeconomic characteristics of the residents and their attitudes to relevant issues • Travel behavior before moving to the present dwelling (if moving occurred < 5 years ago) • Subjective opinions about needs of transport and car dependency 	<ul style="list-style-type: none"> • Studies of and measurements on maps • Information from municipal planners • Technical visits • Questionnaire questions about the residents' travel and the distances traveled by their vehicles • Questionnaire questions about socioeconomic and demographic characteristics of the residents, and transport attitudes, environmental attitudes and leisure interests • Qualitative interviews including questions about motives for choices of trip destinations and modal choices, and retrospective and hypothetical questions about travel behavior in a different residential situation¹
Does the location of the residence within the urban structure influence the range and frequency of activities in which people engage?	<ul style="list-style-type: none"> • The activities in which the residents engage, their location, and possible changes compared to previous residential location and/or life situation 	<ul style="list-style-type: none"> • Questions in questionnaires and qualitative interviews about activities, their location, and the meaning attached to different places in the city by the residents. Retrospective and hypothetical questions about activity patterns in a different residential situation
On which rationales do people base their choices of activity locations and travel modes?	<ul style="list-style-type: none"> • Location of activities, use of different modes of transport, and the considerations behind these choices 	<ul style="list-style-type: none"> • Qualitative interviews including questions about destinations and travel modes, and the motivations for these choices
Are the relationships between residential location and travel behavior different among different subgroups of the population?	<ul style="list-style-type: none"> • The information required for the above-mentioned questions 	<ul style="list-style-type: none"> • The data sources of the above-mentioned questions
Is the effect of a residential situation where the need for everyday transportation is low, offset by a tendency to compensate this by more travel in weekends?	<ul style="list-style-type: none"> • The information required for the above-mentioned questions, plus • Comparison of weekday travel with weekend travel 	<ul style="list-style-type: none"> • Questions in qualitative interviews about holiday and leisure trips, based on the present residential situation • Retrospective and hypothetical questions in qualitative interviews about holiday- and leisure trips in a different residential situation • Questionnaire questions about leisure trips

In accordance with the above, the Hangzhou Metropolitan Area study included a large travel survey among inhabitants of a number of residential areas (of which 28 with more than 50 respondents), a more detailed travel diary investigation among some of the participants of the first survey, and qualitative interviews with 28 households. Table 3.2 provides an overview of the research methods used in the empirical collection of data.

The questionnaire included questions about a number of topics, among others: residential address, contacting detail, gender, age, type of residence, ownership of large items, household composition, income, any recent move to the present dwelling, travel after moving⁸, responsibility for transporting children, driver' license, ownership/access to private car and other motor vehicles, perceived dependency on private motor vehicles, travel modes and distances for each day during the week of investigation, business travel, holiday travel, education, workforce participation, location of workplace/place of education, location of activities, frequency of activity participation, residential preferences, transport attitudes, environmental attitudes.

Table 3.2 *The main methods of the empirical collection of data*

Qualitative interviews of 28 households

- Semi-structured, each lasting about an hour and a half
- Focus on the interviewees' reasons for activity participation, location of activities, travel modes and routes, as well as their opinions about different parts of the metropolitan area as places to visit and to live in

Questionnaire survey among inhabitants of selected residential areas (3155 respondents)

- Travel distances by different modes during one whole week
- Location of any workplace or place of education
- Annual driving distance with the household's car(s)
- Changes in the amount of travel among respondents who have moved during the latest 5 years
- Perception of being dependent of car travel in order to reach daily activities
- Frequency of participation in different activities
- Holiday trips
- Attitudes to transport and environmental issues

Detailed travel diary survey Saturday - Tuesday (27 respondents)⁹

- Location of the various trip ends
- Purpose, length, mode and travel time of each trip
- Driving distance of the household's car(s) (based on odometer registration)
- Changes in activity participation and car ownership among respondents who have moved during the latest 5 years
- Flights and other trips outside the local region

Registration of urban structural conditions, including the distances from each respondent's dwelling to various centers and facilities

As is evident from the above, we have aimed at a "triangulation" (Patton, 1987; Yin, 1994:92), both regarding data sources (combination, among others, of questionnaire data and data from personal, qualitative interviews) and methods of analysis (statistical analyses and qualitative interpretation of interview material). We believe that this has given us a broader and more nuanced

understanding of our research questions and contributed to more reliable and robust conclusions.

3.3 The Hangzhou Metropolitan Area

Hangzhou has been selected as a case both for practical reasons (it is the location of Zhejiang University) and because it is an example of a large and rapidly growing (economically as well as in population size) East Asian city. Hangzhou is the capital of the Zhejiang province and located in south-eastern China, 180 kilometers south-west of Shanghai and is the economical and political centre of this province. In 2002, the continuously built-up urban area of Hangzhou has 1.92 million inhabitants. Hangzhou Metropolitan Area includes about 3.9 million inhabitants and is composed of one main city (i.e., the continuously built-up urban area), 2 second-order centers outside the city of Hangzhou and 6 local centers outside Hangzhou. In 2002, there were 1.4 private cars owned per hundred households. Most of the inhabitants in Hangzhou travel by bicycle, electric bicycle and public transit (mainly bus). Two metro lines totaling 82 km are presently under construction and are expected to be opened in 2010. Further extensions into a comprehensive network totaling 278 km are planned to be completed by 2035.

Hangzhou is one of the seven imperial capitals in ancient China. Traditionally, Hangzhou was the 'capital of silk and tea', situated in the middle of a 'land of milk and honey'. Today, it is the capital of the Zhejiang province and one of China's economically most prosperous cities. Since 1992, the city has experienced continuous period of annual GDP growth above 10 %. Housing standards have increased rapidly, and new apartments for typical families of 3 persons are nowadays usually built at a size of approximately 100 square meters, compared to approx. 80 square meters ten years ago. In 2006, the average residential floor area per person in Hangzhou is 27.5 square meters (Chen, 2006). Most of the building stock has been constructed during the latest couple of decades. In Hangzhou, twenty year old buildings are considered old. The high construction activity has involved the demolition of a considerable part of the traditional architecture of the city, but a number of historical temples, pagodas and artistically designed parks still make up an important heritage. A lake of about 10 square kilometers (West Lake), surrounded by green hills and artistically landscaped parks, is situated close to the city center. Together with its cultural heritage, the landscape setting makes Hangzhou an important destination for national and international

tourists. Tourism accounts for 15% of the city's GDP. Other important trades are industry (notably hi-tech), research & development, and commerce. Hangzhou has a reputation as a forerunner among Chinese cities in environmental protection and has been awarded the title of State Environment Protection Model City. Environmental problems arising from industrial growth, more intensive agriculture and, not the least, the rapidly growing traffic are still becoming increasingly apparent.

Whereas there has been a strong tendency for decreasing population densities in many European, American and Australian cities during most of the Post World War II period, most Chinese cities have maintained or increased their population densities during this period. Although some of the growth of Chinese cities has taken place in the form of outward spatial expansion, the rate of this expansion has generally been lower than the rate of population growth. Instead of suburban low-density development, the strong population growth in Chinese cities during the latest decades has to a high extent been catered for through redevelopment of existing urban areas, typically by replacing old built-up districts with new buildings at higher densities. For example, in Wuhan, a city approximately twice as large as Hangzhou, population densities increased in all the districts of the inner city (i.e. the non-suburban part including 4 million inhabitants by 2004) between 1964 and 2000, in particular in its central parts (Yuanyuan, 2004).

Similar to European cities, the historical urban cores of Chinese cities are usually the areas with the highest concentration of workplaces, retail stores and other service facilities. Typically, Chinese cities have a hierarchical center structure with a main center, a few sub-centers, several community centers and a number of local centers (Yuanyuan, 2004). Thus, within an urban region, one may speak of centers of first, second, third and fourth order. The centers of second or lower order may also include previously autonomous towns now included in a larger metropolitan area around a core city. This also applies to Hangzhou Metropolitan area.

The inner city of Hangzhou has an unchallenged status as the dominating center of the metropolitan area. The population density in this part of the region is considerably higher than in the outer parts of the region. There is a clear tendency to decreasing density of population as well as workplaces when the distance from the city center of Hangzhou increases. In particular, the concentration in the downtown area and its closest surroundings is strong for the office and service workplaces. Industrial workplaces are to a higher extent

located in a belt in the outer eastern and northern parts of the city of Hangzhou, and in the new Economic and Technical Development zones of Binjiang (at the south side of the Qiantang river) and Xiasha (see below).

The central business district of Hangzhou is often referred to as the area on both sides of Yan'an Road from Jiefang Road in the south to Wulin Square in the north. The southern end of this axis is the historical center of Hangzhou, whereas the northern end has a concentration of large shopping centers, cultural facilities, and office workplaces. Based on discussions with representatives from the planning department of the Municipality of Hangzhou as well as researchers from the Urban Planning Department and the Sustainable Development Center of Zhejiang University, we have defined the central point of Hangzhou Metropolitan area as the crossing between Yan'an Road and Quingchun Road. This crossing is situated slightly south of the midway distance between Jiefang Road and Wulin Square.

However, as already mentioned, Hangzhou Metropolitan area also has a number of lower-order centers. The central parts of the towns of Xiaoshan and Yuhang (North-east) could be characterized as *second-order centers*. Both these towns include a comprehensive set of center functions, with a variety of workplaces as well as service facilities. The range and number of specialized functions is, however, lower than in the central part of Hangzhou.

Six smaller towns and villages outside the city of Hangzhou (Yuhang (West), Liangzhu, Tangxi, Yipeng, Guali and Linpu) make up the category of *third-order centers*, cf. the latest master land use and infrastructure plan for Hangzhou Metropolitan Area (the Municipality of Hangzhou, 2003). These centers, too, include a more or less comprehensive set of center functions, but with a considerably more narrow range (generally limited to the less specialized types of functions) and with a lower number of facilities within each category than the higher-order centers.

In addition, a number of concentrations of workplaces and facilities within particular trades make up a fourth category of centers within Hangzhou Metropolitan Area. Distinct from the above-mentioned centers of first, second and third order, the fourth category of center does not include a comprehensive set of center functions, but are more or less one-sided industrial centers an/or centers for retail within particular trades. Within these trades, this category of center may have a dominant or at least a very strong position, compared to other parts

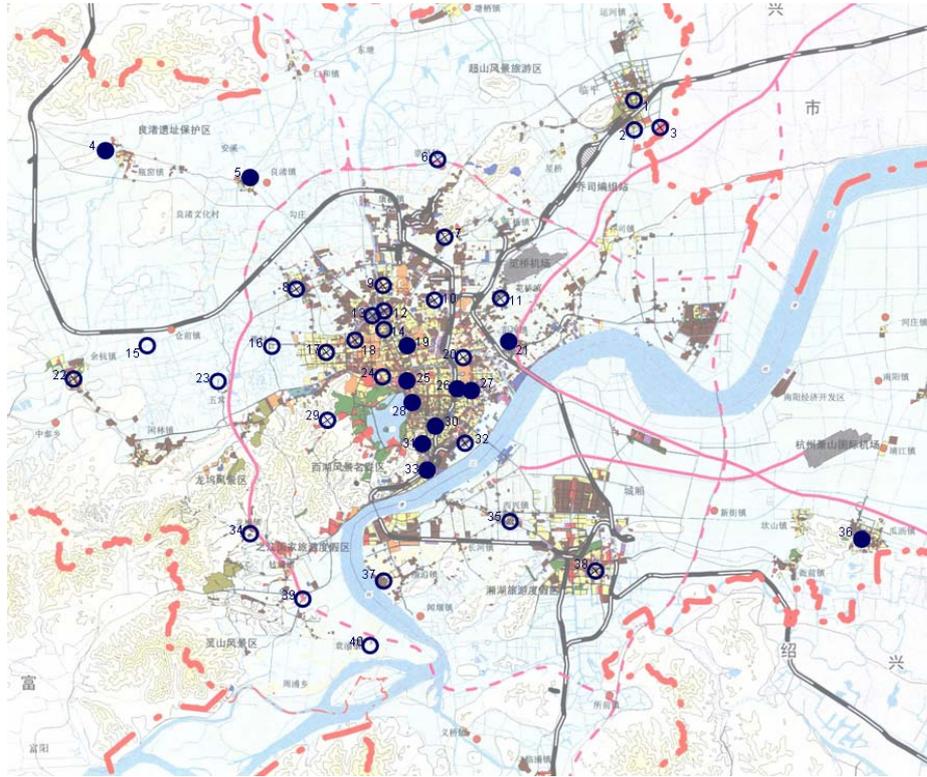
of the metropolitan area. It would therefore not be correct to classify them as fourth-order centers. At the same time, they are of a type qualitatively different from the much more comprehensive third-order centers and therefore cannot be included in the latter category. The one-sided industrial and retail centers for particular trades should instead be classified as a separate category outside the traditional hierarchy of centers. In Hangzhou Metropolitan area, this category includes five industrial or retail concentrations within the city of Hangzhou and two in outer parts of the metropolitan area (Yang, personal communication). The five one-sided centers within Hangzhou are Wensan Road between Gucui Road and Xueyuan Road; Hushu Road at both sides of the crossing with Chaowang Road; the area to the north-west of the crossing between Shangtang Road and Dengyun Road (near the Canal Museum); the area immediately south-west of Hangzhou's eastern railway station; and the area immediately to the northwest of Hangzhou's ordinary railway station. The two outer-area one-sided centers are the central part of Hangzhou Economical and Technological Development zone in Binjiang (at the middle of Dongxin Avenue), and the central part of Xiasha¹⁰ (around the crossing between Wenze Road and No. 2 street).

The center structure of Hangzhou Metropolitan Area could be characterized as hierarchic, with the supplement of the above-mentioned trade-specific concentrations of workplaces and stores which attract employees and customers from a large catchment area, but contain only a limited segment of the functions usually available in a 'comprehensive' center. The 'trade-specific centers' therefore do not fit into a traditional hierarchical classification of centers. Among the remaining centers of Hangzhou Metropolitan Area, the higher-level centers offer – in line with central place theory – a broader range of workplaces, service facilities, commodity types and brands, whereas the lower-order centers contain less specialized functions and commodities. Figure 3.1 shows the locations of the main center of the metropolitan area, the second-order centers, the third-order centers and the trade-specific centers.

level of public transport services. The dwelling types and densities also vary, from the dense inner-city blocks to lower-density settlements at the urban fringes and in exurban parts of the metropolitan area.

At the outset, we intended to recruit 100 respondents from each of 30 residential areas selected according to the criteria mentioned above. However, in some of the selected areas, less than 100 persons could be recruited. Additional respondents were therefore selected from a number of other locations. As a result, the main survey included a total of 3154 respondents from 115 different locations, of which 75 with less than 10 respondents, 12 with 10 – 49 respondents, 17 with 50 – 99 respondents, and 11 with more than 100 respondents. Figure 3.2 shows the location of the 40 residential areas with more than 10 respondents. Table 3.3 shows the number of respondents from each of these 40 locations, along with the distances from each area to the city center of Hangzhou, the closest second-order center, the closest third-order center, and the closest trade-specific center.

Figure 3.2 *Locations in which respondents of the main survey live.*



Scale 1/320.000. Only locations with more than 10 respondents are shown in the figure. These locations include 2913 of the 3155 respondents, i.e. 92.3% of the respondents. The remaining 242 respondents are distributed between 75 locations with numbers of respondents ranging from 1 to 9.

Legend:

- Location with 100 or more respondents
- ⊗ Location with 50 – 99 respondents
- Location with 10 – 49 respondents

Table 3.3 *Key characteristics of the residential areas from which ten or more respondents were recruited*

No.	Location	Number of respondents	Linear distance from downtown Hangzhou (km)	Linear distance from closest second-order center (km)	Linear distance from closest third-order center (km)	Linear distance from closest trade-specific center (km)
1	Linping	39	23.1	0.6	12.8	15.3
2	Nanyuan	24	22.0	1.3	13.4	13.6
3	Donghu	58	23.1	2.5	15.5	12.6
4	Pingyao	104	24.6	33.5	8.5	19.6
5	Liangzhu	104	16.8	25.0	0.9	11.1
6	Chongxian	85	14.0	13.4	10.3	8.7
7	Banshan	75	10.0	15.0	13.1	5.5
8	Sandun	80	10.7	24.7	6.5	5.9
9	Gongchen	88	7.1	20.1	11.1	0.7
10	Dongxin	81	6.3	17.9	13.9	3.0
11	Jian Bridge	94	8.2	15.0	17.9	2.8
12	Daguan	98	5.6	19.6	12.2	1.0
13	Hemu	89	5.7	19.9	11.7	1.3
14	Hushu	12	4.6	18.8	12.3	1.4
15	Cangqian	19	16.9	30.2	5.2	12.8
16	Jiang Village	13	10.0	23.9	9.8	5.9
17	Wenxin	97	6.1	21.0	11.6	1.8
18	Cuiyuan	65	5.2	19.9	12.0	1.5
19	Zhaohui	103	3.2	17.2	14.5	0.6
20	Hulongkou	97	3.9	15.0	17.4	1.6
21	Pengbu	104	7.0	15.8	19.1	1.7
22	Yuhang (West)	54	21.5	34.8	0.3	17.5
23	Wuchang	17	12.5	25.6	9.3	8.5
24	Xixi Road	14	2.4	17.2	15.3	1.9
25	Tianshui	102	1.1	15.8	16.1	2.1
26	Kaixuan	101	2.6	12.3	18.6	1.5
27	Caihe	125	3.4	12.6	19.3	2.0
28	Hubin	117	0.6	14.9	17.1	1.9
29	Lingyin	84	6.2	20.9	18.0	4.0
30	Wangjiaing	100	2.8	13.1	19.3	1.4
31	Ziyang	127	3.2	13.8	19.6	2.2
32	Jingjiang	92	4.6	10.9	21.0	2.3
33	Nanxing	100	4.9	11.2	21.5	3.6
34	Longwu	44	16.4	23.1	15.0	12.6
35	Xixing	40	10.7	4.8	16.9	8.7
36	Guali	91	30.9	19.0	0.5	19.3
37	Puyan	43	11.1	11.9	17.2	10.7
38	Xiaoshan town	69	16.3	0.9	13.8	14.4
39	Zhuangtang	40	13.6	20.5	18.5	16.1
40	Yuanpu	14	17.2	16.6	14.5	17.1

Among the 40 locations with more than 10 respondents, distances to downtown Hangzhou vary from 0.6 to 31 km. However, some of the locations with less than 10 respondents are situated at even longer distances from the city center of Hangzhou. Thus, among the total sample of respondents, the longest distance between the dwelling and the city center of Hangzhou is 44 km.

Recruiting participants of our investigation from a limited number of demarcated residential areas instead of, e.g. drawing a random sample among the inhabitants of Hangzhou Metropolitan Area, was partly motivated from the possibility of mapping a large number of urban structural properties in each area and include this broad range of characteristics as variables in our study. If the respondents had been randomly sampled from all over the metropolitan area it would have been far more difficult to get detailed information about the urban structural situation of each residential address.

The participants of the *qualitative interviews* were recruited from five of the residential areas, one situated close to the city center of Hangzhou (area no. 24, with 6 interviewees), one located somewhat further from the center but quite close to a trade-specific center within the city of Hangzhou (area no. 18, with 6 interviewees), two outer suburbs of Hangzhou (areas nos. 7 and 39 on the map, with a total of 11 interviewees), and one in the central part of the secondary center town of Xiaoshan (close to area no. 38, with 5 interviewees), located south of the Qiantang river at about 16 km airline distance from downtown Hangzhou. The logic behind this selection was to illuminate distinctly different urban structural situations: high-density in the city of Hangzhou (nos. 24 and 18), affluent outer-area (no. 39), lower-income outer-area (no. 7), and high-density in the central part of the largest secondary town of the metropolitan area (no. 38). The qualitative interviews were semi-structured, focusing on the interviewees' reasons for choosing activities and their locations, travel modes and routes, as well as the meaning attached to living in or visiting various parts of the city. The interviews were carried out by one of the members of the research team, based on an interview guide translated into Chinese from its original English-language version. Usually, the interviews took place in the homes of the interviewees, except for a few interviews carried out at the interviewee's workplace. All interviews were tape recorded and transcribed. The Chinese-language transcriptions were subsequently translated into English.

As an important tool for the analysis an *interpretation scheme* was developed. This scheme comprised more than 30 research questions which we, as researchers, tried to answer, based on the information

given by the interviewees. These questions were first answered with reference to each separate of the 28 interviews. Cases potentially suited for being used as illustrative examples in the research report were identified. Synthesizing from our answers about each separate interviewee, a comprehensive interpretation was written for each of our research questions, summarizing the information from all the 28 interviews. By being required to make written interpretations of each interview in the light of each of the detailed research questions, we were forced to read and penetrate the transcribed interview texts in a far more thorough way than what we would probably have done otherwise. Thus, the use of the interpretation scheme has, in our opinion, contributed significantly to increase the validity and reliability of our qualitative interpretation.

Questionnaires were distributed personally to residents of the selected residential areas willing to participate in the investigations (cf. Figure 3.2). In each area, respondents were recruited by ringing doorbells, starting from a randomly chosen building within the demarcated area. Investigation assistants (master students and Ph. D. students from Zhejiang University) explained the purpose of the study and the content of the questionnaire, enquiring one of the household members (the person above 15 years next to have her/his birthday) to answer the questions. They also collected the completed questionnaires. This procedure went on until the number of collected questionnaires in each area was considered sufficiently high or no more willing participants could be found. As already mentioned, the number of respondents varies between the residential areas. In each of 20 locations, 85 or more respondents participated (with a maximum of 127), in 8 additional locations, the number of respondents was between 50 and 85, and in 12 locations between 10 and 50 respondents participated. There were, however, also a large number of locations with only a few or one single respondent (the latter applying to as much as 47 locations).

After having received the questionnaires, a quality inspection of the received material was conducted and invalid questionnaires were eliminated. As compensation, some additional respondents were recruited. The remaining 3154 questionnaires made up the data file used in the statistical analyses of the main survey.

Because questionnaires were only delivered to those residents of the chosen areas who were at home and accepted to participate in the investigation, it is not possible to calculate a response rate based on the numbers of distributed and collected questionnaires. However, based on information from the investigation assistants, the residents

participating in the main survey made up a high proportion of the total number of dwellings where doorbells were rung.

The questionnaires of both the main survey and the travel diary investigation were to a high extent based on the questionnaires of a similar study carried out by the project leader in Copenhagen Metropolitan Area a few years ago (Næss & Jensen, 2005; Næss, 2006a), but with several adaptations to the Chinese situation, in particular with respect to differences in motor vehicle ownership. The method of recording trip lengths and travel times for chained trips in the travel diary investigation were also improved compared to the Copenhagen Metropolitan Area study.¹¹ The questionnaires were originally formulated in English and subsequently translated into Chinese.

In addition to recording socioeconomic background variables and travel distances by different modes on each day during a week, the *main survey* included questions about frequency of participation in activities, attitudes to transport and environmental issues¹², perception of motor vehicle dependency, changes in the amount of transport among respondents who had moved during recent years, annual driving distance of the households' motor vehicles, and holiday trips.

The *travel diary investigation* intended to provide a more detailed picture, including location of destinations for the various trips, trip length and travel mode by travel purposes, changes in activities and car ownership due to moving, and flights and other trips outside the domestic region. Our travel diary investigation questionnaire included trip purposes, trip lengths and travel times of all trips during a four-day period¹³ (from Saturday morning to Tuesday evening). In addition, the driving distances of the household's motor vehicles (if any) in the weekend (Saturday-Sunday) and on Monday-Tuesday were recorded, based on odometer monitoring.

The respondents of travel diary investigation were recruited by means of a method similar to the way the respondents of the main survey were recruited, but from only a few of the residential areas of the main survey and with a very limited number of respondents from each area. The travel diary investigation thus included a total of only 28 respondents from areas nos. 7, 18, 24, 38¹⁴ and 39, cf. Figure 3.2. The travel diary investigation was carried out without the assistance from the municipal authorities. In the first survey, the encouragement by authority representatives no doubt was an important motivational factor for residents to answer the questionnaire.

In addition to the low number of travel diary participants, the respondents also left a higher proportion of the questions unanswered. For most of the questions, the material was too limited to enable statistical analyses. In particular, this applies to the questions about changes in activity pattern and car ownership after having moved from one residence to another, as very few respondents had moved during the relevant period. Since each travel diary respondent had carried out a number of trips during the relevant period, it was possible to compare trip lengths among respondents living in different areas, but only when combining several trip purposes into broader categories. The travel diary questions about travel times and destinations of trips with different purposes were answered by only a few respondents and could not be used in the analyses.

The concentration of respondents was necessary as a result of the chosen method of distributing and questionnaires, and also to make it practically possible to measure distances¹⁵ from the residences of the respondents to the city center of Hangzhou and lower-order centers. But this method of selecting respondents also makes it problematic to carry out statistical generalizations from our sample of respondents to the populations of the Hangzhou Metropolitan Area. Therefore, the statistical levels of significance are only indicators of the certainty of the various relationships found *within* the sample¹⁶. A generalization from our samples to the inhabitants of the metropolitan area must instead rely on *qualitative* arguments to a large extent (Sayer 1992:103): To what extent do our residential areas, seen as a whole, deviate from the residential areas of the Hangzhou Metropolitan Area in general with respect to characteristics relevant to our research questions? To what extent do relevant characteristics of the individual respondents, also seen as a whole, differ from the total population of the Hangzhou Metropolitan Area? Does it appear likely and reasonable to assume that differences between the sample and the population of Hangzhou Metropolitan Area have exerted decisive influence on the relationships found between residential location and travel behavior?¹⁷ (For a more thorough discussion, see Næss & Jensen, 2002 or Næss, 2004.)

Table 3.4 shows some key characteristics of the respondents of the main survey. As we can see, female respondents are somewhat overrepresented, whereas the proportion of students/pupils appears to be quite low. Apart from this, the respondents are probably fairly representative of their residential areas. The data collecting method ensuring a high response rate from each area has of course contributed to this. The extent to the whole sample of respondents is also representative of Hangzhou Metropolitan Area depends on the

representativeness of the selected residential areas. Given the fact that they include both high-income and low-income areas, different housing types and a broad specter of different locations within the metropolitan area, we consider the respondents to be fairly representative of the metropolitan population in general. The values of the respondents on indicators such as median household income and percentage of workforce participants also support this conclusion.

In order to identify the *separate* effects of the various, potential factors of influence, multivariate regression analyses were applied on the quantitative data. This multivariate control also makes it possible to neutralize any known biases between the sample and the population of the metropolitan area. If, for example, income is included among the independent variables in the multivariate analysis, the controlled relationship between residential location and travel will not be biased by any distortion in the income levels of the sample.

Table 3.4 *Demographic and socioeconomic characteristics of the participants of the main survey*

	Respondents of main survey (N = 3155)
Proportion of men and women	58.5 % women, 41.5% men
Average number of persons per household	2.79
Average number of children aged 0 - 6 years per household	0.134
Average number of children aged 7 - 17 years per household	0.341
Average age among respondents/interviewees	42 years
Proportion of workforce participants among respondents/interviewees	75.4%
Proportion of students/pupils among respondents/interviewees	2.7%
Median household income (1000 yuan)	30 - 40
Proportion with university education of 4 years or more	11.2%
Proportion of households having at least one motor vehicle available for private transport	18.3%
Proportion of households having at least one e-bike available for private transport	5.0%
Proportion of households having at least one car available for private transport	6.1%

4 Typical mobility patterns in different parts of the metropolitan area

4.1 Introduction

In this chapter, we shall take a look at key travel behavioral differences between respondents living at different distances from the city center of Hangzhou. These introductory comparisons are not adjusted for socioeconomic and attitudinal differences between the areas, or for other urban structural conditions than the distance from the dwelling to downtown Hangzhou (this will be done in chapter 6 and the subsequent chapters). The simple comparisons presented in this chapter may still give a first indication of relationships between travel behavior and residential location. First, travel on weekdays will be presented, thereupon travel in the weekend and over the week as a whole. Subsequently, we will also take a look at how commuting distances vary between workforce participants living at different distances from downtown Hangzhou. The last part of the chapter addresses geographical differences in the perception of being dependent on private motorized transport in order to reach daily activities.

In the following sections, a number of graphs are presented where the respondents have been subdivided into four categories, depending on the distance belt from the city center of Hangzhou in which they live. As mentioned in chapter 3, the city center of Hangzhou has been defined as the crossing between Yan'an Road and Qingchun Road. The four distance belts have been defined in such a way that each belt includes approximately one fourth (a quartile) of the total number of respondents. The quartile of the respondents living closest to downtown Hangzhou live less than 3.4 km from the city center, the

second most central quartile of respondents live between 3.4 and 6.2 km from the city center, the third quartile between 6.2 and 13.6 km from downtown, and the quartile of respondents living furthest away from downtown Hangzhou live more than 13.6 km away from the city center.

4.2 Travel on weekdays

Studies in several European cities and metropolitan areas have shown that residents of outer suburb travel longer total distances and carry out a higher proportion of their transport by motorized modes of travel than their inner-city counterparts (cf. e.g., Næss, 2006a and b; Næss & Jensen, 2004). This overall pattern is also evident in Hangzhou Metropolitan Area. Due to a generally lower level of mobility in China, the average daily traveling distances are considerably lower in all parts of the metropolitan area than in European cities, and the absolute difference between suburb and central city in terms of total traveling distances as well as traveling distances by different modes (measured in kilometers) are therefore much smaller in Hangzhou Metropolitan Area than in European urban regions. The relative differences between outer and inner parts of the metropolitan area are still very similar to what has been found in a North European context.

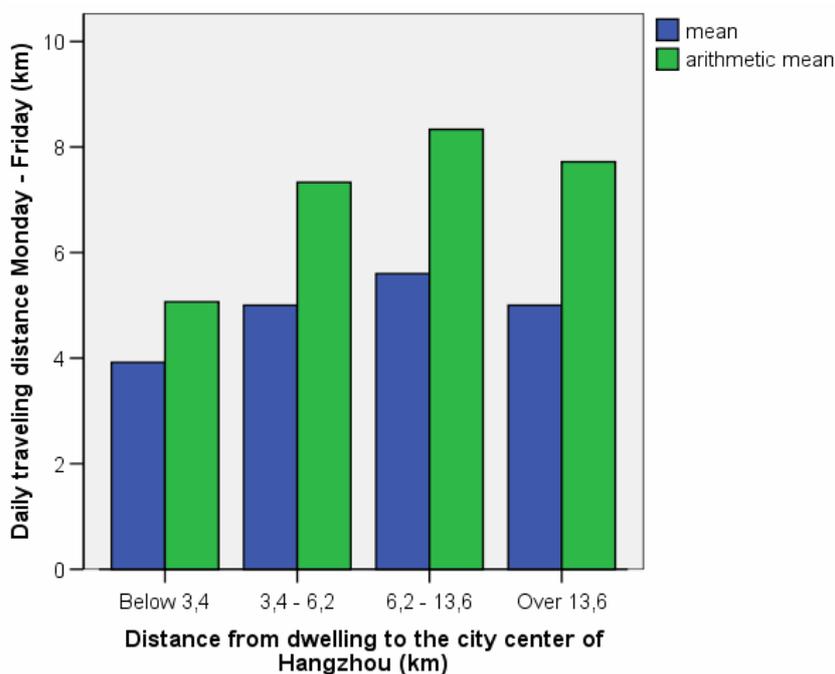
In the analyses below of travel on weekdays, respondents with extremely long daily traveling distances as well as respondents who have not at all traveled during the five weekdays have been excluded¹⁸. By extreme traveling distances we mean traveling distances more than three interquartile ranges above the upper quartile (cf. Norusis, 1992). These exclusions imply a reduction of the sample from 3154 to 2900 persons¹⁹. In addition, some people have failed to provide information about traveling distances and/or to answer other questions of the questionnaires. The number of respondents on which the figures and tables are based is therefore usually lower than 2900.

Among the respondents included in the analysis who have provided the necessary information, the average distance traveled per day during the period Monday-Friday is 7.3 km. Out of these 7.3 km, 2.7 km are by bike or by foot, 1.4 km by electric bike, 1.8 km by bus, 1.3 km by private car or taxi, and less than 0.1 km each by train and by other modes.

Figures 4.1 to 4.5 shows how the average total daily traveling distance on weekdays and the distances traveled by non-motorized modes, electric bike, bus and car/taxi varies according to the distance belt

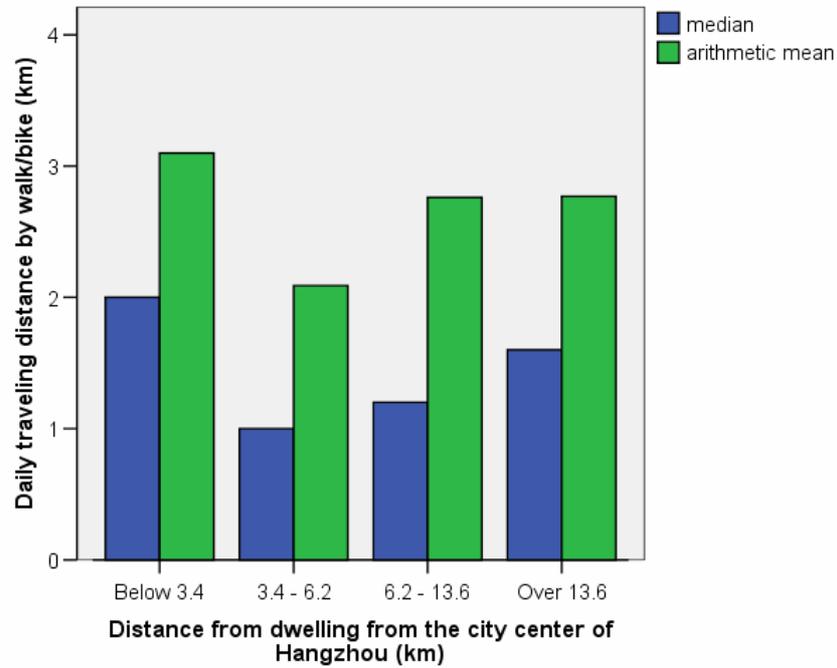
from the city center of Hangzhou wherein the respondents live. In the figures showing total daily traveling distances and traveling distances by non-motorized modes, both arithmetic means and median values are shown²⁰. For the remaining travel modes, the figures only include arithmetic means, as less than half the respondents within each distance belt has traveled by car/taxi, bus and train, respectively, and the median values of all these modes are therefore zero in each distance belt.

Figure 4.1 *Mean and median daily traveling distances on weekdays (Monday-Friday) among respondents living within different distance belts from the city center.*



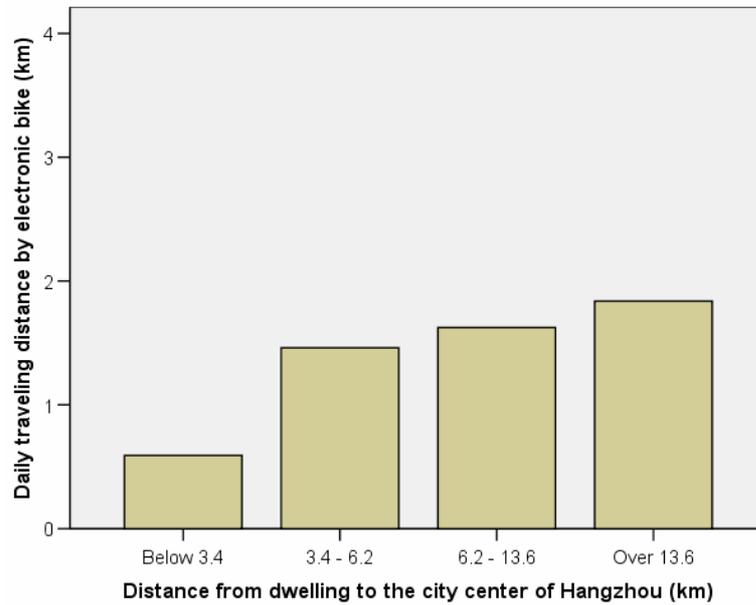
N = 2798, with 781, 697, 678 and 642 respondents, respectively, in the innermost, second inner, second outer and outermost distance belt. 247 respondents with zero or extreme traveling distances (above 34.5 km daily) have been excluded from the analysis.

Figure 4.2 *Mean and median daily traveling distances by foot or by bike on weekdays (Monday-Friday) among respondents living within different distance belts from the city center of Hangzhou.*



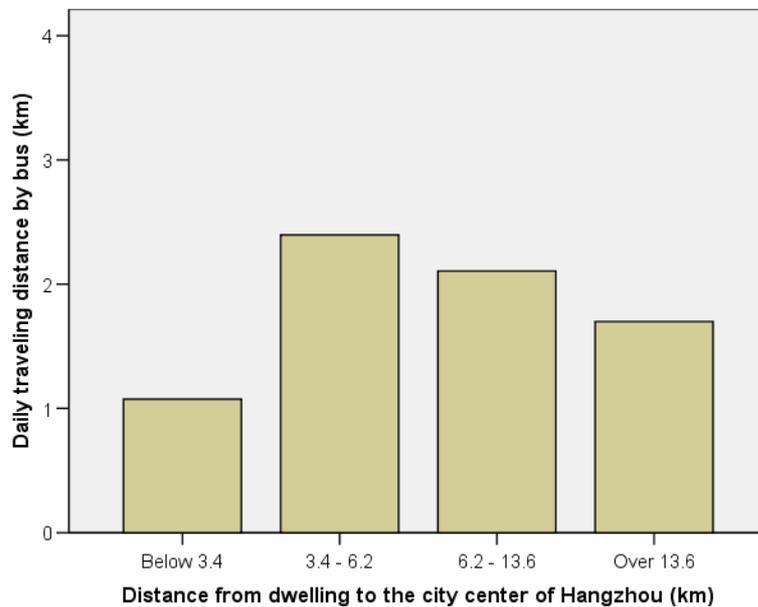
N = 2798, with 781, 697, 678, and 642 respondents, respectively, in the innermost, second inner, second outer, and outermost distance belt. 247 respondents with zero or extreme traveling distances (above 34.5 km daily) have been excluded from the analysis.

Figure 4.3 *Mean daily traveling distances by electronic bike on weekdays (Monday-Friday) among respondents living within different distance belts from the city center of Hangzhou.*



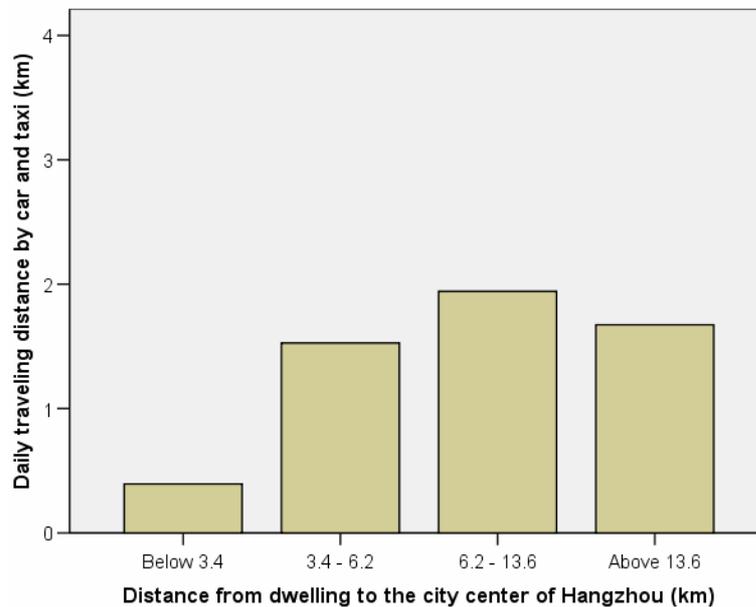
N = 2798, with 781, 697, 678, and 642 respondents, respectively, in the innermost, second inner, second outer, and outermost distance belt. 247 respondents with zero or extreme traveling distances (above 34.5 km daily) have been excluded from the analysis.

Figure 4.4 *Mean daily traveling distances by bus on weekdays (Monday-Friday) among respondents living within different distance belts from the city center of Hangzhou.*



N = 2798, with 781, 697, 678, and 642 respondents, respectively, in the innermost, second inner, second outer, and outermost distance belt. 247 respondents with zero or extreme traveling distances (above 34.5 km daily) have been excluded from the analysis.

Figure 4.5 *Mean daily traveling distances by car or taxi on weekdays (Monday-Friday) among respondents living within different distance belts from the city center of Hangzhou.*



N = 2798, with 781, 697, 678, and 642 respondents, respectively, in the innermost, second inner, second outer, and outermost distance belt. 247 respondents with zero or extreme traveling distances (above 34.5 km daily) have been excluded from the analysis.

We see a clear tendency to shorter traveling distances among respondents who live close to the city center of Hangzhou. In particular, this applies to travel by car or taxi, where respondents living less than 3.4 km from the city center of Hangzhou travel on average less than a quarter of the average distance traveled by car/taxi among the remaining respondents. Respondents living close to the city center of Hangzhou travel shorter distances than those living more peripherally also the other motorized modes (bus and e-bike). In contrast to that, the average traveling distance by non-motorized modes is about 20% longer among the respondents of the innermost distance belt than among the remaining respondents. As a result, non-motorized modes account for 74% of the distance traveled on weekdays among the respondents living less than 3.4 km away from the city center of Hangzhou, compared to 47% among the remaining respondents.

The total traveling distances on weekdays is about 35–40% shorter among those living in the innermost distance belt than among the remaining respondents. This is in line with expectations. However, the variation between the distance belts outside the most central one is less clear. Traveling distances are on average longer in the second-inner distance belt (3.4 to 6.2 km from the city center of Hangzhou) than one might expect from theoretical considerations and from comparison with studies in European cities. The longest traveling distances are found among respondents living between 6.2 and 13.6 km from the city center of Hangzhou. In the outermost distance belt, traveling distances are on average slightly shorter than in the second outer distance belt. This may indicate a decreasing use of facilities in the city center of Hangzhou among those who live beyond a certain distance, i.e. what has been termed ‘distance decay’ in the power of attraction of a center or a facility when people have to travel a long distance to reach it. In addition, the two second-order center towns of Xiaoshan and Yuhang are both located in the outermost distance belt. For respondents living close to these centers, a number of facilities will be available within a moderate distance from home.

However, a closer look at the data shows that the longest traveling distances among respondents of the outermost distance belt are found among those who live close to one of the two second-order centers. Probably, the good transport connection from these centers to the concentration of facilities found in the city of Hangzhou reduces the friction of distance and thus makes it more relevant for these residents than other residents of the outermost distance belt to choose jobs and other facilities in Hangzhou. One might imagine that the direct rail connections from Xiaoshan and Yuhang to Hangzhou would make it convenient for respondents living in these towns to use the train for commuting trips to Hangzhou as well as other trips with destinations in the central city. However, the data on the proportions traveled by different modes clearly indicates that no such tendency is present. Train plays a negligible role in daily travel among all respondents, including those living close to one of the two second-order centers. Neither do the residents living close to one of the two second-order centers travel much by bus – their average traveling distance by bus is considerably shorter than among those respondents who live in the second and third distance belts. Instead, those living close to one of the second-order centers have a particularly long average traveling distance by car. This suggests that the long weekday daily traveling among residents living close to the centers of Xiaoshan and Yuhang may rather be reflecting a high income level and possibly also the easy motorway access from these towns to Hangzhou.

4.3 Travel in the weekend

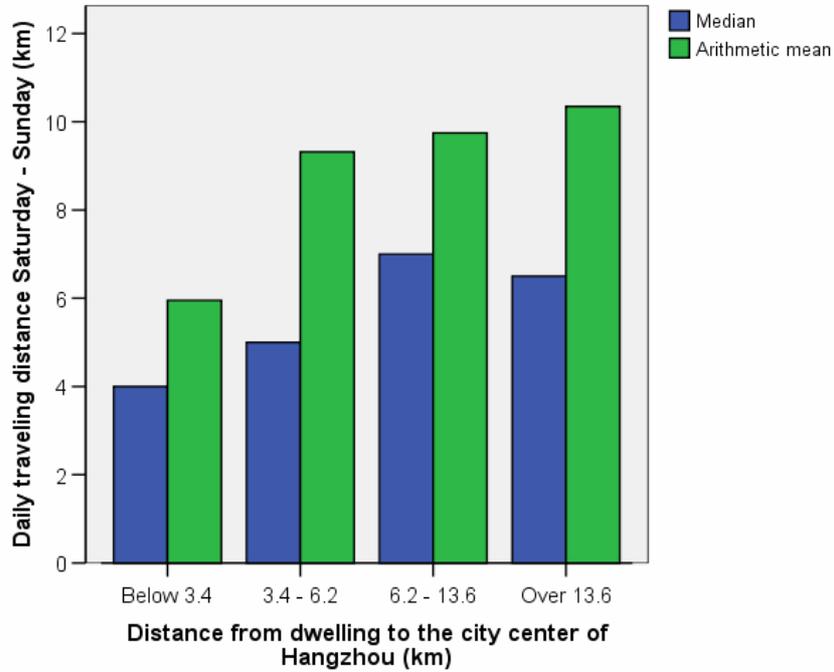
Similar to our analyses of travel on weekdays, we have carried out a number of analyses of how travel during the weekend (Saturday and Sunday) varies with the location of the residence. In the latter analyses too, respondents with extremely long traveling distances as well as respondents who have not at all traveled during the weekend have been excluded. By extreme traveling distances we mean traveling distances more than three interquartile ranges above the upper quartile (cf. Norusis, 1992). These exclusions imply a reduction of the sample from 3154 to 2925 persons²¹. In addition, some people have failed to provide information about traveling distances and/or to answer other questions of the questionnaires. The number of respondents on which the figures and tables are based is therefore usually lower than 2925.

Among the respondents included in the analysis who have provided the necessary information, the average distance traveled per day during the period Saturday - Sunday is 8.3 km. Out of these 8.3 km, 2.6 km are by bike or by foot, 1.5 km by electric bike, 2.5 km by bus, 1.7 km by private car or taxi, and less than 0.1 km each by train and by other modes.

Figures 4.6 to 4.10 show how the average total daily traveling distance on weekdays and the distances traveled by non-motorized modes, electric bike, bus and car/taxi varies according to the distance belt from the city center of Hangzhou wherein the respondents live.

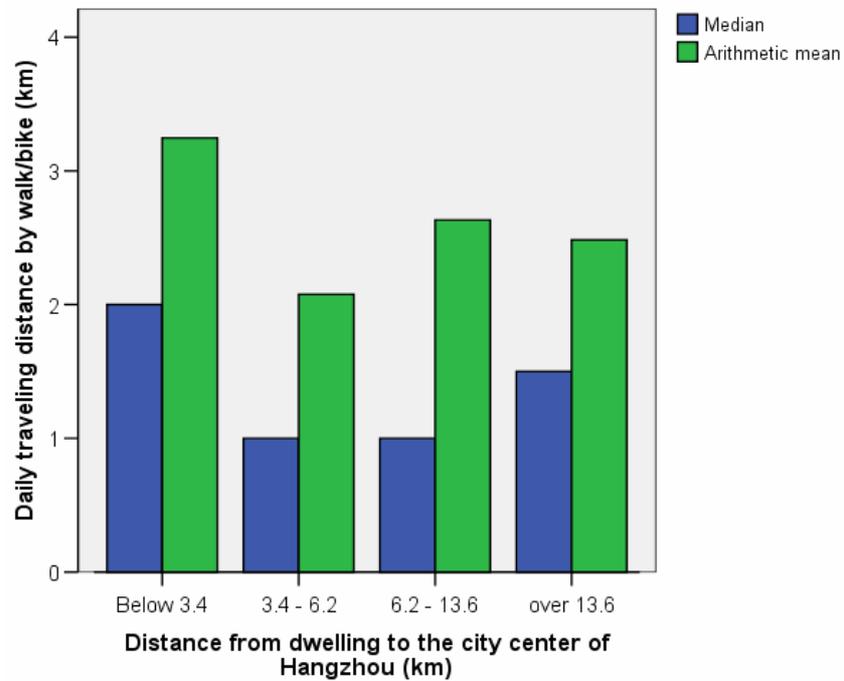
In the figures showing total daily traveling distances and traveling distances by non-motorized modes, both arithmetic means and median values are shown²². For the remaining travel modes, the figures only include arithmetic means, as less than half the respondents within each distance belt has traveled by car/taxi, bus and train, respectively, and the median values of all these modes are therefore zero in each distance belt.

Figure 4.6 *Mean and median daily traveling distances during the weekend (Saturday and Sunday) among respondents living within different distance belts from the city center of Hangzhou.*



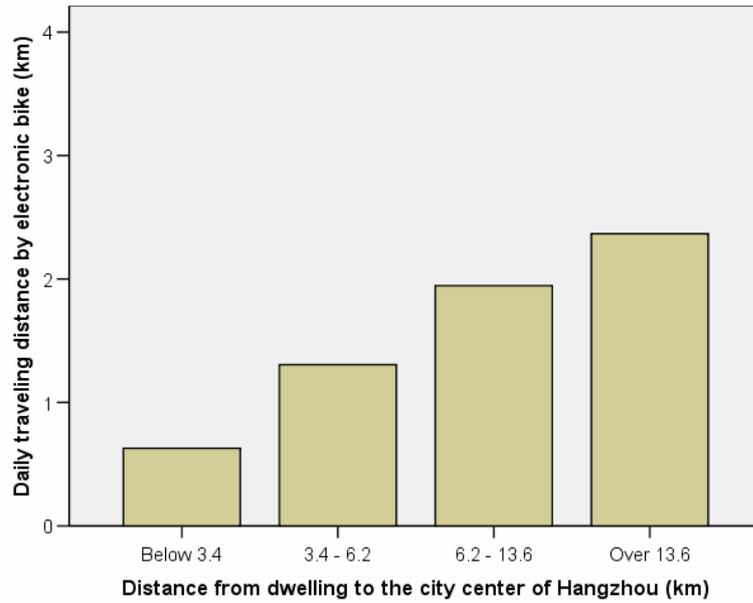
N = 2832, with 789, 701, 687 and 655 respondents, respectively, in the innermost, second inner, second outer and outermost distance belt. 228 respondents with zero or extreme traveling distances (above 40.3 km daily) have been excluded from the analysis.

Figure 4.7 *Mean and median daily traveling distances by foot or by bike during the weekend (Saturday and Sunday) among respondents living within different distance belts from the city center of Hangzhou.*



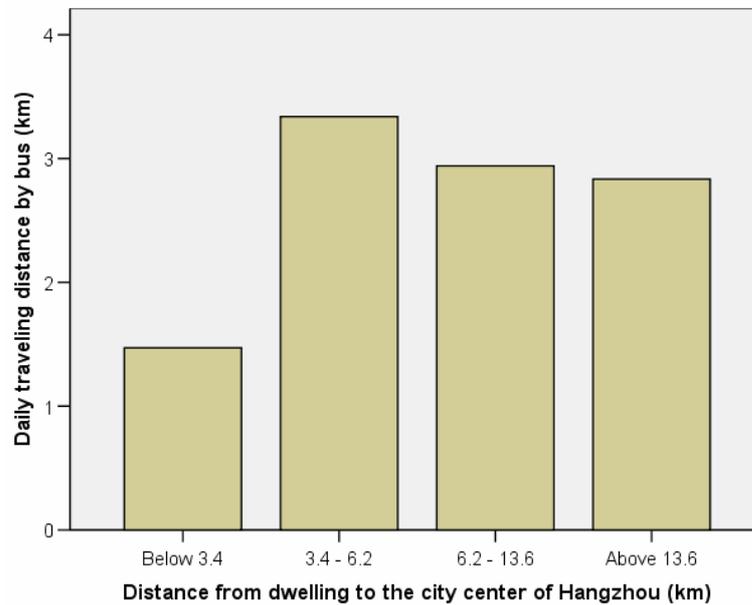
N = 2832, with 789, 701, 687 and 655 respondents, respectively, in the innermost, second inner, second outer, and outermost distance belt. 228 respondents with zero or extreme traveling distances (above 40.3 km daily) have been excluded from the analysis.

Figure 4.8 *Mean daily traveling distances by electronic bike during the weekend (Saturday and Sunday) among respondents living within different distance belts from the city center of Hangzhou.*



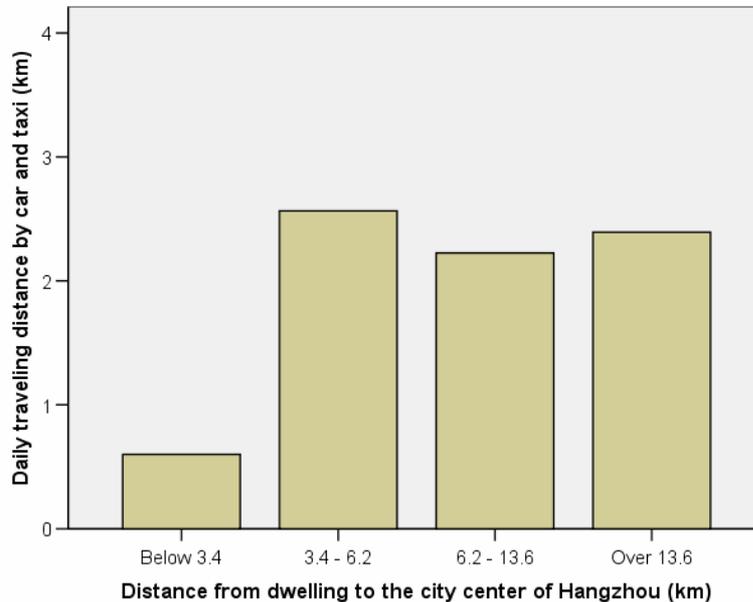
N = 2832, with 789, 701, 687 and 655 respondents, respectively, in the innermost, second inner, second outer, and outermost distance belt. 228 respondents with zero or extreme traveling distances (above 40.3 km daily) have been excluded from the analysis.

Figure 4.9 *Mean daily traveling distances by bus during the weekend (Saturday and Sunday) among respondents living within different distance belts from the city center of Hangzhou.*



N = 2832, with 789, 701, 687 and 655 respondents, respectively, in the innermost, second inner, second outer, and outermost distance belt. 228 respondents with zero or extreme traveling distances (above 40.3 km daily) have been excluded from the analysis.

Figure 4.10 *Mean daily traveling distances by car or taxi during the weekend (Saturday and Sunday) among respondents living within different distance belts from the city center of Hangzhou.*



N = 2832, with 789, 701, 687 and 655 respondents, respectively, in the innermost, second inner, second outer, and outermost distance belt. 228 respondents with zero or extreme traveling distances (above 40.3 km daily) have been excluded from the analysis.

In the weekend too, we see a clear tendency to shorter traveling distances among respondents who live close to the city center of Hangzhou. In particular, this applies to travel by car or taxi, where respondents living less than 3.4 km from the city center of Hangzhou travel on average a quarter of the average distance traveled by car/taxi among the remaining respondents. Respondents living close to the city center of Hangzhou travel shorter distances than those living more peripherally also by the other motorized modes (bus and e-bike). In contrast to that, the average traveling distance by non-motorized modes is nearly 50% longer among the respondents of the innermost distance belt than among the remaining respondents. Similar to weekdays, the proportion of non-motorized travel is considerably higher among respondents living close to the city center of Hangzhou. In the weekend, non-motorized modes account for 69% of the distance traveled among the respondents living less than 3.4 km away from the

city center of Hangzhou, compared to 42% among the remaining respondents.

The total traveling distances in the weekend are about 40% shorter among those living in the innermost distance belt than among the remaining respondents. This is in line with expectations. Traveling distances tend to increase somewhat also when moving further outward from the second to the fourth distance belt, but the differences here are much smaller than between the innermost and the second inner distance belts.

The above-mentioned results indicate that the differences between the distance belts in traveling patterns are very similar in the weekend and on weekdays. Indeed, the difference between the innermost and the remaining three distance belts is larger in terms of total traveling distance and traveling distance by non-motorized modes in the weekend than on weekdays. This is very different from what has been found in European cities, where the influence of residential location on travel is typically much stronger on weekdays than in the weekend. Possibly, the Chinese working life is to a lesser extent than in Europe divided into distinct parts of the week that are workdays and a weekend in which most people do not do paid work. If wage labor takes place to a high extent in the weekend too, and not only on weekdays, weekend travel will to a higher extent than in Europe consist of “bounded” trips. However, the destinations of leisure trips also appear to be located in the central parts of the metropolitan area to an even higher extent than what is the case e.g. in Copenhagen Metropolitan Area. One of the reasons for this is probably the fact that one of the most attractive areas for outdoor recreation, the West Lake and its parkland and forest surroundings, is bordering to the downtown area of Hangzhou. This, in combination with the generally much shorter commuting distances among Hangzhou Metropolitan Area residents than in European urban areas (reflecting the lower availability of private cars among the former), may explain why the relationships between residential location and travel seem to be equally strong in the weekend than on weekdays among Hangzhou Metropolitan Area respondents.

4.4 Travel during the week as a whole

Supplementing our analyses of travel on weekdays and in the weekend, we have carried out a few analyses of how travel during the week as a whole varies with the location of the residence. Since a

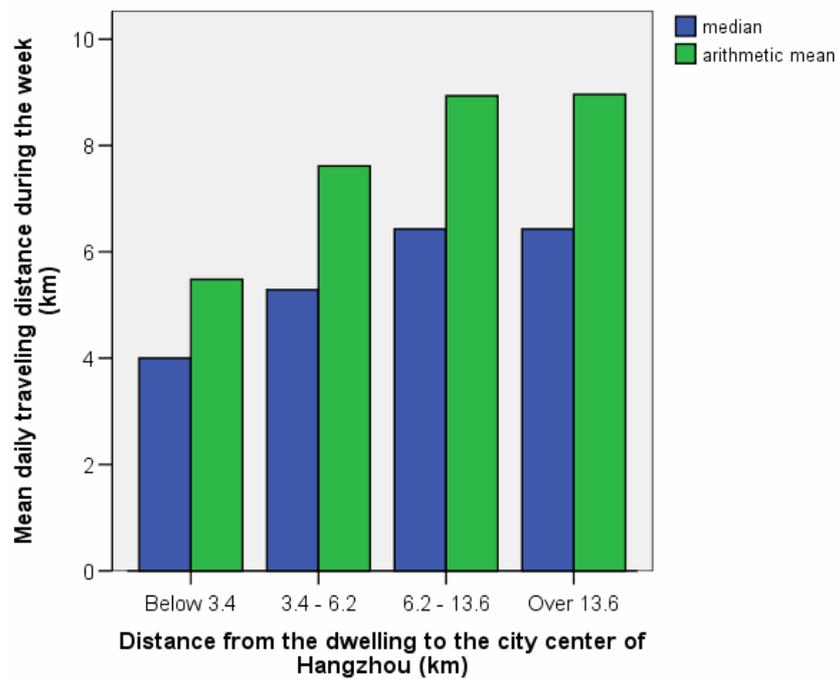
number of aspects have already been dealt with in the analyses of weekday and weekend travel, respectively, only a limited number of transport variables will be addressed in this section: The total weekly traveling distance, travel by car and taxi, and the proportion of non-motorized travel. These dimensions of travel activity are in particular interesting in relation to ongoing debates on environmentally sustainable urban developmental patterns.

Similar to the previous analyses, respondents with extremely long traveling distances as well as respondents who have not at all traveled during the week have been excluded. By extreme traveling distances we mean traveling distances more than three interquartile ranges above the upper quartile (cf. Norusis, 1992). These exclusions imply a reduction of the sample from 3154 to 2929 persons. In addition, some people have failed to provide information about traveling distances and/or to answer other questions of the questionnaires. The number of respondents on which the figures and tables are based is therefore usually lower than 2929.

Figure 4.11 shows how the average total daily traveling distance during the week varies according to the distance belt from the city center of Hangzhou wherein the respondents live. Both median values and arithmetic means are shown.

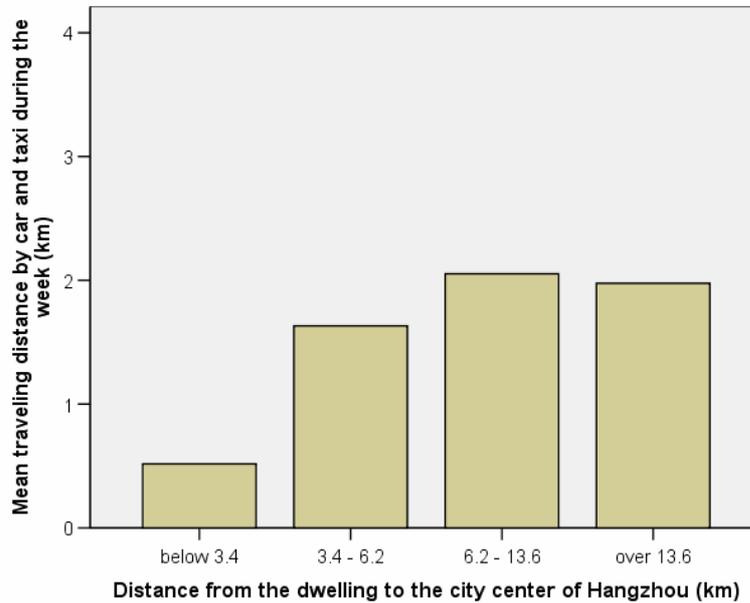
In accordance with the patterns on weekdays and in the weekend, we find a clear tendency to longer traveling distances the further away from the city center of Hangzhou the respondents live. This also applies to the distances traveled by car and taxi (Figure 4.12). In this figure, median values are not shown, as less than half of the respondents in each distance belt have been using any of these modes during the week. The median values of the traveling distance by car and taxi are therefore zero in all distance belts.

Figure 4.11 *Mean and median daily traveling distances during the whole week among respondents living within different distance belts from the city center.*



N = 2829, with 791, 700, 683 and 655 respondents, respectively, in the innermost, second inner, second outer and outermost distance belt. 225 respondents with zero or extreme traveling distances (above 37.2 km daily) have been excluded from the analysis.

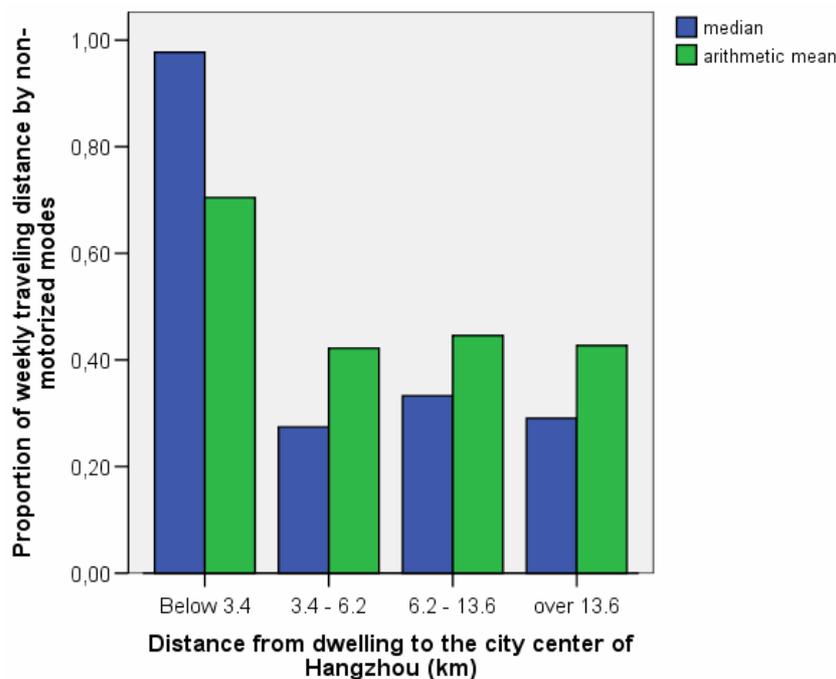
Figure 4.12 *Mean daily traveling distances by car or taxi on weekdays (Monday-Friday) among respondents living within different distance belts from the city center of Hangzhou.*



N = 2829, with 791, 700, 683 and 655 respondents, respectively, in the innermost, second inner, second outer and outermost distance belt. 225 respondents with zero or extreme traveling distances (above 37.2 km daily) have been excluded from the analysis.

Figure 4.13 shows how the proportion of non-motorized travel varies between the distance belts. Here, too, both median values arithmetic means are shown. We see that the proportion of walk/bike travel is in particular high in the innermost distance belt. The difference between the inner and the three remaining distance belts is larger when comparing median values than when comparing arithmetic means. This indicates that there are some respondents in all distance belts who carry out a high proportion of their travel by non-motorized modes. However, the median values show that it is much more typical among the residents of the inner distance belt than among the remaining respondents to carry out a very high proportion of the weekly travel by non-motorized modes.

Figure 4.13 *Mean and median proportions of weekly traveling distances by non-motorized modes among respondents living within different distance belts from the city center of Hangzhou.*



N = 2829, with 791, 700, 683 and 655 respondents, respectively, in the innermost, second inner, second outer and outermost distance belt. 225 respondents with zero or extreme traveling distances (above 37.2 km daily) have been excluded from the analysis.

4.5 Commuting distances

In spite of a rapid increase in leisure travel, journeys to work still make up a major proportion of travel in urban areas on weekdays. Among workforce participants in the United States, work tours accounted for 45% of the travel time on weekdays and 42% of weekday traveling distance in 2001. In Europe, higher proportions of daily traveling distances are often reported, for instance, among workforce participants in Copenhagen Metropolitan Area, commuting accounts for about two thirds of the distance traveled within the region on weekdays, and nearly half the weekly traveling distance.

Previous studies have shown that a high proportion of the differences in average overall traveling distances between inhabitants living in different parts of a metropolitan area is due to longer commuting distances among workforce participants living in peripheral than central parts of the region (e.g. Næss & Jensen, 2004; Næss, 2006a). These studies have, however, been carried out in cities where the mobility resources of the inhabitants (notably in terms of car ownership) are high, enabling them to choose among workplaces far beyond their local districts. In cities like Hangzhou, where motor vehicle ownership is still comparatively low, people may still orient themselves to a higher degree towards the local rather than the metropolitan labor market. We therefore considered it highly interesting to investigate whether or not the commuting distances of Hangzhou Metropolitan Area residents vary with their residential location in a similar way as in Scandinavian cities.

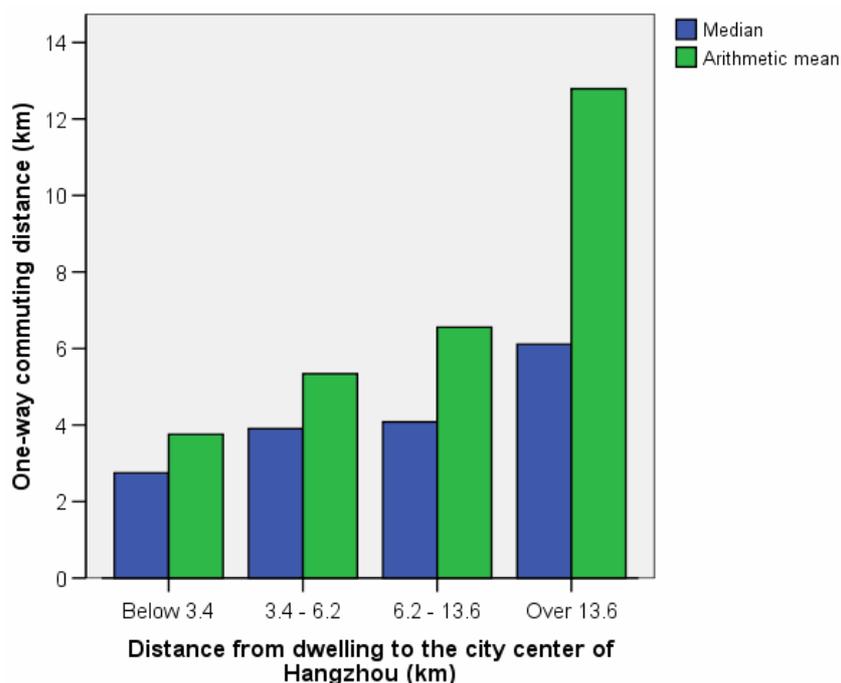
Below, we shall take a look at how commuting distances vary between workforce participants living within different distance belts from the city center of Hangzhou. The commuting distances referred to include the journeys to work among workforce participants as well as the distances from home to place of education among those respondents who are students. The distances have been measured along the road network²³, based on information given by the respondents about the addresses of their workplaces and/or places of education. Because nearly two thirds of the employed respondents failed to provide sufficient information about their workplace addresses to make it possible to identify the locations, data on commuting distances are available for only 878 of the 2321 employed respondents.

In the following analyses, only respondents with one-way commuting distances less than 50 km have been included, as commutes exceeding this length imply that the workplace must be located outside Hangzhou Metropolitan Area. This implies that 8 respondents with commuting distances along the road network ranging from 61 to 325 km have been excluded from the analyses.

Among our respondents, the typical commuting distance is 3.7 km. This figure refers to the median value, i.e. the commuting distance of the respondent in the middle of the row when all the respondents are ranked from the longest to the shortest commuting distance. Because a number of respondents – even with the exclusion of respondents with commuting distances above 50 km – travel several times longer than the typical traveling distance, the arithmetic mean is higher (6.3 km) than the median value. Compared to a European context, commuting distances in Hangzhou Metropolitan Area are significantly shorter.

For example, in a similar study of Copenhagen Metropolitan Area, the mean commuting distance was found to be 12.5 km and the median commuting distance 9.1 km.²⁴

Figure 4.14 *Median and mean one-way commuting distances to workplace or place of education among respondents living within different distance belts from the city center of Hangzhou.*



N = 843, with 279, 207, 225 and 132 respondents, respectively, in the innermost, second inner, second outer and outermost distance belt.

Figure 4.14 shows how the average commuting distance varies according to the distance belt from the city center of Hangzhou wherein the respondents live.

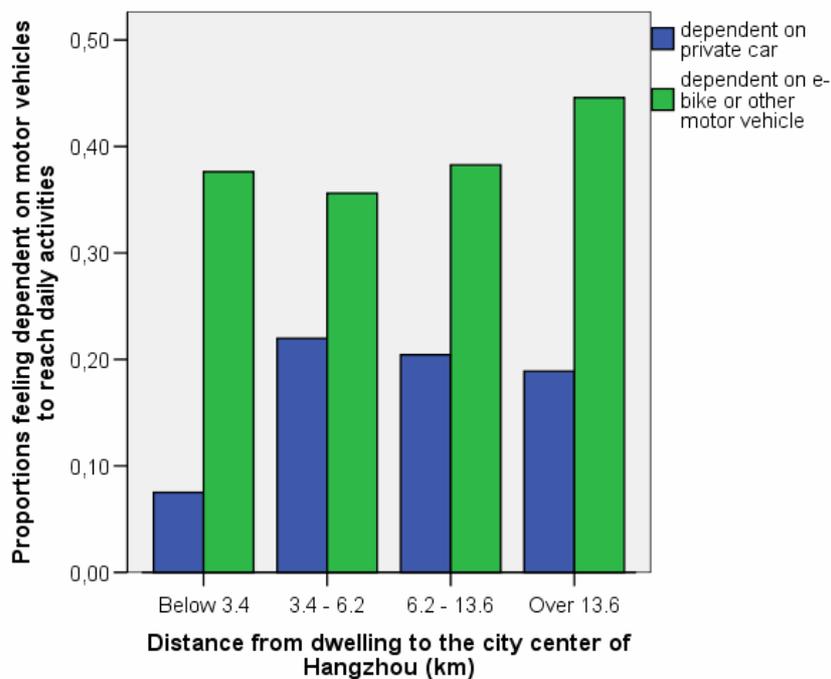
Commuting distances are on average considerably longer among respondents living in the outer than in the inner parts of the metropolitan area. The typical (median) commuting is more than twice as long (6.1 km) in the outer distance belt as in the distance belt closest to the city center of Hangzhou (2.7 km). Looking at the arithmetic means, the differences are even more pronounced, with average distances between home and workplace/place of education three and a half times as long (12.8 km) in the outermost as in the

innermost (3.8 km) distance belt. These differences suggest that commuting trips account for a considerable proportion of the differences in overall traveling distances on weekdays found between respondents living in central and peripheral parts of the metropolitan area.

4.6 Perception of being dependent on private motorized transport in order to reach daily activities

The questionnaire survey included questions about the extent to which the respondents considered dependent on different types of motorized private transport in order to reach daily activities. Figure 4.15 shows the proportion of respondents living within different distance belts from the city center of Hangzhou who consider themselves dependent on car transport and e-bike or other motor vehicle transport, respectively, to some or a high extent. Compared to the answers to similar questions in Copenhagen Metropolitan Area, the overall proportion who consider themselves dependent on car transport in daily life is moderate, with a total average of 17%. There are also small differences in perceived car dependency between the respondents living in the three outer distance belts, with proportions ranging from 19 to 22%. However, the inner distance belt stands out with a considerably lower percentage of perceived car dependency (7.5%).

Figure 4.15 *Proportions of respondents living within different distance belts from the city center of Hangzhou who consider themselves dependent on private motor vehicle transport.*



The columns show the proportions who consider themselves dependent on car transport and e-bike or other motor vehicle transport, respectively, to some or a high extent.

This difference between the inner and the remaining distance belts is in line with the findings in Copenhagen Metropolitan Area, and reflects the availability of a high number and a wide range of workplaces and service facilities within short distance from the dwellings in the inner distance belt, making motorized travel unnecessary for a large proportion of the residents. In addition, the accessibility to different parts of the suburban and outer parts of the metropolitan area is generally good from the inner city of Hangzhou.

The perception of being dependent on other types of private motor vehicles than cars is generally higher within all distance belts, and there is also less difference between center and periphery. This group of private vehicles includes electronic bikes, motorbikes and any vans or trucks at the respondents' disposal. Probably, several respondents

have also included taxi travel in this category (among others, the fairly high proportion of inner-city respondents stating some dependence on private vehicle transport may indicate this). As evident in Figure 4.15, there is a somewhat higher perception of being dependent on other types of private motor vehicles than cars in the outermost distance belt. This probably reflects the poor public transport services in many of the residential areas located within this distance belt. However, the outermost distance belt also includes the second-order and third-order towns, where fairly good public transport opportunities are available. This may explain the relatively small difference between the outermost and the other distance belts in the proportions who consider themselves dependent on electronic bikes or other motorized means of transport apart from cars.

4.7 Concluding remarks

The graphs and maps above have provided some preliminary indications about relationships between the location of residences within the metropolitan urban structure and the travel behavior of the residents. Most of the respondents living in the outer and peripheral areas have a higher amount of travel and use cars to a higher extent than their counterparts living in the inner and central districts. Conversely, especially the respondents from the inner of the four distance belts are distinguished by a low total amount of transport, short commuting distances, a high share of non-motorized travel, and a low propensity of feeling dependent on car travel to reach daily activities.

Apparently, the higher amount of transport and the longer commutes and other trip lengths among outer-area residents have something to do with the geographical concentration of workplaces and other facilities in the central and inner parts of the Copenhagen Metropolitan Area. It should, however, be noted that the results presented in this chapter have not taken into account socioeconomic, demographic or attitudinal differences between the respondents. They also provide only a first hint at possible causal relationships between residential location and travel. In order to uncover such causal links, we need to know more about the considerations people make around their daily-life travel, for example concerning activity participation, and the rationales on which their choices among possible destinations and modes of transport are made. These issues will be addressed in the next chapter.

5 How does urban structure motivate daily-life travel behavior? – examples from qualitative interviews

5.1 Introduction

In the previous chapter we saw that considerable differences in transport behavioral patterns exist between respondents living in different investigation areas. Those respondents who live in the outer parts of the metropolitan area tend to travel longer distances and carry out a higher proportion of their transport by car than what is common among their inner-city counterparts. On the other hand, the latter respondents travel more by bike or foot. Apparently, the shorter traveling distances among respondents living close to downtown Hangzhou are related to the fact that the proximity of their dwellings to the concentration of workplaces, service facilities and leisure opportunities existing in the central districts of the city.

However, showing this correlation between the amount of travel and residential location is not the same as demonstrating the existence of a causal relationship. In order to substantiate that a peripheral residential location is a (contributory) cause of a higher amount of travel and more extensive car driving than what is the case among inner-city dwellers, we must show the basic mechanisms by which residential location influences travel behavior. If not every mechanism, at any rate sufficiently many mechanisms to make plausible the influence of residential location on the amount of transportation and travel modes. Examples showing the rationales on which people base their frequency of participation in out-of-home activities, the location of these activities, the modes of travel used to reach these locations, and the routes followed make up important elements in this endeavor.

In order to explore the mechanisms through which residential location may influence travel behavior, we shall now turn to the material from the qualitative interviews. First, we shall look more in detail at the daily-life trips made by interviewees of central and peripheral parts of the Hangzhou metropolitan area. Thereupon, we shall focus on the interviewees' rationales for activity participation, location of activities, travel modes and route choice, and the ways these rationales contribute to the differences in travel behavior between inner- and outer-area residents shown in the previous section.

5.2 The interviewees and their residential areas

The location of the five investigation areas from which the interviewees were selected is shown on the map in Figure 3.2. The two most centrally located interviewee areas (Xixi Road and Cuiyuan, marked on the map as nos. 24 and 18, respectively) are situated at 2.4 km and 5.2 km airline distance from the city center of Hangzhou (defined as the crossing between Yan'an Road and Quingchun Road). In both these areas, the supply of stores, culture and entertainment facilities and public transport services in the proximity of the dwellings is high. There are also a very high number of workplaces within a short distance from the areas. From Xixi Road, there is also a short distance to Geling Hill and Baoshi Hill and the recreational areas along the northern shore of West Lake. In Cuiyuan, the availability of local green areas is much more limited. The two central areas differ from each other regarding housing types (Xixi Road consists of older apartment buildings 3 – 5 stories high, whereas Cuiyuan consists of blocks of 6 – 7 storey apartment buildings built in the 1980s).

The three peripheral interview areas (Banshan, Zhuangtan and Xiaoshan, situated at locations 7, 39 and approx. 0.8 km to the west²⁵ of area no. 38 in Figure 3.2) are all located far away from the large concentration of workplaces and service facilities in the central part of the metropolitan area. Airline distances from these interview areas to the city center of Hangzhou of 10.0, 13.6 and 16.1 km, respectively. However, there are considerable mutual differences between the three areas. Banshan consists of 5-storey apartment blocks owned by Hangzhou Steel Factory and rented to the factory's employees. Thus, among these interviewee households, at least one household member is an employee of the steel factory, which is located about 3.5 km away from the area, or is a pensioner who used to work at the factory. Apart from the proximity to the factory workers' workplaces, the

availability of facilities close to the residences of the Banshan interviewees is poor, limited to a small supermarket, a fruit market and a vegetable market. In contrast, the residents of Xiaoshan, the interview area located at the furthest distance from downtown Hangzhou, have a broad range of service facilities within a short distance from the dwelling. This residential area, consisting of 6-storey apartment blocks, is located very close to the downtown area of the second-order center town of Xiaoshan. Most of the Zhuangtang interviewees live partly in a new residential area consisting of large single-family houses and some low apartment buildings. Among these interviewees, the average income level is high. One interviewee lives in a lower-standard dwelling in the center of the little town of Zhuangtang. The provision of local facilities in Zhuangtang is quite modest, although it has improved during recent years. Compared to Banshan, Zhuangtang also has local teahouses and restaurants providing an opportunity for local residents to socialize playing Mah-jong or eating together. The interviewee areas in Banshan, Zhuangtang and Xiaoshan are all located close to forested hills, and smaller local parks also provide opportunities for outdoor recreation. In Zhuangtang the larger forested areas southwest of the West Lake) also provide an outdoor recreation opportunity within some 3 or 4 kilometers distance.

Figures 5.1 to 5.5 show aerial photographs and views from the five interview areas. Table 5.1 provides an overview of selected characteristics of the interviewee households. In order to enable an assessment of the extent to which the interviewees are representative of the participants of the main survey investigation, the above-mentioned characteristics of the interviewees have been compared with the average values among the survey respondents from the interview areas as well as the total number of survey respondents. This comparison is shown in Table 5.2. Unfortunately, parts of the information are missing for some of the interviewees.

Figure 5.1 *Aerial view showing the location of the Xixi Road interview area (to the left, scale 1/36.000) and view toward the investigation area of Xixi Road (to the right, in the middle ground).*



Figure 5.2 *Aerial view showing the location of the Cuiyuan interview area (to the left, scale 1/36.000) and pedestrian street inside one of the blocks of the investigation area of Cuiyuan (to the right).*

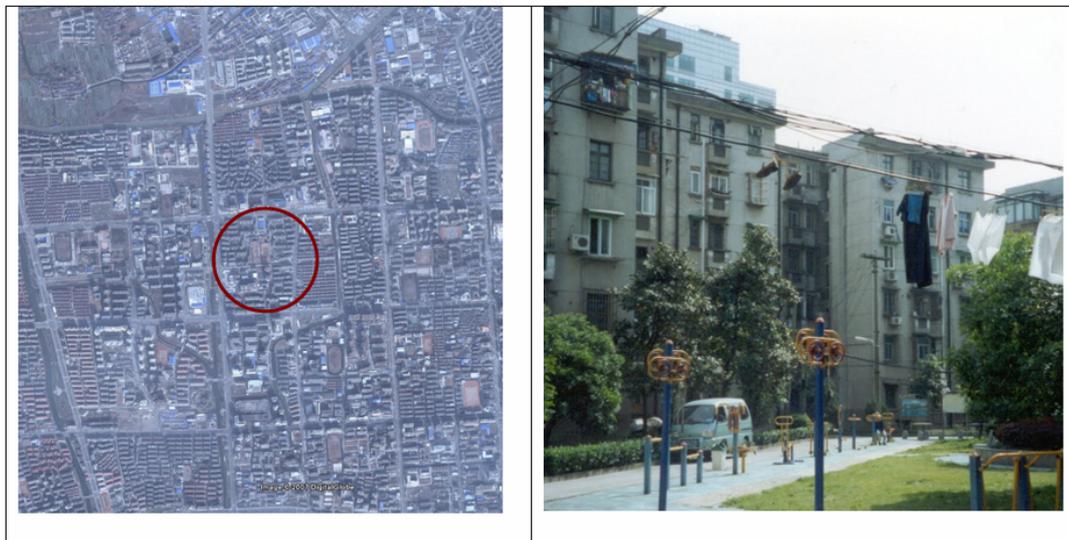


Figure 5.3 *Aerial view showing the location of the Banshan interview area (to the left, scale 1/36.000) and typical street in the investigation area of Banshan (to the right).*



Figure 5.4 *Aerial view of the Zhuangtang interview area (to the left, scale 1/36.000) and single-family house in the investigation area of Zhuangtang (to the right).*

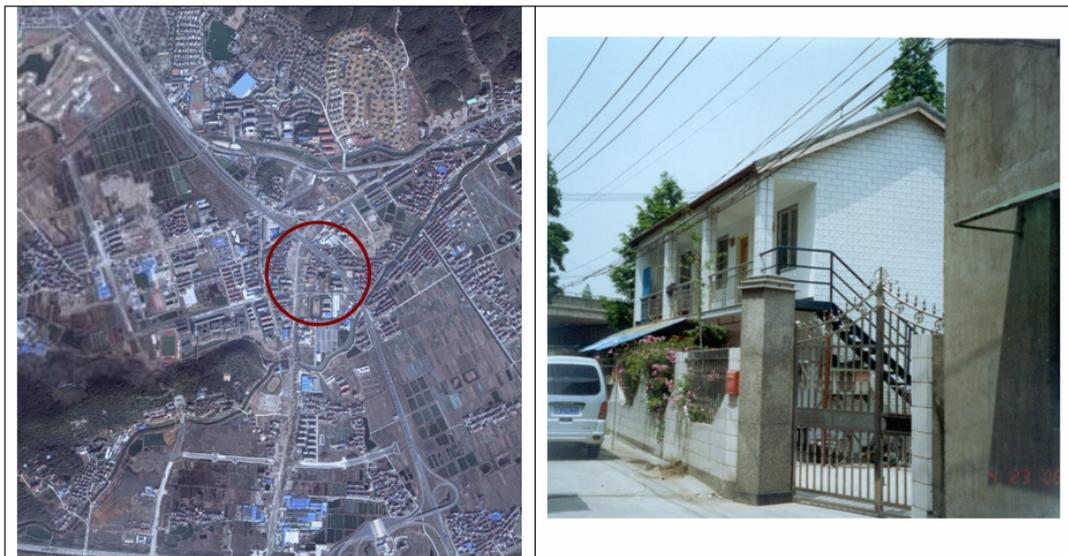
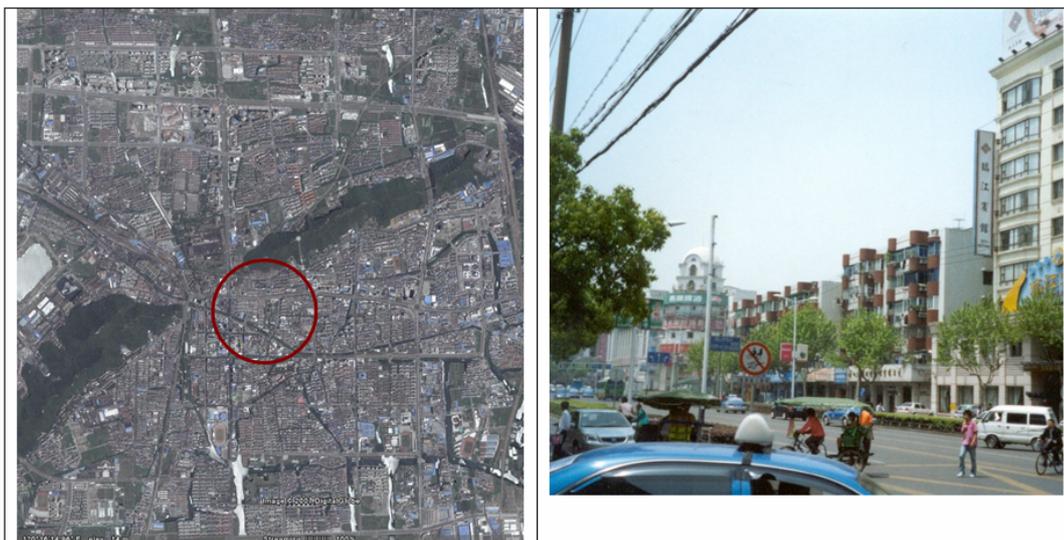


Figure 5.5 *Aerial view of the Xiaoshan interview area (to the left, scale 1/36,000) and view toward the investigation area of Xiaoshan (to the right).*



Whereas all interviewees but one are workforce participants, the proportion of workforce participants among the respondents of the main survey is 74%. Pensioners, unemployed persons and other non-participants of the workforce are thus clearly underrepresented among the interviewees. The proportion of interviewees who have access to a private car (either privately owned or company-owned available for private purposes) is also considerably higher among the interviewees. Whereas more than a third of the interviewees belong to a household that has access to a car for private travel, the corresponding proportion among the survey respondents is only 8%. The number of household members is also generally somewhat higher among the interviewees than among the survey respondents. At the same time, the number of children per household living at home is approximately the same among the interviewee households as among the survey respondents (albeit with a higher proportion of preschool children and a lower proportion of schoolchildren among the interviewees). The similarity of the number of children, combined with the generally larger household sizes among the interviewees implies that single persons are somewhat underrepresented among the interviewees.

Table 5.1 *Selected characteristics of the interviewees (household level).*

Interviewee	Zhang	Jingeng	Jun	Ni	Wang	Yao
Residential area	Xixi Road	Xixi Road	Xixi Road	Xixi Road	Xixi Road	Xixi Road
Gender of household members	<i>M, F, F</i>	<i>M, F, M</i>	<i>M, F, F</i>	<i>M</i>	<i>M</i>	<i>F, M, F</i>
Age of household members	35, ?, 7		?, ?, 5			
Profession	Driver	Fruit seller	IT staff employee	Bank clerk	University teacher	Human resource worker
Interviewee	Zhu	Li Liangchao	Wang Zhigang	Wang Hao	Xutao	Zhang Honghua
Residential area	Cuiyuan	Cuiyuan	Cuiyuan	Cuiyuan	Cuiyuan	Cuiyuan
Gender of household members	<i>F, M, F</i>	<i>M</i>	<i>M, F, ?, M, F</i>	<i>M</i>	<i>M, F, F</i>	<i>M, F, F</i>
Age of household members	?, ?, 15					
Profession	University teacher/researcher	IT staff employee	Salesman	Office clerk	Material manager/student	Teacher
Interviewee	Wang	Liu	Sun	Wang	Yang	
Residential area	Banshan	Banshan	Banshan	Banshan	Banshan	
Gender of household members	<i>M, F, F</i>	<i>F, M</i>	<i>M, F, M</i>	<i>F, M, M</i>	<i>M, F</i>	
Age of household members			?, ?, 5		?, 20	
Profession	Worker	Engineer	Pensioner	Office clerk	Technician	
Interviewee	Hu	Hu Bin	Lai	Yu Sanrong	Zhou	An
Residential area	Zhuangtang	Zhuangtang	Zhuangtang	Zhuangtang	Zhuangtang	Zhuangtang
Gender of household members	<i>M, F, F</i>	<i>M, F</i>	<i>M, F</i>	<i>M, F, ?, ?</i>	<i>M, F, M</i>	<i>F, M, F</i>
Age of household members	?, ?, 14					38, 9, 5
Profession	Truck driver	Bank manager	Owner of small business	Bank officer	Shop owner	Emporium worker
Interviewee	Xu Zhuoping	Sun	Xia	Zhao	Jia	
Residential area	Xiaoshan	Xiaoshan	Xiaoshan	Xiaoshan	Xiaoshan	
Gender of household members	<i>M, F</i>	<i>F</i>	<i>F, M, M</i>	<i>M, F, ?</i>	<i>M</i>	
Age of household members	32, ?		?, ?, 2			
Profession	Company manager	Accountant	Office clerk	Manager	Office clerk	

The person interviewed in each household is marked in italics.

Table 5.2 *Comparison of characteristics of the interviewees and their households with averages among the survey respondents.*

	Xixi Road		Cuiyuan		Banshan		Zhuangtang		Xiaoshan		All interview-holds (N = 28)	All respondents (N = 2543-2851)
	Interview-holds (N = 6)	Respondents in the relevant distance belt (N = 728-784)	Interview-holds (N = 6)	Respondents in the relevant distance belt (N = 618-703)	Interview-holds (N = 5)	Respondents in the relevant distance belt (N = 606-684)	Interview-holds (N = 6)	Respondents in the relevant distance belt (N = 405-479)	Interview-holds (N = 5)	Respondents in the relevant distance belt (N = 184-189)		
Average number of persons per household	2.3	1.8	2.7	1.7	2.6	1.9	2.8	1.8	2.0	1.9	2.5	1.8
Average number of pers. 0-6 yrs in the household	0.33	0.09	0.17	0.13	0.40	0.13	0.17	0.21	0.40	0.14	0.29	0.13
Average number of pers. 7-17 yrs in the household	0.17	0.33	0.50	0.29	0.17	0.37	0.17	0.35	0	0.35	0.18	0.33
Share of workforce participants among resp./interviewees	100%	60%	100%	77%	80%	80%	100%	84%	100%	82%	97%	74%
Share of students/pupils among resp./interviewees	0%	2%	16%	2%	0%	2%	0%	5%	0%	0	3%	2%
Share of households with access to car for private travel	17%	2%	33%	9%	20%	10%	67%	15%	40%	10%	36%	8%

The relevant distance belts to which the interviewee areas belong are the following: Xixi Road: 0-3.4 km from downtown Hangzhou. Cuiyuan: 3.4-6.2 km from downtown Hangzhou. Banshan: 6.2-13.6 km from downtown Hangzhou. Zhuangtang: More than 13.6 km from downtown Hangzhou and more than 3.4 km from the closest second-order center. Xiaoshan: More than 13.6 km from downtown Hangzhou and less than 3.4 km from the closest second-order center.

The above-mentioned demographic and socioeconomic differences between the interviewees and the respondents (who are fairly representative of the population in general in Hangzhou Metropolitan Area) implies that the mobility resources as well as the need for daily travel (in the form of journeys to work) are likely to be higher among the interviewees than among the respondents. Due to their higher mobility resources, the interviewees will tend to emphasize the possibility to choose the most attractive among several facilities higher than minimizing traveling distances, and because of their higher workforce participation they will also more often need to commute out of the local area in which they live. For both these reasons, the daily-life traveling patterns of the interviewees could be

expected to depend somewhat more than the survey respondents on the location of the residence relative to the main centers of the region (in particular the central part of Hangzhou).

5.3 The regular activities and destinations of the interviewees

The most frequent types of trips made by the interviewees in connection with “bounded” activities are trips to workplace or place of education. For most interviewees, the journey to work is the only bounded trip, but for five interviewees the bounded trips also include family obligations (bringing kids to kindergarten, picking up wife at her workplace, and/or trips for daily dinners with parents or parents-in-law.). The occurrence of other ‘bounded’ trips than journeys to work is hardly related to the location of the residence, but may reflect gender differences and workforce participation. The most regular trips in connection with “partially bounded” activities are daily necessities shopping, which is carried out more or less frequently by nearly all interviewees. The frequency of daily necessities shopping does not appear to be influenced by residential location, but there is a clear gender difference, where some of the male interviewees say that shopping in supermarkets and other markets is mainly or entirely a task of their wives.

Traveling distances

Among the interviewees, journeys to work are the dominating type of ‘bounded trips’. Apart from the truck driver and the three self-employed interviewees, who all work with their home or a small shop very close to their home as a base, there is a certain tendency to longer ‘bounded trips’ among the interviewees living in the peripheral parts of the metropolitan area. There are still some exceptions from this general tendency. Notably, three workforce participants of Banshan who live in company-owned apartments have short journeys to work.

The distance from the dwelling to the main fixed workplace varies among the employed interviewees of the five areas in the following way:

- Xixi Road: 2 short, 3 moderate, 0 long.
- Cuiyuan: 4 short, 0 moderate, 1 long
- Banshan: 3 relatively short, 0 moderate, 1 long
- Zhuangtang: 2 short, 0 moderate, 1 long

- Xiaoshan: 1 short, 1 moderate, 3 long.

In the absence of the particular company-based provision of apartments in the proximity of the Banshan steel factory, the commuting distances among the Banshan interviewees would probably have been more similar to those among the other two outer interviewee areas. If the Banshan interviewees living in apartments provided by their employer are excluded, the two inner-city interviewee areas include 6 employed interviewees with short, 3 with moderate and 1 with long commuting distance, compared to 3 short, 1 moderate and 4 long in the three outer interviewee areas.

Most of the interviewees travel out of their local area to reach their workplace. Yet, in the Zhuangtang area, only one interviewee does so. The fact that two of the Zhuangtang interviewees are self-employed having their office or shop at home and in the village, and a third interviewee a truck driver also working with his home as the place of departure, of course plays a role here. In addition, the location of the village surrounded more or less rural areas implies that fewer job opportunities within a moderate distance from home than what is the case in areas located within the continuous built-up urban area (in particular in the inner city), and the local residents will be less exposed to competition from workers living close to, but not within the local area.

Apart from self-employed persons and drivers working with their home as point of departure, only 4 interviewees work within their local area: 2 in Zhuangtan, 1 in Cuiyuan and 1 in Xixi Road. There thus does not seem to be any center-periphery influence on the occurrence among employees with a fixed main workplace of working within their local area. This may mirror that the higher occurrence of local jobs in the inner-city interviewee areas is balanced by the lower competition in the outer interviewee areas from job opportunities close to but not within the local areas, and from workers living in these adjacent areas.

The relatively high number of outer-area interviewees working close to their residence might seem a bit surprising, as the probability of finding a vacant job matching one's own qualifications within a short distance from the dwelling is considerably lower when living on the periphery than if the residence is close to downtown. This follows both from the generally more centralized locations of workplaces than dwellings, and from the fact that the distance along the road network to a randomly chosen address in the Hangzhou Metropolitan Area will on average be longer from a peripheral than from a centrally located

residence. For specialized jobs, the catchment area from which employees are recruited will be large and typically include large parts of or the entire Hangzhou Metropolitan Area. However, most of our outer-area interviewees have relatively non-specialized jobs, whereas a higher proportion of the inner-area interviewees have a high professional specialization. For non-specialized jobs, commuting distances are not to the same extent influenced by the location of the residence relative to the center of Hangzhou. Jobs as e.g. cashiers have largely the same job content and wages, independent of the workplace's specific location within the metropolitan area, and the employees within this job segment therefore have a higher possibility of finding a suitable job close to the dwelling than persons with more specialized qualifications. The job markets for non-specialized jobs are therefore likely to be more locally delimited (cf. also the discussion in chapter 2 on catchment areas and center hierarchies).

The length of other types of 'bounded trips' than journeys to work (notably bringing children to kindergarten and daily trips to visit family members for dinner) do not seem to vary in any systematic way with the location of the residence. This partly reflects the fact that kindergartens are less concentrated to the inner city of Hangzhou than workplaces and are also a less specialized type of facility, and partly also that daily dinners with family members not belonging to the household is a phenomenon probably taking place only if the visited family members live relatively close to the visitors. Among our interviewees, two such examples exist among Xixi Road interviewees, one among Zhuangtang interviewees and one among Xiaoshan interviewees. In all the interviewee areas, all the interviewees who regularly visit family members not belonging to their own household travel out of their local area to reach these family members' homes.

Shopping in food/vegetable markets and small supermarkets mainly takes place locally in all five interviewee areas. In the two inner-city interviewee areas and in downtown Xiaoshan, shopping in big supermarkets also to a high extent takes place locally, and in Xiaoshan also some special commodity shopping. The latter reflects the local area of the Xiaoshan interviewees overlaps with the downtown area of Xiaoshan, where there is quite broad supply of special commodities. Interviewees living in the inner city of Hangzhou or close to a second-order center (like downtown Xiaoshan) thus seem to carry out a higher proportion of their shopping in the local area than those living in smaller centers (like Banshan and Zhuangtang).

The children's schools and kindergartens are located relatively close to the residence, both among inhabitants of the inner city and those

living on the urban fringe. Bringing and picking up children is typically carried out in connection with the journey to the workplace or place of education. Often, this implies that little additional transport is required, but the daycare or school may also be situated in a different direction from home than the workplace. Thus, two of the peripheral interviewee households had to drive a bit further away from the workplace in order to bring their children before they could start the journey towards the job site.

Travel modes

The variation in travel modes for 'bounded trips' to a high extent reflects variations in traveling distances, but also the interviewees' availability of cars and e-bikes. For journeys to work, 8 of the 11 interviewees of Xixi Road and Cuiyuan travel by non-motorized modes or e-bike to their normal workplace, whereas none of the interviewees of Xiaoshan use these modes for their journeys to work. Conversely, all the interviewees of Xiaoshan commute by car or bus (2 by car and 3 by bus), compared with 3 of 11 interviewees in Xixi Road and Cuiyuan (1 of which by car and 2 by bus). Whereas the patterns found among interviewees in the two inner-city areas and Xiaoshan suggest a clear center-periphery variation in travel modes²⁶, the travel modes of the journeys to work among the interviewees of Banshan and Zhuangtang deviate from this pattern. Among these interviewees, five out of seven persons with fixed workplaces use non-motorized modes for their journey to work, whereas the remaining two interviewees go by bus. This modal split must be seen in the light of the short commuting distances of the interviewees in these areas with fixed workplaces, partly facilitated by the provision of company-owned apartments not far from the Banshan steel factory. The total dominance of biking, e-biking and walking among the Banshan and Zhuangtan interviewees with short commuting distances must probably also be seen in the light of the much lower competition from bus in these areas than in the two inner-city interviewee areas.

When shopping daily necessities, the travel modes vary little with the location of the interviewee area. For such trips, non-motorized modes dominate across residential locations except when visiting big supermarkets. For visits to big supermarkets and when buying special commodities, there is a certain tendency to more frequent use of bus and car among interviewees of the outer areas, but this tendency is modified by the fact that some outer-area interviewees who work in the downtown area walk to nearby shops in their lunch break or in connection with their journey to and from work.

5.4 Non-bounded trips

Activity participation and trip frequencies

A high proportion of the interviewees socialize with friends at teahouses, mah-jong centers or restaurants more or less frequently. They also sometimes visit restaurants, bars and – somewhat less frequently - cinemas alone or together with household members. The interviewees' participation in such activities does not seem to be influenced by their residential location, but rather by their family situation, workload and economy. Many interviewees also carry out regular exercise-bringing outdoor activities, such as exercise walking, hill climbing, jogging, swimming etc. The frequency of these activities seem to be influenced by the local urban structural situation (availability of hills and other green areas, swimming pools and gym centers) to some extent. For example, the interviewees who climb hills are mostly residents of Xixi Road and Banshan, whereas fewer of the interviewees from Xiaoshan and Zhuangtang climb hills and none of the interviewees from Cuiyuan. The facilitation for these activities does, however, not follow any clear center-periphery dimension. Similarly, swimming in swimming pools depends on local urban structural conditions in that it is more common among those who live close to such a facility. Here, a center-periphery dimension can be identified, as swimming pools more available in the inner and central parts of Hangzhou than in the outer parts of the metropolitan area.

Most interviewees carry out special commodity shopping (including window-shopping) occasionally; a few interviewees do this more frequently. The occurrence of this activity does not seem to follow any clear center-periphery dimension, perhaps because some of those who live peripherally work in the inner part of Hangzhou and purchase special commodities or do window-shopping in connection with their journeys to work. Neither do the interviewees' visits to hobby facilities like art exhibitions etc. seem to be influenced by their residential location.

Our interviews indicate that people's participation in leisure activities is influenced to some extent by the distance from the residence to relevant facilities. Needless to say, people's interests, resources and commitments are of the highest importance to their activity patterns, but the distances to the places where the various activities can be carried out also has certain significance. What appears to be influenced by residential location is first and foremost the *frequency* of activity participation. Among our interviewees, activities are seldom completely dropped as a result of long distance to the facilities

where they can be performed. There are few, if any examples of interviewees having taken up any new activities or dropped previous activities as a result of moving from one residential location to another²⁷. For at least half of the interviewees, the question is hardly relevant since they have lived in the same residential area for a very long period and in some cases even since they were born.

Among the interviewees of four of the investigated areas, there are few, if any indications that the *outdoor life and use of recreational areas* are constrained by the urban structural situation of the dwelling. This probably reflects the fact that these four interviewee areas (Xixi Road, Banshan, Zhuangtang and Xiaoshan) actually have a good access to green areas (including hills).

Only one of the areas (Cuiyuan) has low availability of local parks and is situated far away from any hills or larger natural areas. In Cuiyuan, outdoor recreation in green areas still seems to make up a smaller part of the actual leisure activities than in the remaining four areas.

Thus, the availability of green recreational areas in and close to the residential area seems to influence the interviewees' level of outdoor recreation activity. A few of the Cuiyuan interviewees also mention the fact that there are no local parks or other green areas in the district. However, the interviewees of this area generally do not articulate any experience of being constrained in their outdoor recreation activities. This may partly be due to self-selection: persons who are keen on outdoor recreation may prefer other residential areas where the availability of green areas is higher.

It should be noticed that the five interviewee areas, seen as a whole, probably have a higher availability of green outdoor recreational areas in the proximity of the dwelling than what is the case for the population of Hangzhou Metropolitan Area in general.

Traveling distances

In the two inner-city areas, almost all the interviewees' 'non-bounded' activities take place within a short distance from the dwelling. The only exceptions are some of the football games and teahouse visits (in Meijawu) of one interviewee, and two interviewee's relatively infrequent visits to cousins and parents.

In the three outer interviewee areas too, a considerable proportion of the 'non-bounded' activities (notably visits to local green areas for exercise and recreation) take place within a short distance from the dwelling, and in two of these interviewee areas gatherings with friends also most often take place locally. However, among the interviewees

from the three outer areas some of the leisure activities (notably visits to restaurants, teahouses and to green areas around the West Lake) take place at a long, or at least moderate, distance from the dwelling. In one of the outer interviewee areas (Banshan), gatherings with friends also take place at a moderate or long distance from the dwelling, because there is no suitable local facility. Among the interviewees of the three outer areas too, the relatives occasionally visited often live quite far away from the interviewees' dwellings.

Visits to teahouses and restaurants etc. (and meeting friends at these facilities) take place locally to a high extent in all interviewee areas except Banshan, where interviewees must leave their local area if they want to go to a teahouse because there is no local facility of the kind. The proportion of local visits to teahouses, restaurants etc., actually seems to be highest in Zhuangtang. Probably, this partly reflects the lower competition from adjacent facilities in these areas than in the two inner-city interview areas; partly the high local orientation of the interviewees of Zhuangtang, who have lived in the area for a long time and have most of their friends and networks in the area. In all interviewee areas, yet, some of the visits to restaurants and teahouses (with friends or confined to members of the interviewee's own household) take place in other districts than the local one (for the sake of scenery, atmosphere etc., or in order to combine with other leisure activities). The trips of the interviewees to such locations, which are often located in the downtown of Hangzhou or around the West Lake, tend to be longer among the interviewees of the three outer interviewee areas. A similar difference between inner and outer interviewee areas can be seen regarding the trips to non-local green areas and leisure facilities, where interviewees from all interviewee areas sometimes visit green areas at the West Lake and its surroundings, cinemas in the inner city of Hangzhou, arts exhibitions, hobby markets etc. Such trips tend to be longer among outer-area interviewees than among the interviewees from Xixi Road and Cuiyuan.

Sports and outdoor recreation activities are carried out to a higher extent within the local area of Xixi Road in particular, but also in the local areas of Banshan and Xiaoshan than in the remaining two areas, with the lowest amount in Cuiyuan. This reflects availability of hills and green areas close to each interviewee area, and for Xixi Road interviewees also the availability of swimming pools and gym centers within the local area.

Thus, the total amount of travel for 'non-bounded' trips tends to be somewhat higher among interviewees from the three outer areas for the following reasons:

- Lack or limited availability of certain facilities (notably special commodity stores, cultural/entertainment facilities, and in some outer areas also teahouses/restaurants)
- For the sake of variation and/or because of particular qualities of certain non-local facilities, leisure facilities outside the local districts are sometimes chosen. The distances to such facilities tend to be longer from the outer interviewee areas than from the inner interviewee areas.

Travel modes

For leisure trips too, travel modes vary to a high extent with traveling distances. Since a large proportion of the visits to teahouses, restaurants and green areas have destination relatively close to the dwelling, more or less regardless of the location of the interviewee area, no systematic variation in travel modes due to residential location can be identified for such leisure trips. For leisure trips to non-local destinations, it is also difficult to identify any systematic variation according to the center-periphery dimension of residential location. Two oppositely working mechanisms seem to be at work: on the one hand, the non-local leisure trips tend to be somewhat longer when living in a peripheral area, but on the other hand, it is more convenient to choose bus instead of bike for such trips when living centrally. In addition, a tendency of traveling by taxi or as car passenger with a car-owning relative when several friends or family members go out together is observed among some interviewees both in central and peripheral areas. This too contributes to level out any differences between central and peripheral areas in the travel modes for leisure trips. The somewhat higher car ownership in the peripheral interviewee areas (except Banshan, where income levels among interviewees seem to be lower than in the other areas) than in the central ones may still contribute to a higher use of cars than in the inner-city areas, in particular for short trips (where it is less likely that residents will travel together with car-owning relatives or use company cars).

5.5 Rationales influencing travel behavior

Our interviewees' *rationales* for activity participation, location of activities, choice of transport modes and route choice make up important links in the mechanisms by which urban structures influence travel behavior. With a common concept, these rationales could be termed as *transport rationales*. This term refers to the basic backgrounds, motives and justifications to which the interviewees' choices concerning activity participation, location of activities, choice of travel mode and route choice could be traced. Such rationales may be based on different rationalities (Habermas, 1991) and include instrumental/efficiency-oriented, safety-oriented, comfort-oriented, esthetic and affective criteria (Næss & Jensen, 2005:165).

In the following sections, the rationales for activity participation, location of activities, choice of transport modes and route choice identified in each interviewee area have been summarized. The rationales identified in each area have been summarized and interpreted in a theoretical and comparative perspective.

5.6 Activity participation

Among our 28 interviewees, all but one pensioner are workforce participants. For the workforce participants, their paid work (in some cases combined with additional education) is the main 'bounded' activity, occupying a considerable proportion of their time. The actual time spent on work/education and the role that income-earning work fills in the interviewees' lives still varies quite a lot. The same applies to their family obligations. The time spent on work/education and family chores in its turn has implications to the available time for non-work activities, notably leisure.

Life forms and lifestyles

Some of the interviewees show activity patterns fitting well with Højrup's (1983) classification into a career-oriented life-form, a wage laborer life form and the life-form of the self-employed. In total, 13 of our 28 interviewees could be said to fit within one of these categories. However, other interviewees are more difficult to place within these categories. For some interviewees, the life-form appears to be a combination of and tradeoff between elements of two or three of Højrup's basic types. However, some additional life-forms are also suggested, notably a 'money-making' life form where people spend a high proportion of their time on paid work, but without pursuing any

clear career course like in the career-oriented life-form. Instead, earning money in order to realize wishes for a high material consumption appears to be the underlying rationale.

In addition to the life-forms based on the role that paid work fills in the interviewees' lives, some overall lifestyle patterns of leisure preferences and activities can be distinguished. Two interviewees could be characterized more or less as belonging to an upper middle class, affluent lifestyle where shopping and the symbolic content of leisure activities appear to play an important role. Three other interviewees pursue quite specialized leisure interests, which can also be characterized as mainly middle-class, but without any strong element of consumerism. Rather, these leisure interests could be characterized as culture-oriented.

Among our interviewees, one or more of Højrup's three life forms can be recognized in all interviewee areas except Xiaoshan. In the latter interviewee area, the interviewees either represent one of the two above-mentioned 'additional', leisure-based lifestyle patterns, or more vague combinations of wage-laborer and career-oriented lifestyles. Among the remaining four interviewee areas, the wage-laborer life-form is represented in all areas (one each in Xixi Road and Cuiyuan and two each in Banshan and Zhuangtang); the career-oriented life-form only in the two most central areas (two in Xixi Road and two in Cuiyuan); and the self-employed life-form only in Xixi Road (one interviewee) and Zhuangtang (two interviewees). The higher occurrence of career-oriented lifestyles in the two central areas may partly reflect a wish among career-oriented people to live close to their jobs (since they visit their workplaces often and often work overtime at odd hours), combined with the concentration of workplaces offering career opportunities (e.g. universities and other higher education institutions) in the inner part of Hangzhou. Partly, it may reflect a prevailing cultural taste among members of the career-oriented life form group, where 'urban' facilities (notably cultural) are valued and used to a higher extent than among members of the self-employed and wage-laborer groups. It should, however, be borne in mind that the interviews cannot provide any base for statistical generalizations regarding the distribution of life-form groups over the metropolitan area.

Interviewees pursuing a money-making lifestyle were identified in three of the interviewee areas (Cuiyuan, Zhuangtang and Xiaoshan), whereas interviewees belonging to one of the two leisure-based lifestyle groups can be found in all areas. The more consumerism-oriented of these lifestyle groups was, however, only identified in

Zhuangtang and Xiaoshan. Whether or not this reflects any general pattern in the cultural geography of the metropolitan area cannot be concluded from this qualitative material, but may be thrown light on through an analysis of the attitudinal questions of the quantitative surveys. One could, however, imagine that people with a high cultural capital (Bourdieu, 1984) compared to their economic capital would prefer to live close to the cultural facilities of the inner city, whereas people with a higher economic than cultural capital more often would prefer to live in the suburbs and outer areas.

The above-mentioned life-forms and overall lifestyle patterns have some implications to the interviewees' frequency of out-of-home activities. Thus, both the career-oriented life form and the life-form of the self-employed tend to reduce the time available for out-of-home leisure activities.

In particular, this is the case when a high proportion of the time occupied by work is combined with family obligations, as in the case of a female university teacher and researcher living in the Cuiyuan area. This interviewee spends a considerable part of her time on her work, staying at the university from 8.15 a.m. to 5 p.m. and working most of the weekday evenings and half the weekend leisure time. Her activity pattern seems to be an academic variant of Højrup's (1983) ideal type of a career-oriented way of life, where self-realizing, acknowledgement and interest in the subject are more important as motives than making a career in order to become wealthy. Apart from her work, the interviewee's activity pattern is centered on her family (she is the mother of a 15-year old daughter), with walks and recreational trips in the neighborhood, the West Lake area or sightseeing driving around in Hangzhou as typical activities. In addition she spends half of the weekend with her parents. The interviewee states by several occasions that time is a scarce resource to her and that she does not want to travel too long distances in daily life because it consumes too much time. Thus, her activity pattern seems to be limited to a considerable extent by time-geographical constraints. She also tries to save time by reducing the frequency of shopping trips by buying for almost the whole week's supply when visiting the supermarket.

A female, single (married-to-be) accountant living in the Xiaoshan area illustrates the consumerism-oriented middle class lifestyle. In addition to her work, this interviewee carries out several shopping and leisure activities (including long-distance leisure trips). Her non-work activities seem to be chosen for their substantive and symbolic contents, not for any function as arenas for social contact. Her activity

pattern seems to reflect an upper middle class, affluent (female) consumerist lifestyle rather than a career-oriented form of life (the latter would probably focus her time spending more on overtime work and activities improving her work qualifications). Her activity pattern also seems to be quite open to impulses, e.g. shopping when passing by and seeing something of interest in the window. She does not want social contact with neighbors because it ties up time which she wants to spend on other activities. This perhaps reflects a time-saving rationale as well as a lifestyle where social networks are formed on the base of interests instead of neighborhood.

Compared to the above-mentioned life-forms and lifestyles, the wage-laborer life-form increases the scope for out-of-home leisure activities (except among shift-workers, whose possibility to engage in weekend activities together with family members and friends are significantly limited). Family obligations (notably care of small children) also make constraints on the scope for out-of-home leisure activities, and in particular among career-oriented parents of small children the leisure time tends to be home-oriented. Low income also makes up a restraint on leisure activities requiring the spending of money, such as visits to cinemas, teahouses, restaurants, bars, and shopping. On the other hand, the above-mentioned upper-middle class, affluent lifestyle implies a high participation in precisely this kind of activities.

A male teacher living in the Cuiyuan area with his wife and a daughter may serve as an example of the wage-laborer life form. Apart from his work as a teacher, this interviewee's main out-of-home activity is meeting friends, which takes place often on weekdays in the evening and once each month in the weekends. Other weekends he goes with his daughter and wife to parks near the West Lake. He also goes to a gym center twice a week, swims frequently in the summer, and goes often to concerts. His activity pattern thus seems to reflect a wage-laborer form of life where his work does not occupy an excessive part of his time, leaving time for considerable social contact and pursuit of personal leisure interests.

Social contact as an important partial motive for leisure activities

Apart from the bearings of the above-mentioned, more basic socio-cultural characteristics of the interviewees, *social contact* stands out as an important motive for a number of the leisure activities carried out by the interviewees. When the interviewees visit teahouses and mah-jong centers, they most often go together with a group of friends who have made an appointment to meet at a specific teahouse or mah-jong center. The same applies to many of their visits to restaurants. These

gatherings appear to be motivated mainly by the social contact among the group of friends, rather than by the drinking or eating *per se* or to play mah-jong with random visitors at the mah-jong centers. Among our 28 interviewees, 9 explicitly mention visits to teahouses etc. as an event where a group of friends gather at a place and time according to an appointment made in advance. In addition, one interviewee mentions concerts and sports activities (football games, badminton playing etc.) as arenas for social contact with friends.

A male, married company manager living in the Xiaoshan area may serve as an example of an activity pattern influenced considerably by the motive of social contact. A wish for (or obligation to) social contacts with family makes this interviewee make many visits to his parents and (in particular) parents-in-law, who live some 15 km and 2 km, respectively, away from his home. He also visits tea houses with friends, probably also an activity generated from a wish for social contact. He says that his residence is used only “as a hotel” – a statement underlining his strong emphasis on out-of-home social contacts.

Visits to parks and other recreational facilities also appear to be motivated partially by social contact, but in this case the social group is typically the interviewee’s own family. Among our interviewees, we find 7 explicit examples of visits to parks etc. as something the family does together. Needless to say, social contact with the family is not the only rationale behind outdoor recreational activities. For such activities, a rationale of social contact is usually combined with rationales of fitness/physical exercise and esthetics/landscape experience.

Visits to restaurants etc. may also be arenas for contact with family members, either from the ‘core family’ (e.g. the spouse) or with close relatives. Restaurant visits are also sometimes events for more formal social contacts, such as business dinners with clients or customers.

Among some interviewees, a wish for social contact with close relatives makes up an important generator of regular visiting trips to parents, parents-in-law, grandparents or grown-up children living on their own. In particular, this is the case among three interviewees who have daily dinners in the homes of parents or parents-in-law. Other interviewees follow family members on shopping trips to downtown mainly as a social activity.

A wish to establish new social contacts is also apparent in the activity patterns of some interviewees, in particular among young persons pursuing a ‘single-person lifestyle’ involving high participation in

leisure activities where there is possibility to socialize with and get to know other people. One of these interviewees represents an example of 'adventure seeking/escape from boredom' as a rationale for out-of-home activities in the form of visits to downtown areas 'where something might happen' at weekend nights.

The high importance of social contact as a motive for leisure activities among our interviewees is in line with findings of Schlich et al. (2004) that social contact is crucial to leisure. This implies that not only the interviewees' 'bounded activities' (notably work and school) are subject to 'coupling constraints'. Such constraints also to a high extent apply to leisure activities, necessitating that the location and time of the activities need to be acceptable for all participants.

Other rationales for leisure activities

Two other main motives that can be traced from our interviewees' leisure activities are *physical exercise/fitness* (indicated by seven interviewees) and *esthetical experience* (indicated by four interviewees). These rationales make up a (partial) base for a number of leisure activities among our interviewees, sometimes in combination. The latter is the case for a number of outdoor recreation activities, such as hill climbing and walking in parks and other green areas. The fitness/physical exercise rationale also motivates interviewees to exercise walking in the streets, badminton playing, swimming, football, jogging/running and long-distance biking. The esthetical rationale is – besides its role as a motive for outdoor recreation in green areas – a motivator of activities like visits to arts and craft exhibitions, visits to coffee-bars etc. from which beautiful landscapes can be viewed, and maybe some of the window-shopping of certain interviewees. The importance attached to esthetics, and which features are appreciated as esthetically valuable or interesting, of course differs between social groups. Among our interviewees, the esthetic rationale appears to be associated primarily with a middle-class culture.

Availability of facilities/distance decay

The activity patterns of the interviewees appear to depend primarily on socio-cultural characteristics, like life-form and lifestyle, family situation, education level etc., but also by constraints set by their economic ability. However, the availability of facilities in the proximity of the dwelling also appears to play a role. Judged from the interviewees' actual activity patterns as well as their answers to retrospective questions about changes in activity patterns due to previous changes in place of residence, and corresponding

hypothetical questions concerning future moves, the use of green areas (and probably afternoon visits to parks etc. in particular) appears to be influenced to some extent by what is available in the neighborhood. On the other hand, the participation in 'urban' activities like visits to cinemas etc. appears to be reduced among interviewees living far away from such facilities, and in Banshan, where there is no local teahouse, the interviewees also go less frequently to teahouses. Thus, a certain 'distance decay' in the use of facilities can be observed, in particular among interviewees with low mobility resources.

'Distance decay' in the frequency of activity participation implies that there are limits to how long people are willing to transport themselves in order to be able to perform an activity with a given frequency. Where many different optional facilities are available, this may make people prefer a closer, 'second best' facility to a too remote, 'best' facility (cf. section 5.6 on the balancing and prioritization between various rationales for activity location). In situations where even the closest facility is located far away, there will instead be a prioritization between, on the one hand, the efforts, time consumption and costs of traveling, and, on the other hand, the utility or joy from participating in the activity. The freedom to abandon an activity is of course limited to the 'non-bounded' types of activities. Such 'distance decay' may form the base of 'compensatory mechanisms' leading to a certain reduction of the transport-reducing effect of living close to relevant facilities.

The disadvantages of living far away from facilities thus consist partly of the need of spending more time, money and efforts on traveling to the facilities, and partly on having to renounce on some of the needs or wishes for activity participation. In other words, living far away from relevant facilities has some environmental and resource-related consequences, in the form of a high amount of transport, as well as some negative welfare consequences, in the form of unfulfilled wishes for activity participation.

Another 'compensatory mechanism' influencing the out-of-home activity pattern of some interviewees is saturation with visiting places due to extensive professional driving (encountered among three of the interviewees). This latter compensatory mechanism does, however, not seem to be related to the residential location of the interviewees.

Gendered family obligations

One third of the 21 male interviewees never do daily necessities shopping, as this is a responsibility of their wives or other (female) family members. On the other hand, all the seven female interviewees

do such shopping. Both male and female parents engage in activities with their children (e.g. walking in nearby parks), but the main responsibility for child care still lies with the female interviewees. Due to these conditions, the clearest examples of interviewees with a tight time budget are found among mothers of small children. A few of these interviewees try to combine their domestic chores with a professional career, among others by taking evening or weekend courses at universities. For such persons, the time-geographical constraints on daily activities are considerable.

Minimizing time consumption for partially bounded activities

Among interviewees with a tight time budget, strategies to minimize the time consumption on 'partially bounded' activities (notably daily necessities shopping) were observed. Distinct from the 'bounded' activities, the interviewees have the possibility to influence how much time they spend on the 'partially bounded' activities. At the same time, they are probably less rewarding in terms of social contact, fitness, esthetic experience or self-realization than most 'non-bounded' activities. 'Partially bounded activities' such as daily necessities shopping are therefore likely candidates for time-saving strategies. Two interviewees try to reduce their time spent on shopping by searching commodities on the internet before going to the store and buying special commodities on the internet when possible. A third interviewee chooses non-crowded shops in order to save time. (In addition, several interviewees, in particular those with a tight time budget prefer to do daily necessities shopping in stores close to their home or in a shop that is anyway passed along the route home from work.)

5.7 Location of activities

Main rationales and sub-rationales

The interviewees' choices of locations for their activities seem to be influenced by two main, competing rationales which are balanced against each other in different ways, depending on a number of circumstances. These two rationales are:

- Choosing the best facility, and
- Minimizing the friction of distance

Each of these two rationales includes several more detailed aspects or sub-rationales. The rationale of *choosing the best facility* thus includes

criteria related to the instrumental purpose of the activity (e.g. job content, salary, qualification requirements etc. of workplaces, and range of commodities, prices etc. of shops), but also to some extent criteria related to cultural, symbolic or esthetic properties of the locations (e.g. the 'atmosphere' of a particular place), and an aspect of variety-seeking. The rationale of *minimizing the friction of distance* (Lloyd & Dicken, 1977) includes an aspect of minimizing the spatial distance that must be traveled in order to reach the facility (e.g. measured in km); an aspect of minimizing the traveling time; an aspect of minimizing the stress or physical efforts of traveling to the location (e.g. in the form of changing between different means of transport); and an aspect of minimizing the economic costs of the trip. Among our interviewees, the rationale of minimizing the friction of distance is often expressed in terms of choosing *convenient* locations. To a considerable extent, the sub-rationales under the rationale of minimizing the friction of distance overlap each other, but under certain conditions (e.g. congested roads, scarce parking, or a particular configuration of the public transport lines) the fastest, least costly or most conveniently accessible locations may be different from the physically closest ones.

Seen in relation to the main research question of our study, viz. how the intra-metropolitan location of residences influences the residents travel behavior, the sub-rationale of minimizing the spatial traveling distance is of particular interest. The friction of distance is a function of the time consumption, economic expenses and discomfort involved when traveling from one place to another. The friction of distance is thus the inverse of the *accessibility* of the destination. Other things equal, the friction of distance will of course be highest for the closest facilities. However, what is the easiest accessible location varies with travel modes, depending on, among others, the layout of the public transport network, the driving conditions along the road network, and the conditions for walking and biking. For example, differences in parking conditions may imply that a somewhat more distant supermarket is easier accessible by car than the closest supermarket, i.e. that the friction of distance will be lower when driving to the former than to the latter location.

Summarizing from the above, the interviewees' location of their activities appear to be influenced by two main rationales, each encompassing several sub-rationales:

- 1) *Choosing the best facilities, including sub-rationales of*
 - Choosing facilities where the instrumental purpose of the activities can best be met

- Choosing facilities where social contacts can be maintained
 - Choosing facilities matching the interviewees' cultural, esthetic and symbolic preferences
 - Variety-seeking
- 2) *Minimizing the friction of distance, including sub-rationales of*
- Minimizing the spatial traveling distance
 - Minimizing travel time
 - Minimizing the stress or physical efforts of traveling to the destination
 - Minimizing economic expenses associated with the trip.

Among our interviewees, the sub-rationale of choosing facilities where the instrumental purpose of the activities can best be met is clearly more common than the sub-rationales associated with cultural, esthetic and symbolic preferences and variety-seeking. The two latter sub-rationales exert some influence on the destinations of shopping and leisure trips among some interviewees. For example, a female office clerk living in Xiaoshan sometimes joins her husband on trips to downtown Hangzhou, where he has an instrumental purpose (meeting or picking up someone) while the interviewee herself has no special purpose. Her motivation for these trips is based on an 'atmosphere' rationale or a mere wish for sightseeing.

For 'bounded' activities like income-earning or studies, meeting the instrumental purpose of the activity is practically the only sub-rationale under the 'choosing the best facility' rationale.

When choosing among workplaces, the importance attached to criteria such as job content, working conditions and salary seems to vary somewhat between population groups, with the highest emphasis on job content among academics with a specialized education. Besides being predisposed by their disciplinary specialization to seek quite narrow niches in terms of job content, academics also face a job market where salary differences between the relevant jobs are modest, as emphasized by one of the interviewees. For shops, the range and quality of commodities, the price level, the service level and friendliness of the employees and the degree of crowding are mentioned by interviewees as aspects influencing the attractiveness of stores. In addition, some interviewees who have a car at their disposal mention parking conditions as an aspect influencing which facility is considered the best one. This latter criterion overlaps to a considerable

degree with the rationale of minimizing the friction of distance, as shortage of parking places implies that a parking place further away from the destination has to be chosen, or the destination must be reached by a slower mode.

Variety-seeking is in particular important as a rationale for choosing locations for outdoor recreation at weekends or on holidays, where much of the motivation is the esthetic experience of new landscapes. (Yet, one single natural area – at least if the area is of a certain size – may also offer opportunities for numerous trips where new aspects of the landscape are discovered each time.) Variety-seeking as a motive for leisure activities was not identified in the Copenhagen Metropolitan area study, but has been mentioned in the literature on leisure travel (Stauffacher et al., 2005).

The sub-rationale of choosing facilities where social contacts can be maintained is important for certain leisure activities such as visits to teahouses and restaurants and some of the visits to outdoor recreation areas (cf. the section on rationales for activity participation). For some other activities, the social contact in question is mandatory or necessary for the activity and should rather be understood as a ‘coupling restriction’ (e.g. attending the workplace or school, or participating in tennis games or football matches) than a rationale for activity location. For several other non-work activities (e.g. shopping, swimming, hill climbing), however, the possibility of social contact in connection with the activity appears to play little or no role for the choice of location.

In our material, we also find an example of a young interviewee who visits certain locations (the downtown areas of Hangzhou and Xiaoshan) with ‘adventure-seeking’ as the main purpose. The possibility of experiencing ‘adventure’ (e.g. in the form of random social contacts) is arguably a part of the particular opportunities of downtown centers, where many people pass by on their way to and from workplaces, leisure facilities etc. ‘Adventure-seeking’ could thus be considered a second-order sub-rationale under the sub-rationale of social contact.

For most interviewees, the choice of workplace appears to be influenced more by salary and job content than by the distance (in travel time or kilometers) from the dwelling. The interviewees usually admit that there is a balancing between the two criteria, but they generally seem to be willing to travel quite far, if necessary, in order to find a job matching their qualifications. This willingness does not seem to be influenced by the location of their residence, but to some

extent by gender and family responsibilities (some women with small children say that they do not want to work far away from home as long as their children are small).

Rather than limiting commuting distances by confining their choice of workplace to the local area, some interviewees seem to consider the workplace as a fixed location and limit their choice of residence to what is available in its proximity (exemplified by two interviewees from Zhuangtang). For most of the Banshan interviewees, such proximity has been ensured institutionally through the steel factory's provision of local residences for employees.

In addition to the physical distance, convenient access with public transport is a part of the distance criterion, in particular among residents of the outer areas (but also mentioned by a Cuiyuan interviewee).

For shopping facilities too, the interviewees balance between choosing the best facility (in terms of assortment, prices, quality of products) and proximity, with a higher emphasis on the 'best facility' criterion for special commodities and lower for daily necessities. The proximity criterion does not necessarily refer to the residence, but may also refer to the workplace. In particular, this seems to be the case among interviewees living in the two areas with the poorest local facilities (Zhuangtang and Banshan).

For kindergartens too the interviewees try to balance the criteria of proximity and perceived quality. Because the variation in the suitability of jobs is far larger than the variation in the quality of kindergartens, even those who emphasize quality over proximity usually choose a kindergarten relatively close to their residence, compared with the distance from their residence to the workplace. For leisure activities where friends meet, an accessibility criterion for the group of friends collectively seems to be most important, but in some cases the quality of the facility (e.g. the dishes of a restaurant) or its surroundings (e.g. the West Lake or the Meijawu village) override this criterion. For other leisure activities carried out by the individual or members of the same household, the choices of location are also based on a balancing between accessibility and the attractiveness of the facility. Moreover, there is a tendency to choose downtown locations when combining several leisure activities in the same evening.

Conditions influencing the balancing between rationales

A high emphasis on choosing the best facility implies that relatively long traveling distances will be accepted if necessary, whereas a high

emphasis on minimizing the friction of distance implies that less-than-ideal facilities are accepted if facilities of the desired quality are not available within a low threshold for acceptable traveling distance. The balancing between the two main rationales differs between individuals, depending on their skills, interests, mobility resources and social obligations, and between different types of activities. The point of departure from which the friction of distance applies is often the dwelling, but may also be the location of a 'bounded' activity, e.g. the workplace.

Among our interviewees, the emphasis on choosing the best facility compared to minimizing the friction of distance is generally higher, the more specialized is the activity. In other words, the more specialized the activity, the longer traveling distance is usually accepted. In particular, this is evident for choices of workplaces, where the formal qualifications of the worker must match the qualification requirements of the employer, the job content, working conditions and salary must be acceptable, seen from the point of view of the worker, and the worker must be able to actually be employed in competition with other applicants for the job. Thus, the percentage of all jobs within a geographic region which are both attainable and sufficiently attractive for a particular person may be quite small. In particular, this may be the case for persons with very specialized job qualifications. Conversely, for people with a low degree of work specialization, the propensity of finding local jobs is higher.

A high willingness to travel a long distance to reach facilities of the desired quality is also found among interviewees participating in specialized leisure interests, e.g. arts and crafts exhibitions. This willingness partly reflects the fact that even the closes among such facilities may be situated far away, but also that events and facilities beyond the closest opportunities may be considered more interesting. The rationale of choosing the best facility is also usually given a high priority when purchasing special commodities. On the other hand, minimizing the friction of distance is usually given the highest priority when buying daily necessities. The same applies to early morning or afternoon visits to parks etc., swimming pools and other facilities for individual exercise. Opportunities for such shopping or visits to small local green areas usually exist relatively close to the dwellings in all parts of the metropolitan area, and the differences in the quality or suitability of facilities at different locations are normally much smaller than what is the case for, e.g., workplaces.

For activities together with friends (e.g. visits to teahouses, mah-jong centers or restaurants), minimizing the friction of distance also often

takes a high priority, but in such cases, the criterion refers to the group of friends as a collective rather than to any particular member of the group. Thus, the 'coupling restrictions' involved when friends make an appointment to go out together, combined with an apparently egalitarian or democratic influence of all members on the choice of location, implies that the criterion of minimizing the friction of distance is lifted from the individual level to the level of the group. If the friends all live relatively close to each other, the location chosen is often situated in the local area. However, inner-city or downtown locations are often chosen, reflecting the high accessibility to downtown by public transport from different outer-area locations as well as the fact that some participants of the gatherings often go to the teahouse (or similar facility) directly from their workplace.

As can be seen above, the individual skills and interests of the interviewees (high vs. low degree of specialization) influence the balancing between the rationales of choosing the best facility and minimizing the friction of distance. The available mobility resources also matter, but in this case, high mobility resources open the possibility both to reduce the friction of a given distance and to choose among a broader range of facilities within a given level of friction of distance. People possessing high mobility resources, notably those with access to a car for private travel purposes, can thus give a higher priority to the 'choosing the best facility' rationale without having to renounce on the wish to limit the friction of distance. Actually, among those with access to a car, the rationale of minimizing the *friction* of distance can be pursued without reducing the actual *traveling distances* to the same extent as among those without access to a car. Of course, increased mobility resources could alternatively be used to reduce the friction of distance associated with accessing a fixed range of facilities (i.e. by reducing travel time). However, among our interviewees who have access to a car for private traveling, it seems to be very uncommon to utilize the reduced friction per unit of distance traveled solely in the form of reducing travel time. High mobility resources thus usually involve higher actual levels of physical movement (and thus increased possibility to choose among various facilities) than among those who have less potentials for mobility.

Here, a male teacher living in the Cuiyuan area may serve as an example. The interviewee himself works close to home (ten minutes' bike ride) but he says that the working environment (internal as well as external) is the most important if he were to change to a new job, and that he doesn't care about distance. This reflects a 'best facility' rationale, also apparent when choosing teahouses, restaurants and hotels for gatherings with friends. These meeting places are chosen

from a 'best facility' rationale and not from a 'distance minimizing' rationale, as the interviewee says that they 'will choose somewhere with a nice environment, not in the local area'. This interviewee's emphasis on 'best facility' over proximity is made possible by the household's car ownership, which has in its turn been triggered by the wife's long commuting distance. Thus, his wife's long commuting distance indirectly increases the interviewee's own (together with the family or alone) trip distances for non-work purposes.

The time available also matters to the interviewees' prioritizing between the two main rationales. Interviewees with a tight time budget (such as career-oriented workforce participants with considerable family obligations, notably female academics with small children) tend to emphasize the rationale of minimizing the friction of distance to a higher extent than those with a less tight time budget.

However, the availability of facilities in the proximity of the dwelling also matters. Similar to high mobility resources, a high availability of facilities near the dwelling enables interviewees to pursue a rationale of choosing the best facility without having to renounce on the wish to minimize the friction of distance associated with accessing the relevant facilities. A residential location close to concentrations of facilities thus enables interviewees to combine a high fulfillment of both the two main rationales, whereas a location of the residence far away from the main concentrations of facilities implies that a tradeoff and balancing has to be made between the two rationales. If a peripheral resident's possibility of choosing among facilities is to be kept at the same level as among residents living close to the concentrations of facilities found in the inner city, this can only be obtained by extensive travel, i.e. by overcoming a high friction of distance. Conversely, if a peripheral resident wants to reduce the friction of distance to that of residents living centrally, the range of facilities to choose among must be reduced and/or her/his mobility resources must be increased (typically by getting access to a fast individual means of transport). A given 'balanced' prioritization between choice and distance minimizing implies a lower fulfillment of each of these two rationales among residents living peripherally in relation to concentrations of facilities than among those living close to such concentrations.

A male bank clerk living in the Xixi Road area illustrates how inner-city residents often do not need to make any tradeoffs between the rationales of minimizing the friction of distance and choosing the best facility. All this interviewee's regular activities (work, shopping, movies, sports and outdoor recreation) are located in quite close

distance from the dwelling, thus one might think that a rationale of distance minimizing was dominant. However, the concentration of facilities in these areas is so high that a one-sided prioritization of a 'best facility rationale' would probably lead to the same choice of destinations.

The propensity of using local facilities is also influenced by the exposure of these facilities to competition from facilities outside the local area. Thus, among interviewees from Xiaoshan, there is a high propensity of using local stores also when purchasing special commodities. This partly reflects the quite high availability of a broad range of facilities in the downtown of Xiaoshan (which is arguably the largest second-order center of the metropolitan area), but it probably also reflects the long distance Xiaoshan residents need to travel if they want to go to a center with a broader range of facilities (i.e. the inner area of Hangzhou).

Summarizing, the following circumstances tend to contribute to a high priority attached to the rationale of choosing the best facility, compared to distance minimizing:

- Specialized job skills
- Specialized leisure interests and 'exclusive' cultural taste
- Much time available
- High mobility resources
- Many facilities available in the local area of the dwelling, enabling residents to choose
- Short distance from the local facilities to the closest competing concentration of facilities

Conversely, the following circumstances tend to contribute to a high priority placed on the rationale of distance minimizing, compared to choosing the best facility:

- Non-specialized job skills
- Non-specialized leisure interests and 'non-sophisticated' cultural taste
- Little time available
- Low mobility resources
- Few facilities available in the local area of the dwelling, restricting residents' possibilities for choice

- Long distance from the local facilities to the closest competing concentration of facilities

An elderly non-specialized industrial worker living in the Banshan area illustrates how the rationale of distance minimizing clearly takes precedence over the best facility rationale among interviewees combining many of the circumstances of the latter list. Distinct from most other interviewees who have more specialized work qualifications, this interviewee prefers proximity to the quality of the facility also when it comes to choice of workplace. Actually, he says that short distance from the dwelling would be the most important criterion if he were to choose a new job. His emphasis of proximity as the most important criterion for choosing among facilities is clear also when choosing where to do shopping, in addition to low prices. His preference of the closest facilities must be seen in the light of the combination of his limited mobility resources (no car of his own, he can only be a passenger in his daughter's car), his old age, his non-specialized work qualifications (and probably also non-sophisticated cultural taste) and the relatively peripheral location of the residence, with cumbersome connection by public transport to the downtown area. Thus, if this person was to choose among workplaces (or shops) outside biking distance, the journeys to the workplace and the shops would be very time-consuming and maybe too exhausting for an elderly worker.

As can be seen from the list above, high mobility resources as well as short distances to local and metropolitan-level concentration of facilities tend to increase the interviewees' prioritization of a 'best facility' rationale. Thus, both mobility resources and proximity contribute to enhance possibilities for choice. One implication of this is that reductions in proximity must be compensated by an increase in mobility resources if a given possibility for choice is to be maintained within a given time budget. This is an important mechanism explaining why ownership of private motor vehicles cannot be considered to be independent of the urban structural situation of the dwelling, but is instead influenced by residential location. Among our interviewees, there is one example of an interviewee who plans to buy a car after moving from a relatively central location (Cuiyuan) to a peripheral suburb (Zhuangtang), and another interviewee tells about several friends who have bought cars as a result of having moved to more peripheral locations.

For some interviewees who walk or bike with a motive of physical exercise, very close trip destinations might imply that their trips with

instrumental purposes do not fulfill their need for exercise, leading to additional trips being made with no other purpose than the exercise itself. In such situations, one might imagine that the rationale of minimizing the friction of distance would be irrelevant. However, our material indicates quite clearly that interviewees who carry out exercise walking beyond their walking to reach the locations of stationary activities prefer to take these walks as separate activities (e.g. in order not to have to carry goods a long distance home from the shop, and perhaps also in order to walk through more pleasant environments). There are no indications that such interviewees choose shops, teahouses etc. further away from the dwelling than what they would otherwise have done.

Ways of coping with conflicting incentives of rationales

Our material shows several examples of how the interviewees actually cope with the competing rationales for activity location in different situations. The most strategic decisions with the most-long-term consequences for travel behavior are the decisions determining the conditions of the interviewees 'bounded trips', notably the decisions about where to live and where to work. Although many of the interviewees do not provide any information about the reasons for their choices of residential address and workplace (in several cases, the interviewees have lived in their dwelling or residential area since they grew up), there is still some information available indicating which criteria are emphasized. (Partially, this information is based on hypothetical questions about possible changes of workplace location.)

Several interviewees thus say that they would be willing to accept quite long traveling distances in order to find a suitable job. It is very common among our interviewees to say that job content and salary matter much more than proximity to the dwelling. Some of the interviewees also actually have one-way commuting distances up to 25 – 30 km. However, the fact that many interviewees would hypothetically accept such long commuting distances if necessary does not imply that many of them are likely to live that far away from their workplace. Given the actual configuration of residences and workplaces in Hangzhou Metropolitan Area, only a small proportion of the inhabitants of the inner parts of Hangzhou would need to commute such long distance, whereas a considerable part of the outer-area residents would need to do so (both because of the deficit of jobs compared to residing workforce participants in these areas, and because the skills and interests of the residents of a given outer-area district do not necessarily match the job contents and qualification requirements of the available local jobs).

Regarding choices of residential location, a few interviewees indicate that this choice is influenced by a wish to limit commuting distances. Thus, one interviewee has bought a new apartment much closer to her workplace than her present residence, and another interviewee plans to move closer to (although still at a considerable distance from) his workplace. However, several other interviewees have moved, are about to move or have more vague ideas of moving to locations further away from their workplace than their previous or existing dwelling. In these cases, the choice of place of residence thus seems to be based on a 'best facility' criterion rather than a criterion of minimizing the friction of commuting distance. Yet, the minimizing of friction of distance need not necessarily refer to the distance to the interviewee's own workplace, but may also refer to the location of the spouse's job, or the homes of friends. The latter is suggested in one of the interviews.

Several of the interviewees of the Banshan area live in factory-owned apartments relatively close to their present or previous (in the case of a pensioner) workplace. This is an example of a limitation of commuting distance arranged for at a structural level.

When choosing places of higher-level education, the 'best facility' rationale also appears to take precedence within quite wide distance threshold. Such thresholds still do exist. In our material, this is illustrated by an interviewee whose daughter started at a school more than one hour's travel by bus away from home, but soon shifted to a closer school.

According to some interviewees, the quality of the facility is also given clearly more priority than proximity to the dwelling when choosing kindergarten for children. However, in practice this does not seem to result in choice of facilities very far from home (hardly more than 2 – 3 km). This probably reflects the fact that kindergartens are to a high degree dispersed all over the metropolitan area, at the same time as the quality differences are much smaller than, e.g., the differences in the suitability of the various jobs within the metropolitan area.

Visiting relatives in their homes is a particular type of activity where the relatives' dwellings are the only locations fulfilling the criterion of 'quality of the facility'. For such trips, the rationale of minimizing the friction of distance does not influence the trips destinations, but only the trip frequencies. For such trips, the rationale of minimizing the friction of distance thus translates into 'distance decay' if the given locations are far away from the interviewees' homes. A high

proportion of the interviewees visit close relatives quite regularly (each weekend or so), cf. the section on rationales for activity participation. This implies that during a considerable part of the week, a location different from the interviewees' own dwelling makes up the point of departure to which considerations about friction of distance minimizing refers.

For other non-bounded and partially bounded activities, the relative weight of the rationale of minimizing the friction of distance is higher, compared to the 'best facility' rationale (cf. above). When trying to balance between the two main rationales, residents may follow different procedures. Among our interviewees, three such procedures have been identified:

- A 'threshold distance' approach, where all facilities within this threshold are in principle considered as relevant locations. Which of them to choose is then based on a 'best facility' rationale, where sub-rationales related to the instrumental purpose and to cultural/atmosphere' criteria may indicate a preference for one or a few locations, whereas a sub-rationale of variety-seeking may lead to an alternation between a wider range of locations within the threshold distance.
- An algorithm of first trying the closest facility and then moving further on if necessary. The clearest example of this procedure is an interviewee who first visits the closest vegetable market, and then travels to the second closest if the desired commodities are not available at the first location.
- Internet-based survey of facilities (notably shops) in order to avoid unnecessary travel (and time spent within the shops) to locations where the desired commodities cannot be bought (or the desired activities cannot be performed).

For some leisure activities, an interesting difference can be seen in the prioritization between the 'best facility' and the 'minimizing friction of distance' rationales. When the main motive of the activity is social contact, such as when friends gather at a teahouse, finding a location that is easily accessible for a group as a whole appear to be much more important than choosing a facility of a particular quality (in terms of view, 'atmosphere', culinary experience, price level, etc.). However, when the main motive is the activity *per se*, the 'best facility' rationale gains more importance. The latter applies to, e.g., the visits of a married couple to a restaurant for a romantic meal. Also when the motive is social contact, but the setting is formal (e.g. restaurant meals with clients or customers), the 'best facility' rationale

gains increased importance, possibly because of a wish to impress the accompanying persons.

Apart from the different possibilities of simultaneously pursuing the 'best facility' and 'minimizing friction of distance' rationales, depending on the location of the residence relative to concentrations of facilities, there are few, if any, indications of systematic geographical variations in the occurrence of different rationales or their mutual prioritization.

5.8 Choosing modes of transportation

Main rationales

The interviewees' choices of travel modes are influenced by a number of different and interconnected rationales. These rationales could be classified into two main groups:

- Rationales concerning the *efficiency* of the movement from origin to destination
- Rationales concerning the *process* of moving from origin to destination

The first of these two groups includes concerns related the time consumption, economic costs and accessibility benefits of traveling by different modes. The second group includes concerns related to physically, psychologically and socially positive or negative aspects associated with traveling by a particular mode.

Among the rationales concerning the efficiency of the movement from origin to destination, the following appear to be the most important ones to our interviewees:

- Time-saving
- Flexibility
- Expansion of the radius of action
- Money-saving

The rationales concerning physical, psychological and social aspects associated with the process of traveling include:

- Comfort
- Limitation of physical efforts

- Relaxation
- Safety
- Aversion against frustrations
- Physical exercise
- Enjoyment of surrounding environment
- Affective dislike or preference for a particular mode
- Habits, and possibly also
- Demonstration of wealth and status

The rationale of *time saving* generally leads interviewees to choose those modes of travel that can bring them as fast as possible from their origin to their destination. Among interviewees who do not have a car at their disposal, this implies a preference for bike on short trips, taxi or bus for long trips, and avoiding the rush hours when traveling by bus. Among car owners, the time-saving rationale encourages the choice of car for long trips and non-motorized modes for short trips where car driving (including walking time to and from parking) would be more time-consuming than biking or walking.

The rationale of *flexibility* generally leads to a preference for individual modes of travel rather than public transport (due to the rigid layout of lines and time schedule of the latter). For short and medium-long trips, this implies a preference for bike (or walking for the shortest distances) rather than bus; for longer trips the flexibility rationale leads to a preference for car (or e-bike).

The rationale of *expanding the radius of action* is related to a rationale for activity location of choosing the best facility (see the previous section), as the use of motorized modes, in particular car, expands the geographical area within which relevant facilities can be chosen. For a particular trip, e.g. with the purpose of shopping, car may be chosen in order to visit a broader range of shops than would otherwise be possible within an acceptable level of time consumption. At a more structural level, the purchase of a car enables interviewees to consider wider geographical areas as potential locations for their 'bounded' trips (notably location of residence, workplace, and children's schools or kindergartens). On the other hand, once the locations of activities have been chosen, the distances to these locations exert important influences on modal choices. There is thus a mutual relationship between the rationale of expanding the radius of action and *trip distance* as a criterion influencing choices of travel mode (see below).

The rationale of *money-saving* generally leads interviewees to choose cheap means of transport. Among those who do not have a car at their disposal, this implies a preference for bike rather than bus or taxi, and for bus rather than taxi, at least when traveling alone. Among interviewees who have a car at their disposal, the money-saving rationale sometimes leads to the choice of other modes than car in order to avoid parking fees at the destination. In the same vein, an interviewee has chosen a cheap parking place five minutes' walk from home. For this interviewee, the money-saving rationale has thus turned walking into the most time-saving mode for short trips. Money-saving is also a (partial, together with social contact and comfort) rationale for traveling as car passenger with family members or friends. There are some indications that the money-saving rationale takes priority mainly for trips characterized by routine, while losing importance for non-bounded trips (in particular leisure/entertainment).

The rationale of *comfort* contributes to rule out walking or bike under unfavorable weather conditions (rain or hot sunshine), and crowded buses in the rush hour. A comfort rationale is probably also one of the reasons why an interviewee considers the soon-to-be-opened subway a much more attractive alternative than going by bus. It also contributes to make interviewees prefer to travel as car passengers when this is possible.

The rationale of *limiting physical efforts* contributes to rule out walk/bike for longer trips. At least, this rationale rules out these modes for trip distances exceeding a threshold value indicated by physical capacity restraints (stamina of the body). Usually, the rationale also implies that motorized modes are preferred for distances way below these thresholds (i.e. a sort of 'laziness', as stated by one interviewee).

A rationale of *relaxation* appears to increase the weight of the comfort rationale for trips to entertainment activities, leading to increased preference for taxi.

A rationale of *safety* is indicated by an interviewee who prefers to go by taxi instead of riding bike with his wife and little daughter along trafficked streets. Another interviewee's strong dislike of biking (see below) may possibly be rooted in exaggerated fear of being injured in a traffic accident. The safety rationale is, however, not expressed explicitly in any of the interviews, and it is not mentioned in any of the remaining interviews.

A rationale of *frustration aversion* contributes to a preference among some interviewees for bike before bus in order to avoid traffic jam

delays and the need to change between different routes, a preference for bike before taxi because of long waiting time before the taxi appears, or for other modes than car in situations where roads are congested or parking places are scarce.

A rationale of *physical exercise* contributes to a preference among some interviewees for non-motorized modes within wider distance limits than what would otherwise be the case, or for separate exercise walks with the walk itself as the main purpose.

A rationale of *enjoying the surrounding environment* induces some interviewees to increased non-motorized travel, both directly (due to the higher possibility of experiencing landscapes when not sitting inside vehicles) and indirectly (by stimulating interviewees to walk a lot for recreational purposes, thus creating a habit which may influence other trip purposes as well).

Affective dislike or preference for particular modes appears to influence the travel modes of some interviewees. In three cases, this makes interviewees totally avoid biking. On the other hand, one of these interviewees expresses a strong loyalty toward the bus mode.

Modal choices based on *habits* are in particular indicated among two interviewees whose more or less routinized car driving for occupational purposes may have created a habit of car driving, making them drive even when destinations are closer and/or other modes of travel would have been possible.

A rationale of *demonstrating wealth and status* probably also exerts some influence, although it is difficult to trace explicit demonstrations of this in the interviews. Such a rationale may induce interviewees to buy (an expensive) car and drive it even in situations where this would not be a rational choice based on other rationales, e.g. to very local destinations. The clear preference of one interviewee for the planned new subway to bus may also, at least partially, reflect a higher perceived status of traveling by rail than bus.

Trip distance as an intermediate criterion

Some of the rationales are encountered in many of the interviews, whereas other rationales are referred to explicitly by only a few interviewees. Several of the rationales are, however, also hinted at indirectly through a criterion of *trip distance* as an important criterion influencing the interviewees' choices of travel modes. Thus, trip distance appears to have the role of an *intermediate rationale* through which more basic rationales such as time saving and limitation of physical efforts influence modal choices. Typically, walking is

preferred for the shortest trips, bike for other trips within acceptable biking distance, and motorized modes (car, e-bike, bus, taxi) for trips beyond that distance. In as much as 19 of the 28 interviews, the interviewees' information about travel modes for different trips indicate clearly that travel modes depend to a high extent on trip distances.

Since long trips will be very time-consuming as well as physically exhausting if they are made by non-motorized modes (in particular by foot), rationales of time-saving and limitation of physical efforts will logically imply a dependence of travel modes on trip distances. Similarly, the time-saving or reduction of physical efforts that may be obtained when driving car (or using other motorized modes) disappears for very short trips, where it may be faster and involve less physical efforts to walk or ride bike directly to the destination than walk to the parking place, start the car, park it again after a very short drive and then walk from the parking place to the destination. By retroductive reasoning, it could therefore be assumed that the criterion of trip distance is likely to be based at least partially on underlying rationales of time-saving and limitation of physical efforts. The more importance attached to these two rationales, the more likely it is that the interviewee will apply trip distance as an important criterion for choice of travel mode.

Some other rationales may contribute to weaken the importance of trip distance as a criterion for modal choice. For example, interviewees sticking to a particular mode as a habit may disregard the benefits in terms of time-saving and efforts of walking instead of driving car for very short distances (e.g. less than a couple of hundred meters). Strong emphasis on rationales of comfort or an affective dislike against/preference for a particular mode could also reduce the role of the trip distance criterion. However, the clear relationship between trip distances and travel modes among more than two thirds of our interviewees suggests that these countering mechanisms are weaker than the mechanisms leading to the importance of the trip distance criterion.

As mentioned above, there is a mutual relationship between the intermediate criterion of trip distance and the rationale of expanding the radius of action. For non-bounded trips, this mutual influence takes place as a circular and more or less simultaneous process (with in a time span defined by the planning horizon of the specific trip). For bounded trips, the situation is somewhat different. Here, too, the decisions of travel modes and locations may be more or less intertwined (as in the case of an interviewee who plans to buy a car in

connection with his approaching move from the city of Hangzhou to a suburban residence). However, the locations once chosen continue to exert their influence (in combination with rationales for on modal choices) on the residents' modes of travel. In particular, this is the case if the choices of locations are based on the expanded radius of action offered by car travel. In such cases, the chosen locations of the origins and destinations of the 'bounded' trips congeal into a dependency on travel modes that can enable the residents to overcome long daily traveling distances.

Conditions influencing the emphasis attached to the various rationales

The emphasis attached by the interviewees on the rationales appears to be influenced by a number of individual and contextual conditions, including the interviewees' mobility resources, social obligations, time-geographical constraints, and the purpose of the trip:

- Individual mobility resources, where people who do not have any private motor vehicle at their disposal are excluded from choosing private car and other individual motorized modes of travel
- Physical stamina of the body, where people who are physically in good form may have a wide radius of action by bike or by foot, whereas physically disabled persons and other people with reduced ability for movement by non-motorized modes may depend on motorized conveyance even for very short distances
- Availability of time, where a tight schedule may increase the importance of a time-saving rationale
- Trip chaining, where the travel mode is usually set by the most distant destination
- Coupling restrictions, e.g. traveling together with family members or friends
- Economic constraints, inducing people to give a high priority to a money-saving rationale
- Cultural predisposition (cf. Bourdieu's (1984) concept of *habitus*), influencing which types of rationales are considered to be important and legitimate
- Trip purpose, where rationales of comfort and relaxation appear to be more important for trips in connection with entertainment and leisure activities

The interviewees' actual choices of travel modes are made in a process where the different rationales are applied to the interviewees' interpretation of the infrastructural facilitation for different modes (public transport service, driving conditions on the roads, parking capacity etc.) in the specific situation. This is usually not done as a conscious thought operation in connection with each separate trip, but is to a high extent routinized practices (cf. Giddens, 1979). However, routines have not always existed; they have once been established. For example, the choice of travel mode for journeys to work may be reflected on when starting to work at a new workplace, moving to a new residence, if the household purchases a car, or if the public transport services are being improved. Moreover, for non-routinized trips (e.g. in connection with leisure activities), a conscious consideration about which mode of travel to use may also take place, unless the interviewee's travel behavior is strongly influenced by habits or affective preference for a certain mode of travel.

Also for relatively routinized trips, the circumstances influencing the travel mode chosen for the particular trip may vary, for example in terms of time available or parking conditions.

For example, a male IT staff employee living in Cuiuyan told that he would take a taxi if he was in risk of being late for an appointment. If he had sufficient but not plenty of time, he would take a bus, whereas he would walk if he had plenty of time. Another interviewee from the same area (a male material manager) usually used to ride bike if the destination was close to his home. For motorized trips, his choices of travel mode were strongly influenced by parking conditions. If parking was expensive, like in the downtown area, he preferred to go by bus, otherwise by car. Parking difficulties could also make him ride bike instead of drive when making moderate-length trips, e.g. to supermarkets. The interviewee's rationales for modal choice thus seem to be time saving (choose fast modes for long trips), money saving (avoid high parking fees), and convenience/stress avoidance (avoid parking difficulties) and comfort/limitation of physical efforts (car is preferred to bike for medium distances if parking is not difficult). His balancing between these rationales is context-dependent, and his travel behavior is therefore characterized by multi-modality instead of being dominated by one mode routinely used.

5.9 Route choice

Alongside rationales for location of activities and modal choice, the reasons influencing choices of routes and paths may contribute to our understanding of the relationship between urban form and travel. Our identification of rationales for route choice applies to those who travel by individual modes of transport only (pedestrians, bike and e-bike riders, and car travelers). In the interviews, questions about reasons for route choices were asked only about trips by individual modes, as the routes of public transport travelers are largely determined by the layout of the public transport network (although some freedom exists e.g. regarding where to shift from one line to another).

Main rationales

The interviewees' choices of traveling routes are influenced by a number of rationales that may be classified into three main groups, i.e.

- Rationales concerning the efficiency of the movement from origin to destination
- Rationales concerning bodily aspects of the trip
- Rationales concerning psychological aspects of the trip

The rationales within the first of these groups are

- Time saving
- Avoiding risk of arriving too late for an appointment

The rationales concerning bodily aspects of the trip include

- Limitation of physical efforts
- Comfort
- Safety
- Physical exercise

The rationales concerning psychological aspects of the trip include

- Frustration aversion
- Esthetics
- Atmosphere
- Variety-seeking
- Habits

The above rationales work, often in combination, via a number of *intermediate strategies* for route choice, notably

- Distance minimizing
- Avoidance of congested streets
- Choosing streets characterized by good environmental qualities
- Avoiding deserted streets

The rationale of *time-saving* makes car drivers sometimes drive a longer route than the shortest one if the increased distance could be expected to be outweighed by higher traveling speed (typically because of less traffic jam). For bike riders, e-bike riders and walkers, the shortest route is normally also the fastest one (unless traffic lights and difficult crossings can be avoided by choosing an alternative route). However, some bike riders state that they prefer wide roads rather than narrow, crowded lanes if this does not increase the traveling distance significantly, thus avoiding to waste time riding slowly through crowds of people.

The rationale of *avoiding risk of arriving too late* for an appointment is tied to the rationale of time-saving, but leads interviewees to focus more on avoiding 'worst case scenarios' than on choosing the route that is normally the fastest one. It is thus a rationale of preparedness in situations where the level of congestion on the normally fastest road is unpredictable. This rationale makes one car-driving interviewee choose alternative, less congested routes if there is a risk of serious congestion on the normally fastest route.

A rationale of *limiting physical efforts* is an underlying motive on which the commonly mentioned strategic principle among bike riders and pedestrians of distance minimizing is partially based (see below). Among our interviewees, the rationale of limiting physical efforts is mentioned explicitly in only one case, but it seems obvious that this rationale is an important reason why interviewees traveling by non-motorized modes seldom choose routes deviating much from the shortest one.

A rationale of *comfort* is indicated by some pedestrians and bike riders who prefer routes where canopies, etc. provide shading from hot sun, and by an e-bike rider who prefer routes with few bumps.

Safety is indicated as a rationale influencing the route choice of some interviewees' trips by bike or by foot. This rationale includes concerns of *traffic safety* as well as safety from being robbed. One bike-riding

interviewee tries to avoid routes with 'too many cars and traffic'. Two other bike riders express their dissatisfaction about the conditions for walkers and bikers in the heavily trafficked streets in their inner-city neighborhood, but this does not seem to make them choose less trafficked routes (possibly because no such alternative exists?). Instead, one of these interviewees chooses to make his trips at a time when traffic is less heavy; i.e. the traffic safety rationale influences his trip scheduling instead of his route choice. Concerns about *safety from robbery* makes an interviewee prefer streets full of people rather than deserted streets when walking.

A rationale of *physical exercise* may make interviewees using non-motorized modes of travel (in particular pedestrians) choose considerably longer routes than the shortest one, in particular if all the trip ends in daily life are very close to the dwelling. This rationale thus acts as a compensatory mechanism in relation to the rationales encouraging interviewees to choose the shortest routes (notably time-saving and limitation of physical efforts).

A rationale of *frustration aversion* appears to influence the route choice of several interviewees in combination with the time-saving rationale. For some interviewees, a general aversion against being stuck in crowded situations seems to be a more important reason for avoiding congested routes than time-saving. For example, a car driver from Xiaoshan chooses roads where traffic jam can be avoided, regardless of any increased distance compared to the shortest route (i.e. even if the increase in traveling distance outweighs the time saving resulting from higher travel speed). The rationale of frustration aversion also applies to some bike riders, for example, a bike-riding inner-city interviewee tries to avoid narrow, crowded lanes, which make her feel frustrated, probably because she cannot ride at the speed she wants.

A rationale of *esthetics* is indicated among some interviewees for non-motorized trips and trips by e-bike, inducing them to prefer routes with 'nice environment' and/or green areas in the surroundings.

A rationale of *atmosphere* is indicated by an interviewee who prefers streets full of people rather than deserted streets when walking.

A rationale of *variety-seeking* is indicated by a few interviewees who sometimes change biking and walking routes for the sake of variation. In one case, this rationale induces an interviewee to choose walking routes (to non-bounded destinations) according to curiosity and his general mood, often leading to longer routes than the shortest ones, and regardless of esthetical qualities along the route. In another case,

an interviewee tried several bike routes to her workplace, but found after a while that those other than the usual one took longer time, and they were therefore no longer chosen. In this case, the variety-seeking rationale was thus quite weak and should probably be characterized rather as an exploratory strategy (cf. Downs, 1962), activated in the period before she had found out which route she actually considered as the preferable one.

Route choice based on *habits* is probably very common for 'bounded' trips, as these trips soon become routinized (cf. Giddens, 1979). Among our interviewees, habits are nevertheless only mentioned in two cases as reasons for the interviewees' route choices. Probably this reflects the fact that the interviewees were asked about their *criteria* for route choice, which would probably lead them to reflect on the origins of their habitual route choices. Since all habits have once been established, and since the routes later to be followed habitually must have been chosen for some reasons in the first place, the rationale of habits could therefore be considered as a 'quasi-rationale' (and more so for route choice than for modal choice, as the latter may be influenced by the traveling experiences of the interviewees during their adolescence).

Intermediate strategies

As mentioned above, the rationales work, often in combination, via a number of intermediate strategies for route choice, notably distance minimizing, avoidance of congested streets, choosing streets characterized by good environmental qualities and avoiding deserted streets.

The strategy of distance minimizing is motivated mainly by the rationales of time saving and limitation of physical efforts. The strategy of avoidance of congested streets is motivated mainly by the rationales of time-saving, frustration aversion and avoidance of risk of arriving too late. The strategy of choosing streets characterized by good environmental qualities is mainly motivated by rationales of esthetics, comfort and (traffic) safety, whereas the strategy of avoiding deserted streets is motivated by rationales of atmosphere and safety (against robbery). The remaining rationales (variety-seeking, physical exercise and habits) do not seem to be associated with any particular intermediate strategy, apart from the fact that interviewees who extend their traveling route in order to obtain physical exercise are unlikely to find congested street very attractive.

Among the four strategies mentioned, distance minimizing and avoidance of congested streets appear to be more influential on the

interviewees' route choices than the remaining two rationales. Moreover, the strategy of distance minimizing unambiguously implies a preference for the shortest route, while the three remaining strategies may or may not imply that a route different from the shortest one is chosen. This implies that the routes followed by the interviewees could be expected on average to exceed the shortest distances only by a small percentage. Needless to say, our qualitative interviews do not provide a basis for quantifying the amount of 'excess distance' compared to the shortest route.

Frequency of occurrence of the rationales

Among the rationales concerning the efficiency of the movement from origin to destination, the rationale of time-saving appears to be equally relevant for both motorized and non-motorized trips. The rationale of avoiding risk of arriving too late is probably more influential to the route choices of motorists than to bicyclists and pedestrians, as it is usually much more difficult for car drivers to escape from a route where they experience an unexpectedly high level of congestion than it is for bike riders to change to a less congested route if the originally chosen one turns out to restrict the traveling speed too much. For pedestrians, the rationale of avoiding risk of arriving too late is hardly relevant at all to route choice.

The rationales concerning bodily aspects of the trip are indicated only in connection with trips by foot, bike and (to a lesser extent) e-bike. Moving by their own muscles, pedestrians and bike riders experience the friction of distance as a bodily strain to a much higher extent than among travelers by motorized modes. The rationale of limiting physical efforts is thus much more relevant to the route choice of non-motorized trips, inducing the interviewees to choose routes not deviating much from the shortest one (and perhaps also to avoid unnecessary uphill climbing). Conversely, pedestrians and bike riders are the only traveler groups among whom a rationale of physical exercise might lead to the choice of a considerably longer route than the shortest one. Travelers by non-motorized modes are also much more vulnerable to injuries in traffic accidents as well as to criminal assaults, and the safety is therefore a more relevant rationale for the route choices of pedestrians and bike riders than for car travelers. The comfort rationale is probably also somewhat more relevant to the route choice of non-motorized travelers, who are more exposed to hot sun than those who sit encapsulated in their vehicles, and also probably have a higher possibility to choose routes through parks where canopies provide shading.

The rationales concerning psychological aspects of the trip are encountered in connection with trips by non-motorized as well as motorized modes. The travel modes still differ somewhat in the importance attached to the different rationales within this group. The rationale of frustration aversion seems to be more relevant to car travelers than to bike riders and pedestrians, for reasons similar to the difference between motorized and non-motorized travelers in the importance of the rationale of avoiding risk of arriving too late (cf. above). On the other hand, the rationale of esthetics is mentioned only by non-motorized travelers and e-bike riders. Compared to car travelers, these groups of travelers have better opportunities to experience the surroundings since they do not sit encapsulated inside vehicles. The rationale of variety-seeking is probably more independent of travel mode. However, this rationale does not appear to exert any strong influence on the interviewees' route choices, apart from an exploratory period when some interviewees try out different alternatives in order to find out which one they prefer.

Seen together, the rationales of time-saving and limitation of physical efforts seem to exert the strongest influence on the interviewees' route choices. In particular, the time-saving rationale seems important in the light of the proportions of travel accounted for by the different modes. Compared to time-saving and limitation of physical efforts, the rationales that may induce travelers to choose other routes than the shortest one are subordinate and only influence the route choice as long as their consequences to time consumption or distance are relatively small.

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

The above-mentioned rationales make up important links in the mechanisms by which urban structures influence travel behavior. As mentioned above, the rationales are partially interwoven. The choice of an individual is usually not based on one single rationale, but on a combination of (and a trade-off between) several rationales. Most of the rationales identified either contribute actively to strengthen the relationships between residential location and travel, or are neutral as regards these relationships. A few of the rationales form the base of "compensatory" mechanisms, which may contribute to weaken the relationships mentioned.

Tables 5.3 to 5.6 summarize how the various rationales contribute to the influences on travel behavior from the location of residences relative to the main concentration of facilities and to local facilities, respectively. The different rationales have all been identified in the qualitative interviews. The texts in columns 3 - 5 from the left are based partly on the data collected in the interviews, partly on theoretical assessments.

Table 5.3 *Contributions of various rationales for activity participation to the relationships between residential location and traveling distances.*

<i>Overall life-forms, lifestyles and rationales influencing activity participation</i>	<i>Frequency of occurrence</i>	<i>Influence on activity participation and location</i>	<i>Influence on the relationship between the amount of travel and the distance from the dwelling to the main center of the metropolitan area</i>	<i>Influence on the relationship between the amount of travel and the distance from the dwelling to local facilities</i>
Wage-laborer life-form	Indicated in 7 interviews	Increases the time available for leisure activities (and decreases the importance of choice rather than proximity as rationale for workplace location)	Since there is a concentration of leisure facilities in and around the downtown area of Hangzhou (including both traditional 'urban' leisure facilities and parks at the West Lake), the wage-laborer life form probably tends to strengthen this relationship somewhat as regards non-work travel. On the other hand, a lower emphasis on choice than proximity for job location increases the likelihood for suburbanites to choose local jobs, and may imply a certain weakening of the relationship between commuting distances and the distance from the dwelling to the main center of the metropolitan area.	Since there is a concentration of 'basic' leisure facilities (e.g. teahouses and restaurants) as well as local jobs in the local centers, the wage-laborer life form tends to contribute to this relationship both in terms of journeys to work and non-work travel.
Career-oriented life-form	Indicated in 5 interviews	Limits the time available for leisure activities (and increases the importance of choice rather than proximity as rationale for workplace location)	By reducing the time available for non-work trips the career-oriented life form tends to weaken the relationship between the amount of non-work travel and the distance from the dwelling to the main center of the metropolitan area. On the other hand, by reducing the propensity of suburbanites to choose local workplaces, the career-oriented life-form strengthens the relationship between commuting distances and the distance from the dwelling to the main center of the metropolitan area.	Since limited time available for leisure activities encourages the use of local facilities, the career-oriented life-form tends to strengthen the relationship between the amount of non-work travel and the distance from the dwelling to the closest local center. On the other hand, by reducing the propensity of suburbanites to choose local workplaces, the career-oriented life-form weakens the relationship between commuting distances and the distance from the dwelling to the closest local center.

Table 5.3 (continued)

Life-form of the self-employed	Indicated in 3 interviews	Increases the possibility of working locally Limits the time available for leisure trips	By reducing the dependence of suburban residents on the concentration of workplaces found in the central and inner city, as well as by reducing the time available for non-work trips, the life form of the self-employed tends to weaken the relationship between the amount of non-work travel and the distance from the dwelling to the main center of the metropolitan area.	Since even self-employed persons usually have their workplace in some kind of local center, the life-form of the self-employed tends to strengthen the relationship between commuting distances and the distance from the dwelling to the closest (lower-order) local center. In addition, since limited time available for leisure activities encourages the use of local facilities, the life-form of the self-employed tends to strengthen the relationship between the amount of non-work travel and the distance from the dwelling to the closest local center.
Upper middle class, consumerism-oriented lifestyle	Indicated in 3 interviews	Increases the amount of special commodity shopping	Since there is a concentration of special commodity shops in and around the downtown area of Hangzhou, the upper middle class, consumerism-oriented lifestyle tends to strengthen the relationship between the amount of non-work travel and the distance from the dwelling to the main center of the metropolitan area.	Since some special commodities may also be bought in (higher-order) local centers, the tendency of these interviewees to sometimes travel beyond the local center to downtown shops is (at least partially) counteracted by their generally higher frequency of special commodity shopping. The upper middle class, consumerism-oriented lifestyle is therefore likely to be relatively 'neutral' in its influence on the relationship between the amount of non-work travel and the distance from the dwelling to the closest local center.

Table 5.3 (continued)

Middle-class, culture-oriented lifestyle	Indicated in 6 interviews	Increases the frequency of visits to cultural facilities and events	Since there is a concentration of cultural facilities in the inner and central districts of Hangzhou, the middle class, culture-oriented lifestyle tends to strengthen the relationship between the amount of non-work travel and the distance from the dwelling to the main center of the metropolitan area.	Although some cultural facilities exist in (higher-order) local centers, the tendency of these interviewees to sometimes travel beyond the local center to downtown cultural facilities is probably stronger than any increased tendency to visit local centers for cultural purposes. Thus, the middle-class, culture-oriented lifestyle probably tends to contribute to a slight weakening of the relationship between the amount of non-work travel and the distance from the dwelling to the closest local center.
Money-making lifestyle	Indicated in 3 interviews	May increase the propensity to buy large consumer goods like cars and expensive dwellings. May at the same time reduce the time available for leisure trips.	By reducing the time available for leisure trips, the money-making lifestyle tends to weaken the relationship between the amount of non-work travel and the distance from the dwelling to the main center of the metropolitan area (around which there is a concentration of leisure facilities). On the other hand, increased mobility resources resulting from a high income may reduce the propensity to use local facilities and thus strengthen the relationship between the amount of travel and the distance from the dwelling to the main center of the metropolitan area.	By reducing the time available for leisure trips, the money-making lifestyle also tends to reduce the frequency of leisure trips to local facilities. Besides, increased mobility resources resulting from a high income may reduce the propensity to use local facilities and thus weaken the relationship between the amount of travel and the distance from the dwelling to the closest local center.

Table 5.3 (continued)

Wish for social contact (with other people than members of the household)	Indicated in 17 interviews	Increases the frequency of visits to teahouses, coffeehouses, restaurants etc.	Because of the high concentration of teahouses, coffeehouses, restaurants etc. in the inner-city, combined with the easy access to these facilities from different parts of the urban area, the rationale of social contact tends to strengthen the relationship between the amount of travel and the distance from the dwelling to the main center of the metropolitan area.	Because teahouses, coffeehouses, restaurants etc. often are available in local centers, and since the group of friends who gather at such facilities often live in the local district, the rationale of social contact also tends to strengthen the relationship between commuting distances and the distance from the dwelling to the closest local center.
Physical exercise/fitness	Indicated in 6 interviews	Increases the frequency of visits to sports facilities and green areas	Although there is a higher concentration of certain types of sports facilities (notably swimming pools) in the inner city of Hangzhou, the facilities for physical exercise are generally probably less centralized than what is the case, e.g., for special commodity stores. The rationale of physical exercise is therefore probably more or less 'neutral' in its influence on the relationship between the amount of travel and the distance from the dwelling to the main center of the metropolitan area.	Since sports facilities (except natural areas for outdoor recreation) are usually located in or close to centers (local or higher-level), the rationale of physical exercise probably contributes somewhat to strengthen the relationship between the amount of travel and the distance from the dwelling to the closest local center.
Esthetics	Indicated in 5 interviews	Increases the frequency of visits to picturesque landscapes and artistic events and facilities	Since esthetic qualities visited include both picturesque landscapes (which are often found outside the city) and art exhibitions, concerts etc. (which are often taking place centrally), the esthetics rationale is probably more or less 'neutral' in its influence on the relationship between the amount of travel and the distance from the dwelling to the main center of the metropolitan area.	Since the esthetic facilities visited are mainly either rural (natural landscapes, ancient villages etc.) or inner-city, the esthetics rationale may distract trip destinations away from local centers and thus imply a certain weakening of the relationship between the amount of travel and the distance from the dwelling to the closest local center.

Table 5.3 (continued)

Distance decay	Indicated in 9 interviews	Reduces the frequency of trips to non-local destinations	Distance decay tends to reduce the frequency of participation among suburbanites in 'non-bounded' and 'partially bounded' activities necessitating trips to the inner-city or to suburbs in the opposite part of the metropolitan area. Thus, distance decay tends to contribute to a certain weakening of the relationship between the amount of non-work travel and the distance from the dwelling to the main center of the metropolitan area.	By reducing the propensity to travel far away to reach facilities for 'non-bounded' and 'partially bounded' activities, distance decay strengthens the relationship between the amount of travel and the distance from the dwelling to the closest local center (which is usually too close to its catchment area for distance decay to occur in the use of its facilities).
Caretaking/family obligations	Indicated in 7 interviews	Limits the time available for leisure trips except with the family. Increases the frequency of visiting trips to relatives' homes and visits to parks	By reducing the time available for leisure trips, caretaking/family obligations tend to weaken the relationship between the amount of non-work travel and the distance from the dwelling to the main center of the metropolitan area (around which there is a concentration of leisure facilities). On the other hand, increased frequency of trips to relatives' homes and parks may strengthen this relationship slightly, since downtown approximates the point of gravity of all dwellings in the region, and due to the popular park areas at the West Lake.	By reducing the time available for leisure trips, caretaking/family obligations tends to reduce the number of such trips, regardless of destinations. On the other hand, those leisure trips which are carried out tend to go to destinations closer to the dwelling (e. g. to local parks and restaurants). Seen together, caretaking/family obligations probably imply a slight strengthening of the relationship between the amount of travel and the distance from the dwelling to the closest local center.

Table 5.4 *Contributions of various rationales for location of activities to the relationships between residential location and travel.*

<i>Rationales for activity location</i>	<i>Frequency of occurrence</i>	<i>Influence on activity location</i>	<i>Influence on the relationship between the amount of travel and the distance from the dwelling to the main center of the metropolitan area</i>	<i>Influence on the relationship between the amount of travel and the distance from the dwelling to local facilities</i>
Choosing facilities where the instrumental purpose of the activities can best be met	Emphasized by nearly all interviewees, but its importance varies between activity types and between individuals (Indicated in 25 interviews)	Tends to make the interviewees consider a large number of facilities within each facility category as potential locations of their activities, regardless of the distance from the dwelling to these facilities (as long as some quite wide threshold distance is not exceeded).	Contributes strongly to this relationship by increasing the likelihood of traveling to the large concentration of facilities in the inner parts of the metropolitan area, but also because of downtown's role as an approximate point of gravity for all peripheral destinations.	Contributes to a certain weakening of this relationship by increasing the likelihood of choosing distant facilities rather than local ones
Choosing facilities where social contacts can be maintained	Emphasized by several interviewees as a criterion for choosing which teahouses, restaurants etc. to visit. (Indicated in 11 interviews)	Tends to make interviewees choose facilities not only based on their own preferences, but on the common preferences (in terms of accessibility, quality criteria etc.) of a group of friends.	Contributes somewhat to strengthen this relationship because of downtown's role as an approximate point of gravity for the housing stock and its high accessibility by public transport.	May contribute somewhat to strengthen this relationship insofar as the groups of friends who decide to meet at teahouses etc. live in the same local district.
Choosing facilities matching the interviewees' cultural, esthetic and symbolic preferences	Emphasized by several interviewees as a criterion for location of leisure activities and also sometimes shopping. (Indicated in 10 interviews)	Tends to make interviewees choose certain picturesque, reputable or historically interesting areas as locations for leisure and shopping activities. These areas are to a high extent located around the West Lake and in the historical core of the city of Hangzhou.	Contributes somewhat to strengthen this relationship because several of the culturally, esthetic and symbolically most attractive areas are either located close to the downtown area or at locations easier accessible from the inner city of Hangzhou than from most of the outer parts of the metropolitan area.	Contributes to a certain weakening of this relationship by increasing the likelihood of choosing distant facilities rather than local ones

Table 5.4 (continued)

Variety-seeking	Mentioned or indicated by some interviewees as a reason for shifting between different recreational areas or supermarkets. (Indicated in 4 interviews)	Combined with rationales of choosing the best facility', variety-seeking tends to make interviewees sometimes choose more distant facilities than the closest one matching the interviewee's quality criteria.	Since a large number of alternative facilities can usually be found close to the dwellings of inner-city residents, variety-seeking is not likely to imply significantly increasing traveling distances among these residents. Due to the lower density of facilities in the outer parts of the metropolitan area, the variety-seeking of outer-area residents is more likely to imply increased traveling distances. The variety-seeking rationale thus probably contributes to a slight strengthening of the relationship between the amount of non-work travel and the distance from the dwelling to the main center of the metropolitan area.	By making interviewees sometimes choose more distant locations than what they would otherwise have done, variety-seeking tends to reduce the use of local facilities and thus tends to weaken the relationship between the amount of non-work travel and the distance from the dwelling to the closest local center.
Minimizing the spatial traveling distance	Emphasized by nearly all interviewees, in particular those without a car. Thresholds for acceptable distances vary between activity types and between individuals (Indicated in 25 interviews)	Tends to make the interviewees limit their choices of facilities for a given type of activity to those facilities which are accessible within a certain geographical radius, and to choose the closest facility meeting his/her quality criteria. Threshold distances are usually widest for workplaces and shortest for daily necessity shopping.	Contributes to some extent to this relationship, both because the facilities in the central districts of Hangzhou are the closest opportunities for inner-city residents, and because of the shortage of facilities in the periphery	Contributes strongly to this relationship by increasing the likelihood of choosing local facilities rather than more distant ones
Minimizing travel time	Although mentioned explicitly only by a few interviewees, time saving is probably of quite general importance as a sub-rationale contributing (together with distance minimizing) to minimizing the friction of distance. Thresholds for acceptable time consumption vary between activity types and between individuals (Indicated in 3 interviews)	Tends to make the interviewees limit their choices among facilities for a given type of activity to those facilities which are accessible within a certain travel time, and to choose the facility meeting his/her quality criteria which can be reached with the least time consumption. Thresholds for travel time are usually widest for workplaces and shortest for daily necessity shopping.	May induce some car drivers to choose, e.g., large suburban supermarkets instead of central-city shops. Contributes nevertheless to some extent to the relationship between the distance from the residence to downtown and the amount of travel, due to the function of the urban center as geographical point of gravity	Contributes to this relationship because it will usually take a short time to go to local facilities. But because travel speeds by car will often be higher when going to e.g. a more distant shopping mall with ample parking space, the influence of this rationale is not as strong as the influence of the rationale of limiting geographical distances

Table 5.4 (continued)

Minimizing the stress or physical efforts of traveling to the destination	Emphasized in particular among interviewees who do not have any private motorized vehicle at their disposal. (Indicated in 7 interviews)	Tends to make interviewees traveling by non-motorized modes limit their traveling distances, and to make interviewees traveling by public transport avoid destinations necessitating several and/or cumbersome shifts between different public transport lines.	Tends to weaken this relationship somewhat by increasing the propensity of suburbanites without a car at their disposal – in particular those living in areas with poor public transport services – to limit their choices among facilities to those available locally.	Contributes to this relationship by increasing the likelihood of choosing local facilities rather than more distant ones.
Minimizing economic expenses associated with the trip	Not mentioned explicitly in any of the interviews, but it is hard to imagine that this does not play some role as a sub-rationale contributing to minimizing the friction of distance, e.g. by limiting the frequency of long leisure trips. (Indicated in 0 interviews)	Tends to make interviewees use facilities within walking or biking distance to a higher extent than what they would otherwise do, and to choose destinations for car trips where it is not necessary to pay high parking fees. Contributes also somewhat to a general limitation of traveling distances by motorized modes.	May induce some car drivers to choose, e.g., suburban stores and leisure facilities instead of downtown facilities. Contributes nevertheless to some extent to this relationship, both because the facilities in the central districts of Hangzhou are the closest opportunities for inner-city residents, and because of the shortage of facilities in the periphery.	Contributes clearly to this relationship because local facilities will usually be the ones that can be reached with the smallest economic expenses.

Table 5.5 *Contributions of various rationales for choosing transport modes to the relationships between residential location and travel.*

<i>Rationales for choice among modes of travel</i>	<i>Frequency of occurrence</i>	<i>Influence on travel mode</i>	<i>Influence on the relationship between the mode of travel and the distance from the dwelling to the main center of the metropolitan area</i>	<i>Influence on the relationship between the mode of travel and the distance from the dwelling to local facilities</i>
Time-saving	Indicated in 9 interviews. In particular important to workforce participants with a tight time-budget, but probably of some importance to almost all interviewees.	Inducing interviewees to choose modes of travel that can bring them fast from their origin to their destination	Strengthens this relationship because the more slowly-moving car traffic in inner-city areas makes up an incitement for residents of these areas to choose non-motorized modes or public transport	Probably neutral, as the inner-city traffic conditions which may induce residents of these areas to choose non-motorized modes or public transport are to a much lesser extent present in local centers outside the inner city.
Flexibility	Indicated in 6 interviews, but probably of somewhat more general importance, dependent on values/attitudes	Inducing interviewees to choose individual modes rather than public transport	May strengthen this relationship because public transport is less flexible in the periphery and car traffic more hampered in inner-city areas	Probably neutral. The traffic conditions hampering car travel in the inner-city are to a much lesser extent present in local centers outside the inner city. At the same time, public transport to and from these centers is not very flexible. These circumstances probably balance the fact that facilities in local centers are often within walking or biking distances of the residents of their catchment areas.
Expansion of the radius of action	Indicated in 1 interview, but probably much more widespread, cf. the very common strategy of differentiating travel modes, depending on the trip distance	Induces interviewees to choose motorized means of travel (notably car) in order to be able to choose facilities otherwise located too far away.	Contributes to strengthen this relationship because the incentive to increase the radius of action, and hence the incentive to use car and other motorized means of transport, is higher in outer areas where a more narrow range of facilities is available within a short distance from the dwelling.	May also contribute to a slight strengthening of this relationship, since some residents who live far away from the closest local center may find it necessary to travel by motorized modes (notably car or e-bike) also in order to reach the most local facilities.

Table 5.5 (continued)

Money-saving	Indicated in 6 interviews	Inducing interviewees to choose cheap modes of travel, i.e. by non-motorized modes (if the destinations can be reached by foot or by bike without too much physical effort) or as car passenger, and to avoid traveling by car in congested areas or to destinations where high parking fees are charged.	Strengthens this relationship because of a higher gasoline consumption and more expansive parking in inner-city areas, and because the money-saving rationale may act as a catalyzer realizing the potential for non-motorized travel among residents living close to relevant destinations.	By increasing the incentive for using non-motorized modes and for avoiding driving by car to downtown areas with expensive parking, the money-saving rationale may increase the use of facilities in local centers, and hence increase the use of non-motorized modes among residents living sufficiently close to such centers. The money-saving rationale thus tends to strengthen the relationship between travel mode and the distance from the dwelling to the closest local center.
Comfort	Indicated in 7 interviews	Contributes to rule out non-motorized modes under unfavorable weather conditions, and crowded rush-hour buses.	By reducing the number of days when non-motorized modes are considered relevant, the comfort rationale may reduce the difference between residents of inner-city and suburban areas (where many destinations are anyway beyond acceptable walk/bike distances) in the use of these travel modes. The comfort rationale may thus weaken this relationship.	By reducing the number of days when non-motorized modes are considered relevant, the comfort rationale tends to reduce the use of such modes to local-center destinations among residents living within acceptable walking or biking distance from such a center. The comfort rationale thus tends to contribute to a slight weakening of the relationship between travel mode and the distance from the dwelling to the closest local center.
Limitation of physical efforts	Indicated in 8 interviews	Contributes to rule out walk/bike for trips above a certain length, but can also prevent the use of non-motorized modes for short trips.	Strengthens this relationship because a higher number of potential destinations are beyond acceptable walk/bike distance when living in a peripheral area, but can also weaken it by making some inner-city residents travel by motorized modes in spite of short trip distances	Strengthens this relationship because a higher number of potential destinations are beyond acceptable walk/bike distance when living far away from local facilities, but can also weaken it by making some residents travel by motorized modes in spite of short trip distances to the local center

Table 5.5 (continued)

Relaxation	Indicated in 3 interviews	Increases the weight of the comfort rationale for trips to entertainment activities, leading to increased preference for taxi.	Tends to contribute to a slight weakening of this relationship by replacing some walk-bike trips otherwise carried out by non-motorized trips among inner-city dwellers.	Tends to contribute to a (very) slight weakening of this relationship by replacing some walk-bike trips to local-center entertainment facilities otherwise carried out by non-motorized trips among residents living within acceptable walking or biking distance from such facilities.
Safety	Indicated in 1 interview	May induce residents to replace bike trips along heavily trafficked roads with bus, taxi or car trips	Tends to contribute to a slight weakening of this relationship by replacing some walk-bike trips otherwise carried out by non-motorized trips among inner-city dwellers	Tends to contribute to a slight weakening of this relationship by replacing some walk-bike trips to local-center facilities otherwise carried out by non-motorized trips among residents living within acceptable walking or biking distance from such facilities.
Aversion against frustrations	Indicated in 3 interviews	Contributes to a preference for bike before motorized modes in situations with congested streets, long waiting time for taxis or scarcity of parking places.	Strengthens this relationship by acting as a catalyst realizing the potential for non-motorized travel among residents living close to relevant destinations.	Both by increasing the incitement for using non-motorized modes to local destinations and by discouraging non-work trips to the congested downtown area where parking places are scarce, the frustration aversion rationale may increase the number of non-motorized trips to local-center facilities among residents living sufficiently close to such centers. The frustration aversion rationale thus tends to strengthen the relationship between travel mode and the distance from the dwelling to the closest local center.
Physical exercise	Indicated in 4 interviews	Contributes to a preference for non-motorized modes within wider distance limits than what would otherwise be the case.	May strengthen this relationship by realizing a potential for walk/bike when distances to facilities are moderate. May in extreme cases lead to the choice of bike even when destinations are far away.	May strengthen this relationship by realizing a potential for walk/bike when distances to facilities are moderate. May in extreme cases lead to the choice of bike even when destinations are far away.

Table 5.5 (continued)

Enjoyment of surrounding environment	Indicated in 1 interview	Induces some residents to an increased amount of non-motorized travel.	May strengthen this relationship by realizing a potential for walk/bike when distances to facilities are moderate.	May strengthen this relationship by realizing a potential for walk/bike when distances to facilities are moderate.
Affective dislike or preference for a particular mode	Indicated in 3 interviews	Makes three interviewees totally avoid biking, but could in principle be directed toward any mode of travel.	Among the actual interviewees, affective dislike or preference tends to reduce the potential for biking among inner-city residents and thus weaken this relationship. However, since affective dislike or preference could in principle be directed toward any mode of travel, this rationale must in principle be considered 'neutral' in its influence on the relationship between travel mode and the distance from the dwelling to the main center of the metropolitan area.	Among the actual interviewees, affective dislike or preference tends to reduce the potential for biking among residents living close to local-center facilities and thus weaken this relationship. However, since affective dislike or preference could in principle be directed toward any mode of travel, this rationale must in principle be considered 'neutral' in its influence on the relationship between travel mode and the distance from the dwelling to the closest local center.
Habits	Indicated in 2 interviews, but probably of some importance to most interviewees. However, new habits may also be developed	Makes some interviewees who travel much by car for occupational purposes prefer car travel even when destinations are close or other travel modes would have been possible. May also imply an inertia among people who have moved to a new dwelling in the adaptation of modal choice to a different urban structural situation	Possibly a certain weakening due to inertia in connection with moving as well as a tendency of not adapting the travel mode to the trip distance or urban structural situation in general.	Possibly a certain weakening due to inertia in connection with moving as well as a tendency of not adapting the travel mode to the trip distance or urban structural situation in general.

Table 5.5 (continued)

Demonstration of wealth and status	(Indicated – but quite weakly – in 3 interviews)	May induce interviewees to buy (an expensive) car and drive even in situations where this would not be rational based on other rationales.	May on the one hand lead to increased car travel among inner-city residents and thereby weaken this relationship. On the other hand, in a situation with a generally low level of car ownership among the population and a considerable potential for increased car ownership also in the suburbs, demonstration of wealth and status may also trigger car purchase and car travel among outer-area residents. Seen together, this rationale could be considered 'neutral' in its influence on the relationship between travel mode and the distance from the dwelling to the main center of the metropolitan area.	Probably more or less 'neutral', see the previous column.
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Table 5.6 *Contributions of various rationales for route choice to the relationships between residential location and travel.*

<i>Rationales for route choice</i>	<i>Frequency of occurrence</i>	<i>Influence on route choice</i>	<i>Influence on the relationship between the amount of travel and the distance from the dwelling to the main center of the metropolitan area</i>	<i>Influence on the relationship between the amount of travel and the distance from the dwelling to local facilities</i>
Time saving	Of importance to the route choice of cyclists and pedestrians as well as car drivers. Indicated in 11 interviews, but probably of a quite general relevance.	Implies a general preference for the fastest route. Makes interviewees (in particular car drivers) sometimes drive a longer route than the shortest one if the increased distance could be expected to be outweighed by higher traveling speeds. Yet, the shortest route is often also the fastest one.	Implies that the interviewees are not apt to make long detours from the fastest route. Such detours might disturb the relationship between the amount of travel and the distance from the residence to relevant facilities. Supports the general activity-based approach to transport analysis	Implies that the interviewees are not apt to make long detours from the fastest route. Such detours might disturb the relationship between the amount of travel and the distance from the residence to relevant facilities. Supports the general activity-based approach to transport analysis
Avoiding risk of arriving too late for an appointment	Indicated in 1 interview.	Implies a preference for routes with a low risk of unpredictable delays. May in some cases induce (car) travelers to choose alternative, less congested routes if there is risk of serious congestion on the normally fastest route.	As unpredictable delays may occur on inner-city as well as outer-area roads, and the increase in trip length resulting from choosing an alternative route hardly differs systematically between inner and outer areas, this rationale must be considered neutral in its influence on the relationship between the amount of travel and the distance from the dwelling to the main center of the metropolitan area.	Neutral, for similar reasons as mentioned in the previous column.
Limitation of physical efforts	Of relevance to the route choice of pedestrians and bike riders. (Indicated in 1 interview, but probably relevant to most non-motorized interviewees)	Induces non-motorized travelers normally to choose the shortest route (unless this route is more physically exhausting for some reason, e.g. hilly terrain).	Implies that the interviewees are not apt to make long detours from the shortest route. Supports the general activity-based approach to transport analysis. Does not cause any distortion of the relationship between the amount of travel and the distance from the dwelling to the main center of the metropolitan area.	Implies that the interviewees are not apt to make long detours from the shortest route. Supports the general activity-based approach to transport analysis. Does not cause any distortion of the relationship between the amount of travel and the distance from the dwelling to the main center of the metropolitan area.

Table 5.6 (continued)

Comfort	(Indicated in 3 interviews)	Induces some pedestrians and bike riders to prefer routes where canopies etc. provide shading from sun, and travelers in general to avoid routes with many bumps.	May imply a certain but usually modest deviation from the fastest or shortest route. Hardly any influence on the relationship between the amount of travel and the distance from the dwelling to the main center of the metropolitan area.	May imply a certain but usually modest deviation from the fastest or shortest route. Hardly any influence on the relationship between the amount of travel and the distance from the dwelling to the closest local center.
Safety	(Indicated in 1 interview)	May induce bike riders to avoid heavily trafficked streets (due to risk of traffic accidents) and pedestrians to avoid deserted streets (due to risk of robbery)	May imply a certain but usually modest deviation from the fastest or shortest route. Hardly any influence on the relationship between the amount of travel and the distance from the dwelling to the main center of the metropolitan area.	May imply a certain but usually modest deviation from the fastest or shortest route. Hardly any influence on the relationship between the amount of travel and the distance from the dwelling to the closest local center.
Physical exercise	(Indicated in 1 interview)	May induce some non-motorized travelers to choose considerably longer routes than the shortest one, in particular if all the trip ends in daily life are very close to the dwelling	Implies a certain blurring of the relationship between the amount of travel and the distance from the residence to relevant facilities. Forms the basis of a compensatory mechanism contributing to a certain weakening of the relationship between the amount of travel and the distance from the dwelling to the main center of the metropolitan area. Since such non-motorized trips are made to a high extent with movement as a purpose of its own, they do not fit with the general activity-based approach to transport analysis.	See the previous column. Contributes to a certain weakening of the relationship between the amount of travel and the distance from the dwelling to the closest local center.

Table 5.6 (continued)

Frustration aversion	(Indicated in 4 interviews)	Influences the route choice of several interviewees (in particular car drivers) in combination with the time-saving rationale, making them avoid congested roads. In some cases, this rationale induces travelers to choose roads where traffic jam can be avoided even if the increase in travel distance outweighs the time saving resulting from higher speed.	Since car travel in the rush hours is more widespread among suburbanites than among inner-city dwellers, the increased traveling distances caused by this rationale are likely to lead to a certain increase in the difference between inner- and outer-area residents in traveling distances. The frustration aversion rationale may therefore imply a slight strengthening of the relationship between the amount of travel and the distance from the dwelling to the main center of the metropolitan area.	For similar reasons as regarding the distance from the dwelling to the main center of the metropolitan area, the rationale of frustration aversion may imply a slight strengthening of the relationship between the amount of travel and the distance from the dwelling to the closest local center.
Esthetics	(Indicated in 6 interviews)	Inducing some interviewees (mainly non-motorized and e-bike travelers) to prefer routes with 'nice environment' and/or green areas in the surroundings. (May also influence the route choices of car drivers' leisure trips in the countryside, but the interviews include no such examples.)	Both because the deviations from the shortest route are usually small among non-motorized travelers and because the extension of trip distance in order to experience esthetically preferred environments is unlikely to vary systematically with the center-periphery gradient, this rationale hardly exerts any influence on the relationship between the amount of travel and the distance from the dwelling to the main center of the metropolitan area.	Neutral, cf. the previous column.
Atmosphere	(Indicated in 1 interview)	Encouraging a choice of streets full of people rather than deserted streets when walking	Since any increased walking distance due in order to follow 'atmosphere-filled' streets is likely to be quite minimal, compared to the total traveling distances of inner- and outer-area residents, this rationale hardly exerts any influence worth mentioning on the relationship between the amount of travel and the distance from the dwelling to the main center of the metropolitan area.	Neutral, cf. the previous column.

Table 5.6 (continued)

Variety-seeking	Indicated in 2 interviews	Encouraging some interviewees to change between traveling routes for the sake of variation	Implies that routes other than the fastest or shortest one are sometimes chosen, and thus a certain blurring of the relationship between the amount of travel and the distance from the residence to relevant facilities. Because the extensions of trip distance due to variety-seeking are unlikely to vary systematically with the center-periphery gradient, this rationale hardly exerts any influence on the relationship between the amount of travel and the distance from the dwelling to the main center of the metropolitan area.	Neutral, cf. the previous column.
Habits	Indicated in 2 interviews, but probably very common for routinized trips. Could be considered a 'quasi-rationale' since the habitual routes must have been chosen for some reason in the first place.	Discouraging interviewees to change from routes once chosen to destinations visited regularly	Not likely to affect the relationship between the amount of travel and the distance from the dwelling to the main center of the metropolitan area.	Neutral, cf. the previous column.

Consequences of life-forms, lifestyles and rationales influencing activity participation

Among the life-forms, lifestyles and rationales influencing activity participation, the relationship between the amount of transport and the distance from the residence to the *main center of the urban region* tends to be strengthened by an affluent consumerist lifestyle, a culture-oriented lifestyle, and a preference for leisure activities involving social contact. This relationship seems to be weakened by the life-form of the self-employed and among persons whose activity pattern shows strong distance decay (i.e. reduced frequency of participation when the activity can only be performed at distant locations). The remaining six life-forms, lifestyles or rationales are either neutral as regards the relationship between the amount of transport and the distance from the residence to the main center of the urban region, or involve counteracting mechanisms more or less balancing each other.

The relationship between the amount of transport and the distance from the residence to the *closest local center* tends to be strengthened

by the wage-laborer life-form, the life-form of the self-employed, a preference for leisure activities involving social contact, a wish for physical exercise and among persons whose activity pattern shows strong distance decay. It also appears to be slightly strengthened among persons with caretaking/family obligations. The relationship between the amount of transport and the distance from the residence to the closest local center tends to be weakened by a money-making lifestyle and, to some extent, a culture-oriented lifestyle and a rationale of esthetics. The remaining two life-forms/lifestyles are either neutral as regards this relationship, or involve counteracting mechanisms more or less balancing each other.

Consequences of rationales influencing the location of activities

Among the rationales influencing the interviewee's location of activities, the relationship between the amount of transport and the distance from the residence to the *main center of the urban region* tends to be strengthened by in particular by the rationale of choosing facilities where the instrumental purpose of the activities can best be met, but also by the rationales of social contacts and cultural/esthetic/symbolic preferences, and (to a lesser extent) the rationales of variety-seeking, minimizing spatial traveling distance, minimizing travel time, and minimizing economic expenses. The only rationale among those identified that contributes to weaken this relationship somewhat is the rationale of minimizing the stress or physical efforts of traveling.

The relationship between the amount of transport and the distance from the residence to the *closest local center* tends to be strengthened in particular by the rationale of minimizing spatial traveling distance, but also by the rationales of social contacts, minimizing travel time, minimizing the stress or physical efforts of traveling, and minimizing economic expenses. This relationship seems to be weakened by the rationales of choosing facilities where the instrumental purpose of the activities can best be met, cultural/esthetic/symbolic preferences, and variety-seeking.

Consequences of rationales influencing choices of travel mode

The relationship between the modal split and the distance from the residence to the *main center of the urban region* tends to be strengthened by the rationales of time-saving, flexibility, expanding the radius of action, money-saving, frustration aversion, physical exercise, and enjoyment of the surroundings along the route. This relationship seems to be weakened by the comfort rationale and to a lesser extent also the rationales of relaxation, safety and habits. The

remaining three rationales are either neutral as regards this relationship, or involve counteracting mechanisms more or less balancing each other.

The relationship between the modal split and the distance from the residence to the *closest local center* tends to be strengthened by the rationales of money-saving, frustration aversion, physical exercise, and enjoyment of the surroundings along the route. This relationship appears to be slightly weakened by the rationales of comfort and safety. The remaining six rationales are either neutral with respect to this relationship, or involve counteracting mechanisms more or less balancing each other.

Consequences of rationales influencing route choice

The relationships between the amount of travel and the distance from the dwelling to the city center and local centers is theoretically based on the assumption that there is no systematic difference between inner-city and outer-area residents in the extent of any deviations from the shortest route. If such a systematic difference weakening the relationship between residential location and travel were to exist, the routes followed to the various trip destinations would on average have to deviate considerably from the shortest ones, and the detours would have to be longer among inner-city than among outer-area residents. Among our rationales, some affect the occurrence of detours, while others affect whether any detours tend to be longest among inner-city or among outer-area residents.

The rationale of limitation of physical efforts indicates that non-motorized travelers tend to make only small, if any, deviations from the shortest routes, whereas the rationale of physical exercise can make some bicyclists and pedestrians choose considerably longer routes than the shortest ones. The rationales of comfort, safety, esthetics and atmosphere apply mainly to non-motorized travelers and may imply some deviation from the shortest route, albeit probably quite modest due to influence from the widespread rationale of limiting physical efforts. The rationales of time-saving and frustration aversion may sometimes cause car travelers to choose longer routes than the shortest one, but since the shortest route is usually also the fastest one, the average additional trip distance is likely to be modest.

Seen together, the rationales influencing the route choices appear to cause little deviation from the shortest routes among car travelers, at least as long as we are dealing with daily-life transport. Some rationales influencing the route choices of non-motorized travelers may also lead to increased trip lengths, compared to the shortest route,

but apart from the rationale of physical exercise, the additional trip distances are likely to be very modest. Thus, with the exception of the rationale of physical exercise, which may lead to considerable deviations from the shortest route when making exercise trips by foot or by bike, the rationales for route choice generally support the activity-based approach in transport research (Jones, 1990; Fox, 1995).

Moreover, for most of the rationales that might imply some deviations from the shortest route, the increases in trip lengths are likely to be independent of whether the resident lives in the inner city or a peripheral part of the urban area. For two rationales, such a systematic variation may still occur. Since the need for extending the length of bike or walking trips in order to obtain sufficient exercise is higher if the destination is close than if it is located far away, the tendency to exercise-motivated detours is likely to be more widespread among inner-city dwellers than among their outer-area counterparts.

However, from an environmental and greenhouse gas perspective, this compensatory mechanism contributing to somewhat increased traveling distances among exercise-minded inner-city residents is unimportant, as these non-motorized trips consume no fossil energy and generate no greenhouse gas emissions whatsoever. The second rationale that tends to increase trip distances differently among inner- and outer-area residents is frustration aversion. This rationale may induce car travelers to choose roads where traffic jam can be avoided, even if the increase in travel distance outweighs the time saving resulting from higher speed. Since car travel in the rush hours is more widespread among suburbanites than among inner-city dwellers, the increased traveling distances caused by this rationale are likely to lead to a certain increase in the difference between inner- and outer-area residents in traveling distances. To some extent, the relationship between the amount of travel and the distance from the dwelling to the closest local center may also be strengthened, although living close to a local center are most often more prone to commute by car than the residents living close to the main center of the metropolitan area.

5.11 Tendencies and necessities

In order to throw further light on the mechanisms by which residential location influences travel behavior, the above consideration of the influences of the various rationales will be supplemented below by a discussion where the Critical Realist concepts of *tendency* and *necessity* are used to illustrate some of the causal links between residential location and commuting distances. Actually, even

respondents giving high priority to the rationale of travel distance limitation, and who are hence at the outset willing to renounce on the wider options available if job opportunities were considered within a larger geographical area, may be compelled to accept long journeys to work in order to have any paid work at all.

As mentioned in chapter 2, our conception of the notion of causality is not confined to monocausal relationships. Rather, we consider – in line with Critical Realist philosophy of science – causes like ‘tendencies’. These may or may not be actualized since counteracting causes can neutralize, trigger as well as reinforce a causal tendency, and thus prevent or create an empirical effect or event. (Danermark et al., 2001:56). Such a notion of causality might be seen as a ‘dynamic’ form of causality, as change and interaction between multiple interacting forces is interpreted in a way qualitatively different from the empiricist concept of causality, where a cause *X* is assumed to always result in an effect *Y*:

“People’s actions are never determined by a certain structure, they are merely conditioned. [...] There is always the possibility that we ‘make a mistake’, intentionally or unintentionally, compared with different structural ‘imperatives’.” (Danermark et al., 2001:56.)

Time-geographical constraints on daily-life activities (Hägerstrand, 1970) amplify the “structural imperative” on travel behavior conditioned by residential location. In our context, the concept of *tendencias* implies, for example, that a peripheral location of residence relative to the distribution of workplaces in the region tends to produce long commutes. Given the spatial distribution of workplaces of different types, there is a structural imperative saying that residents of the outer suburbs need to accept a long commuting distance in order to find a suitable job, unless a workplace of a relevant category happens to be located in the local area, and the resident in question succeeds in getting employed in a vacant job at this local workplace. The possibility (albeit with a low likelihood) of the latter implies that a peripheral residential location does not *always* produce long commutes, but it *tends* to do so. And the long commutes are not equally long: some may go to the inner city, some to a peripheral area at the opposite side of the city region, and some to a workplace between residence and downtown. The actual configuration is contingent on the ways people actually apply for jobs and manage to get employment within the metropolitan labor market. Still, there is a mechanism producing long commutes among a greater proportion of residents living a long way from the largest concentrations of

workplaces than of those living close to them. Hence, residents on the periphery tend to make longer commutes (unless they forego the freedom to choose the most suitable and attractive workplace, that is, limit the number of work opportunities available for choice to a lower number than the number that can be chosen by inner-city dwellers). Given the stronger centralization of jobs than residences within the metropolitan area, even a willingness to make such sacrifices would not prevent a considerable proportion of the peripheral residents from being forced to make long commutes, or accept unemployment.

The Critical Realist notion of tendency is tied to the term of *necessity*. Necessity indicates the existence of internal relations between objects in reality, internal relations which are the cause of emergence or, we might also say, which determine *what* it is that exists. There are also external relationships between the social objects – relations that do not determine what exists, but do determine *whether* and *how* that which exists will manifest itself. (Danermark et al., 2001:187). The actual location of dwellings of different sizes and standards over the Copenhagen metropolitan area, combined with the actual distribution of workplaces with different qualification requirements, results in a shortage of suitable jobs within a moderate commuting distance when living on the periphery, but not when living in the city center. Combined with the coupling restrictions (Hägerstrand, *ibid.*) of being present at the workplace, and the wage labor structure of our society, this *necessitates* that a high proportion of residents on the periphery make long commutes, while the proportion of inner-city dwellers who need to make long commutes is much smaller. This is an *internal* relationship between the location of residences and the location of workplaces within the urban area, given the requirements of the contemporary labor market. The actual way this relationship manifests itself is, however, *contingent* on the ways residents of different areas are actually able to obtain employment. For example, a resident of a peripheral settlement might be employed at a local consulting firm instead of having to commute to a similar firm in the inner city. However, this short commute, which is atypical for her local community, at the same time makes it unnecessary for a resident living closer to the center to make an outward commute to the otherwise vacant job in the peripheral settlement.

After the preceding thorough discussion of rationales for activity participation, location of activities, travel modes and route choice, and the way these rationales influence relationships between residential location and travel, the next sections will focus on some more detailed issues, viz. the interviewees' assumptions concerning accessibility, activity opportunities and car dependency; the role of downtown as a

trip destination; the influence of culturally based locational preferences; the spatial pattern of social contacts, and the role of the transport infrastructure.

5.12 Accessibility, activity opportunities and car dependency – according to the interviewees’ opinions

In the two inner-city interviewee areas, 7 out of 11 interviewees explicitly mention convenient and easy accessibility to a broad range of facilities as a quality of their residential area, whereas the remaining four interviewees do not mention anything specifically about this issue. Distinct from that, none of the interviewees of Banshan and Zhuangtang mention easy accessibility to facilities as a quality of their residential area, except one Banshan interviewee who points at the proximity of her residential area to her workplace. In Xiaoshan, four of the five interviewees say that they find the location of the residential area close to downtown Xiaoshan convenient.

Thus, residential location clearly seems to influence the interviewees’ perception of whether or not they have convenient access to relevant facilities. Density and location close to centers or sub-centers with well-assorted shops and leisure facilities seem to be the key factors. Whether the residential area is located close to downtown Hangzhou or downtown Xiaoshan appears to be less important to the interviewees’ perception of accessibility. However, it should here be borne in mind that the interviewee area of Xiaoshan is located close to the very downtown center of Xiaoshan, whereas the two inner-city interviewee areas of Hangzhou are located at 2.5 and 5 km airline distance, respectively, from the city center of Hangzhou. However, the equally high feeling of living in a convenient area with high facility accessibility among Xiaoshan interviewees as among interviewees of inner-city Hangzhou may also indicate that Xiaoshan is a sufficiently large town to sustain a local downtown with an almost full range of facilities. The interviewees may perhaps also limit their conception of facility accessibility in this context to shopping and leisure facilities while disregarding their commuting distances. (Cf. the fact that Xiaoshan is the interviewee area where long commuting trips occur most frequently among the interviewees.)

Several interviewees think that their frequency of participating in different activities might be influenced if they moved from their

present residential area to a different type of residential location. The activity types mentioned are visits to green areas, use of indoor leisure facilities like restaurants etc., and socializing with neighbors.

Five interviewees living in Xixi Road and downtown Xiaoshan think they would maybe go more often to local parks/green areas if they lived in a suburb. On the other hand, two Zhuangtang interviewees think they would visit parks (notably around the West Lake) more frequently if they lived downtown. Oddly enough, none of the interviewees of Cuiyuan mention more frequent use of green areas as a possible consequence of moving to a suburban location, in spite of the fact that Cuiyuan is the only interviewee area with a low availability of green areas in the proximity of the dwellings. Seen together, the interviews are somewhat inconclusive regarding the influence of the center-periphery dimension on the use of green recreational areas. Again, the high availability of green areas near the dwellings in four of the five interviewee areas, and the easy access from Xixi Road not only to the adjacent Baoshi and Geling hills, but also to the West Lake and its surroundings, should be kept in mind. It should also be noticed that the availability of free-access green areas may be limited in some suburban villages surrounded by mainly rural areas, where trespassing farmland may be forbidden for persons not concerned.

One inner-city interviewee (in Xixi Road) thinks that he would have to spend more time in traffic if he moved to a suburb. Conversely, time-geographical restrictions imply that an outer-area interviewee (in Banshan) makes less use of downtown leisure facilities than she would probably have done with a central residential location, and three interviewees from dense urban districts (Cuiyuan and downtown Xiaoshan) think they would have fewer out-of-home leisure activities if they lived in a suburb. In line with this, two interviewees from Zhuangtang think they would visit teahouses and restaurants more often if they lived in the downtown area of Hangzhou.

The interviews thus indicate quite clearly that the higher availability of restaurants, teahouses and other indoor leisure facilities in central parts of the metropolitan area (including the downtown area of the secondary town of Xiaoshan) encourages the residents of these areas to more frequent use of such facilities than among suburban residents. On the other hand, because it is more inconvenient for residents of a small suburban community like Zhuangtang to visit the broad range of leisure facilities located in the inner city of Hangzhou, their leisure activities tend to be more oriented toward the local area. In line with this, one of the Zhuangtang interviewees believes that he would not

have known so many of his neighbors if he lived in the downtown area. (Cf. also the section below about local acquaintances and neighborhood contact.)

Keeping car dependence for occupational trips aside, five interviewees say more or less explicitly that their activity pattern depends to some extent on car travel. However, for three of these interviewees (living in Cuiyuan and Banshan), the interviews do not mention any activities that would be changed or dropped if the families were to make it without a car, and it does not appear plausible from the interviews that any of their daily-life activities actually depend on car traveling (but maybe some more occasional visiting trips or leisure activities).

The leisure and social activities of two interviewees living in Zhuangtang and Xiaoshan seem to be somewhat more dependent on car travel, and these interviewees would probably have to reduce these activities if they did no longer have access to a car. Several of their leisure activities take place in the inner city of Hangzhou, and these interviewees' dependence on car travel in order to realize their activity pattern is thus to some extent a result of their residential location. The car-dependence of their leisure activities is partly indirect, in the sense that some 'bounded' and 'partially bounded' activities would take more time if the interviewees could not go by car, and thus leave less time available for leisure trips.

5.13 Downtown as a trip destination

In spite of the easier accessibility to downtown from the inner-city areas than from the outer areas, the interviewees from the outer interviewee areas carry out clearly more activities in the downtown area than the interviewees from the two inner-city areas. Admittedly, some of this difference may be due to a tendency among the inner-city interviewees, in particular those from Xixi Road, to define downtown as a quite narrow spot around the middle of Yan'an Road, whereas the interviewees of the outer areas tend to conceive of downtown as a larger part of inner-city Hangzhou. However, this is hardly the only explanation. For outer-area residents, downtown will usually be more accessible by public transport than other inner-city locations. Therefore, outer-area residents may tend to choose downtown facilities rather than similar facilities elsewhere in the inner city. Moreover, it may be easier for outer-area residents to find their way to downtown than to other locations in the inner city, both because downtown will often be a more well-known place and because of its location close to

the West Lake (cf. Lynch, 1960). Downtown and the West Lake may thus have a function as points of orientation, and this may induce people who are not familiar with other parts of the inner city to prefer downtown stores and leisure facilities. Residents of the inner areas are probably to a higher extent aware of facilities outside the very downtown area, and may prefer to use these facilities because they are closer and perhaps also have lower prices and/or are less crowded.

Perhaps a bit surprising, the interviewees living furthest away from downtown Hangzhou (the interviewees of Xiaoshan) are the ones who most often attribute 'atmosphere' qualities to the downtown area, whereas the interviewees of Xixi Road are either silent about the issue or say that there are no particular qualities associated with the downtown area. The reasons for this difference are likely to be partly the same as for the differences in the use of the downtown area: different perceived spatial demarcations of what downtown means, different knowledge of inner-city facilities outside the very downtown area, and higher accessibility for peripheral bus travelers to the downtown area than to other inner-city locations. The tendency is still not clear, and among the interviewees of another peripheral area (Zhuangtang) there are few, if any, who consider that the downtown atmosphere has any particular qualities, whereas three of the interviewees of the inner-city area of Cuiyuan attribute some such qualities to downtown Hangzhou. One might imagine that the valuation of downtown qualities might vary with the interviewees' 'cultural capital' (Bourdieu, 1984) in terms of education level and type, but there are no such indications in the interviews.

Overall, about one third of the interviewees attribute certain 'atmospheric' qualities to the downtown area, but for some of these interviewees, these qualities consist of the scenic location close to West Lake more than the density of activities and people in the streets.

5.14 Culturally based location preferences

Almost none of the interviewees mentions any locations that they for cultural or lifestyle reasons prefer to visit or avoid. Two interviewees reveal such preferences: a female office clerk living in Banshan has a preference for downtown and the surroundings of the West Lake (and is about to move to the downtown area), while a male bank manager living in the Zhuangtang area signals that he does not like to visit shopping malls.

Our material does not provide evidence of any perception among the interviewees of the urban landscape as consisting of particular 'go' and 'no go' areas – at least they generally do not express any such opinions²⁸. The mentioning of two interviewees of downtown/West Lake as attractive and shopping malls as unattractive may be interpreted as supplementary indications of the 'atmosphere' qualities attributed by some interviewees to the downtown area, which may encourage them to choose central-city shopping and leisure facilities rather than outer-area alternatives (see above).

Among the interviewees, about one half say that they prefer to live in the same type of residential location as where they actually live, whereas one fourth say that they would like to live in a different part of the metropolitan area. The remaining fourth of the interviewees do not say anything explicitly about this issue. In general, the interviews indicate a fairly good match between the interviewees' actual and preferred residential locations. (However, this does not necessarily imply 'self-selection' as postulated by many American researchers into land use and travel interaction, as many interviewees have lived in the same area since they were children and therefore cannot be said to have 'selected' their residential area. Moreover, there may be a post-hoc rationalization of residential locations based on what was affordable rather than what was preferred, or interviewees may gradually have become fond of the area they have moved into although the residential location was at the outset a matter of what was possible rather than preference.) The fact that one fourth of the interviewees reveal a mismatch between actual and preferred characteristics of their residential location is another clear indication that people are only to a limited extent 'self-selected' into their actual residential areas.

The positive characteristics of residential areas mentioned by the interviewees are first and foremost availability of well-equipped facilities and a nice environment (in terms of scenery, green areas etc.). The interviewees are more specific in their descriptions of areas in which they would not like to live: inconvenient, dirty, crowded areas, exposed to noise, and areas in the proximity of many factories, train stations, markets, and with old and shabby houses. Some interviewees also mention 'village towns' with many peasants and areas with many immigrants as non-attractive areas. Probably, this reflects what is more or less general opinions of what make up the low-status areas of the metropolitan region. Some interviewees also point at specific geographical areas as examples of non-attractive places to live, such as the Dongzhan area and the Gongshu district. The non-attractive areas appear to be located mainly in the outer part

of Hangzhou city, in particular the eastern and northern part, i.e. at locations that are neither inner-city nor suburban. This less attractive 'middle zone' does, however, not include the western part of the city, which is mentioned by several interviewees among the attractive areas.

5.15 Spatial patterns of social contacts

In the two inner-city interviewee areas, only a very few, if any, interviewees appear to have any friends or acquaintances within the local area. Distinct from that, almost all the interviewees of two of the outer interviewee areas (Zhuangtan and Xiaoshan) appear to have several friends and acquaintances living in their local area. In particular, this is the case in Zhuangtang, where a high proportion of the interviewees' friends and acquaintances live in the local area. In the third outer interviewee area, Banshan, the interviewees have few, if any, friends and acquaintances living in the local area.

The higher occurrence of friends and acquaintances living in the local areas of the interviewees in Zhuangtang and Xiaoshan than in Xixi Road and Cuiyuan is probably due to the following circumstances:

- Zhuangtang and Xiaoshan are both surrounded by predominantly rural areas and are located far away from the densely developed, continuous urban area of Hangzhou. For residents of these interviewee areas, the proportion of the metropolitan population that can be reached within a moderate distance is therefore much lower than what is the case when living in the inner city.
- In addition, the area within which potential acquaintances can be found without traveling beyond belts of rural areas is of a limited size, in particular in the small town of Zhuangtan.
- Due to the relatively high density of downtown Xiaoshan, the number of potential acquaintances within a short distance is relatively high in this interviewee area too.
- The fact the interviewees of Banshan have much fewer local-area acquaintances than the interviewees of Zhuangtan and Xiaoshan have may be due to:
- The less isolated location of Banshan, which is not separated from the continuously developed urban area of Hangzhou

- The lack of local meeting places (teahouses, restaurants) that might facilitate local acquaintance-making

In the two inner-city interview areas, the amount of contact and common activities between neighbors appears to be low. A few interviewees from Cuiyuan and Xixi Road indicate this explicitly whereas most interviewees do not say anything explicit on this issue.

Distinct from this, the amount of neighborhood contact and common activities appears to be high in Zhuangtang and relatively high in the interviewee area of Xiaoshan too. In Banshan, one interviewee says that his wife has some common activities with other women in the neighborhood, but the level of neighborhood contact in Banshan seems to be clearly lower than in Zhuangtang and Xiaoshan.

The explanations of these differences between the interview areas are probably much the same as regarding the interviewees' propensity of having local-area friends and acquaintances. In particular, the quite isolated location of Zhuangtang, with few competing non-local facilities and contact opportunities within a quite large radius around the village, is likely to encourage an orientation towards local leisure activities and local acquaintance-making. Moreover, the fact that most of the Zhuangtang interviewees have lived in their area for a very long time and in many cases grown up there may contribute to a feeling of local identity which may also strengthen the level of contact and common activities among neighbors.

In addition, the inner-city interviewee areas are more exposed to competition from non-local, but still easily accessible activity options. The interviewees of these areas also more often have a high education and may be more likely to make acquaintances based on common specialized interests rather than neighborhood. They also more often have a career-oriented life-form (cf. section 5.6), which is likely to limit their presence in the neighborhood and participation in neighborhood activities, and probably also makes them less prone to live for a long time in the same residence.

5.16 Transport infrastructure

Although several interviewees express dissatisfaction with various aspects of the relevant networks of roads and bike paths, this dissatisfaction in most cases does not appear to have had any actual influence on their travel modes or location of activities. However, one

car-owning interviewee says that her choices of destinations for shopping and leisure trips are influenced by the parking conditions at the relevant facilities. Another car owning interviewee (in the Cuiyuan area) says that difficult parking conditions at the destination is one condition that may make him choose to travel by bus instead of by car. The same interviewee considers the local neighborhood to be very crowded for driving, and he actually walks or rides bikes to local destinations. Another car-owning interviewee, living in Zhuangtang, drives to nearly all destinations, even the local ones. It seems plausible that the congested streets in the Cuiyuan area has prevented the above-mentioned car-owning interviewee from driving to very local destinations, whereas the non-congested streets in the Zhuangtang area encourages his counterpart to drive even to local destinations.

Based on our interviews, the layout of the road network – or, to be more correct, the extent to which road capacity and parking places are ample or scarce – influences traveling patterns on car-owning interviewees, but not on those who do not have access to a car. This seems plausible, as car-owning interviewees can opt between a broader range of transport modes than interviewees without a car, at the same time as cars are more vulnerable than all other modes to lack of parking places and more vulnerable than non-motorized modes to congested streets.

For those interviewees who cannot drive, cannot afford to buy a car or do not have the possibility to be a passenger with someone else, the public transport service is a basic condition making it possible to live beyond biking distance from the workplace (or work beyond biking distance from home). In this sense, the bus services have influenced the workplace or residential location choices of several interviewees. Apart from this basic level, however, the quality of bus connections does not appear to exert much influence on the interviewees' choices of travel modes or destinations. Most of the interviewees of the two inner-city interviewee areas consider the bus connections to be good or fairly good, but their use of bus is lower than among the interviewees of Xiaoshan, where the bus services are poorer, according to the interviewees. The moderate use of bus among the inner-city interviewees reflects the fact that these interviewees walk or ride bike to a large proportion of their daily-life destinations, since so many of the facilities visited are located within a short distance from home. There are, however, some examples where the bus traveling of inner-city interviewees is enhanced through particularly convenient bus connections. Two Cuiyuan interviewees say that they may take bus when it is not necessary to change between lines, otherwise not. A Xixi Road interviewee has the possibility of taking a special shuttle

bringing him from a stop very close to his home to a stop immediately outside his workplace in the northern part of Hangzhou. Without this shuttle it would have been inconvenient for him to change his workplace from the nearby university campus to the campus in the northern part of Hangzhou. Another interviewee (living in Xiaoshan) says she considers moving to a suburb when the new subway opens. These two examples illustrate the mobility-expanding effects of improved public transport services for persons who do not have access to a private car. Another example illustrates that improved public transport may also make some car owners shift to public transport to certain destinations and/or for certain travel purposes: a car-owning Zhuangtang interviewee says that he would like to change from car to subway for some travel purposes (notably leisure) when the new subway opens.

However, for many other interviewees, in particular among those who do not own a car, the perceived quality of the public transport does not seem to influence the modal split much. For example, most Banshan interviewees think the bus connections to downtown are poor, but they still go by bus when visiting downtown. Yet, the good bus connections to his workplace is probably a condition for the practice of a Cuiyuan interviewee of traveling the short distance to his workplace by bus – otherwise he would probably have been walking (he has an aversion against biking so that would not have been his alternative).

5.17 Concluding remarks

Our qualitative interviews show clear tendencies to a higher amount of travel and a higher use of private cars among outer-area residents than among the interviewees living in the central parts of the metropolitan area, whose daily destinations are usually not far from the dwelling and are often reached by non-motorized modes of travel.

Our interviewees' rationales for location of activities, choice of transport modes and route choice make up important links in the mechanisms by which urban structures influence travel behavior. The rationales are partially interwoven. Usually, the choice of an individual is not based on one single rationale, but on a combination of (and a trade-off between) several rationales. Most of the rationales identified either contribute actively to strengthen the relationships between residential location and travel, or are neutral as regards these relationships. A few of the rationales form the base of "compensatory"

mechanisms, which may contribute to weaken the relationships mentioned.

Our interviewees' choices of locations for daily activities are made as a compromise between two different concerns: a wish to limit travel distances and a wish for the best facility. For most travel purposes, our interviewees emphasize the possibility to choose among facilities rather than proximity. This means that the amount of travel is influenced to a higher extent by the location of the residence in relation to *concentrations* of facilities, rather than the distance to the *closest single facility* within a category. In particular, this is the case for workplaces and places of higher education, but also for cultural and entertainment facilities, specialized stores and, to some extent, also grocery stores. For leisure activities, the "atmosphere" and the esthetic qualities at the destination may also play a role, contributing to strengthen the attraction of Hangzhous central parts, in particular the areas bordering the West Lake.

The longer traveling distances among outer-area than among inner-area residents are mainly a result of longer commuting distances. The given configuration of residences and workplaces results in a shortage of suitable jobs within a moderate commuting distance when living in the outer parts of the metropolitan area. Outer-area residents therefore tend to make longer commutes, partly because local job opportunities often do not exist, and partly because jobs outside the local area are considered more attractive. Although the distances to shops are usually also longer when living in the suburbs, the outer-area interviewees often compensate for this by buying daily necessities along the route home from work. In this way, the rationale of distance limitation and the rationale of choosing the best facility can be combined for shopping trips and certain other errands.

Our interviewees' rationales for choosing modes of transportation usually contribute to a more extensive use of cars in the suburbs and a higher use of non-motorized modes in the inner city. The rationales for route choice imply that the interviewees are not apt to make long detours from the shortest route to daily-life destinations, and thus provide general support to the activity-based approach to transport analyses.

Our interviews indicate that people's activity patterns are to some extent adapted to the availability of facilities in the proximity of the dwelling. The interviewees still rarely give up activities completely as a result of moving to a different urban structural situation. Rather, the frequency of participation may change.

6 Which relationships exist between residential location and travel behavior after controlling for demographic, socioeconomic and attitudinal factors?

6.1 Introduction

This chapter presents the results of multivariate regression analyses of the influences of urban structural, demographic, socioeconomic, attitudinal and other control variables on the respondents' travel distances and modal split. In chapters 4 and 5 we saw that considerable differences exist between respondents from the central and peripheral parts of the metropolitan area in terms of traveling distances as well as the proportions of travel carried out by different modes. We also identified a number of rationales and motives for location of activities, choices of travel modes and route choices. These rationales and motives make up important links in the mechanisms by which urban structure influences travel behavior. As mentioned in chapter 5, most of these rationales contribute to strengthen the relationships between residential location and travel behavior. Some rationales still give rise to "compensatory" mechanisms that may contribute to weaken the mentioned relationships.

In which parts of Hangzhou Metropolitan Area will it be favorable to locate future residential development if the aim is to limit or reduce the amount of private motoring? Needless to say, such knowledge is of a high relevance to policy-making and planning. The typical or average relationships between residential location and travel among a

large number of individuals – what could be called the aggregate-level *effects* of residential location on travel behavior – reflect the mechanisms occurring most frequently and exerting the strongest influences on the result among the respondents, seen as a group. In order to identify these effects, it will not be sufficient to compare average figures on travel behavior in areas at different geographical locations, like the comparisons made in chapter 4. Such simple comparisons do not take into account the fact that the residential areas do not differ only in their location and other urban structural characteristics, but also regarding the socioeconomic characteristics and lifestyles of the inhabitants.

In order to distinguish between the differences in travel behavior caused by urban structural conditions from differences caused by characteristics of the residents it is necessary to conduct a statistical control for the influence of non-urban-structural factors, i.e. to “keep constant” all factors of influence apart from those, the effects of which we want to examine. As mentioned in chapter 3, multivariate regression analysis is a method for making such a statistical control.

Needless to say, the quality of this control depends on whether or not all relevant non-urban-structural factors are included in the analysis. By “relevant” we here refer to factors of influence systematically related to both travel behavior and the urban structural characteristics, the effects of which we wish to investigate. In our analyses, we have included the very most of the variables mentioned in the scientific literature as potential sources of false inferences from the immediate (non-controlled) relationships between urban structure and travel. However, it is not always easy to decide whether or not a control variable is relevant. For example car ownership among the respondents varies for a number of reasons that have nothing to do with urban structure, and should therefore be controlled for. On the other hand, the urban structural situation of the dwelling may itself influence the need for people to own a car, or to have two or more cars in the household. Our qualitative interviews show several clear examples of such effects, cf. chapter 5. Arguably, the relationship between residential location and car ownership still existing when controlling for socioeconomic and attitudinal factors are caused precisely by the influence of urban structure on the need for having one or more cars at the household’s disposal. Similar arguments could be put forth concerning certain other characteristics of the respondents imaginably influenced – at least partially – by the urban structural situation of the dwelling. This applies to, among others, transport attitudes, environmental attitudes, and possession of a driver’s license. In our main analyses, this type of “gray zone” control variables have

still generally been included among the control variables. However, this implies a risk of “over-control”, and the controlled, direct relationships between residential location and travel behavior must therefore be considered conservative estimates. In order to take the possible influences of residential location on travel via car ownership, transport attitudes, environmental attitudes etc. into account, separate analyses of indirect effects have been carried out. These analyses are presented in chapter 9.

In this chapter, a number of results from multivariate regression analysis of data from the main questionnaire survey will be presented. First, the attention will be drawn to the influences of urban structural, demographic, socioeconomic, attitudinal and other control variables on travel on weekdays (section 6.3), addressing the total daily traveling distances, travel with separate modes of transport as well as the proportion of non-motorized travel. Thereupon follow sections on travel in the weekend (6.4) and during the week as a whole (6.5). In the final part of the chapter, analyses of factors influencing commuting distances among respondents who are workforce participants or students will be presented (section 6.6), followed by concluding remarks (6.7).

6.2 Methods of the multivariate statistical analyses

Ordinary regression analyses require that the distribution of the values of the dependent variable should not deviate too much from a so-called normal distribution. However, among our respondents, the traveling distances on weekdays are far from distributed symmetrically around the mean, but include a large number of short and a relatively low number of substantially longer traveling distances.²⁹ This skewed distribution is illustrated by a large difference between the median and arithmetic mean of the mean daily traveling distance on weekdays (5 km and 9.6 km, respectively). According to textbooks on statistical analyses, the recommended remedy in situations where the dependent variable does not follow a normal distribution is to transform its values by means of a non-linear function, e.g. into logarithmic values. This is what has been done in the present analysis, where the original traveling distances measured in kilometers have been transformed into logarithmic values.

In these analyses, it has also been taken into consideration that the relationships between commuting distances and the distances from the

respondents' dwellings to downtown Hangzhou and other centers are hardly linear. Based on theoretical considerations as well as preliminary analyses of the empirical data, the distances from the dwelling to these centers have been transformed by means of non-linear functions. These transformations take into account the fact that the attraction of a center as a trip destination tends to be reduced, the further away from it the visitors live.

In our main multivariate analyses, the following three urban structural variables have been included:

- The location of the dwelling relative to the city center of Hangzhou (distance measured in km transformed by means of a non-linear function)³⁰
- The location of the dwelling relative to the closest second-order center (the town centers of Xiaoshan or Yuhang (North-East)).³¹
- The location of the dwelling relative to the closest third-order center (the town centers of Yuhang (West), Liangzhu, Tangxi, Yipeng, Guali or Linpu; distance measured in km transformed by means of a non-linear function).³²

The three urban structural variables of the main analyses were chosen from theoretical considerations as well as iterations based on preliminary analyses of the empirical data. The location of the dwelling relative to the city center of Hangzhou tells something about the situation of the residence relative to the concentration of workplaces and service facilities found in the city of Hangzhou, especially in its inner and central parts. The closer to this concentration a respondent lives, the easier it will be for her/him to find a workplace matching her/his qualification within a short distance from the dwelling, and the shorter will be the distance to special commodity shops and a number of cultural and entertainment facilities. On the other hand, if the distance to the city center of Hangzhou is too long, many residents will prefer more local job opportunities and service facilities even if these jobs and services are, apart from the traveling distances, less attractive than the central ones. The relationship between traveling distances and the distance between the residence and downtown Hangzhou is therefore not likely to be linear, but could rather be expected to follow a curve reflecting a lower propensity to use facilities in the city of Hangzhou when living in the peripheral parts of the metropolitan area.

The location of the dwelling relative to the closest second-order and third-order centers tells something about the location of the residence

relative to the more local concentrations of job opportunities and services. Here, too, 'distance decay' in the form of lower propensity to use facilities in a second- or third-order center when living far away from such a center could be expected. The 'catchment areas' of the lower-order centers, i.e. the areas from which they draw a large proportion of commuters, customers, visitors to service facilities etc., are of a limited size. The distances from the dwelling to these centers could therefore be expected to influence the amount of travel within a relatively narrow zone around the lower-order centers. Beyond this zone, traveling patterns are not likely to be influenced by further increase in the distance from the dwelling to a lower-order center. A hyperbolic tangential transformation of the linear distances from the dwelling to the closest second-order and third-order center takes these circumstances into account.

In addition to the three above-mentioned urban structural variables, the regression model included the following 17 demographic, socioeconomic, attitudinal and other non-urban-structural variables.

- *Demographic variables:* Sex; age; number of children younger than 7 years of age in the household; number of children aged 7 – 17 in the household; and number of adult persons in the household.
- *Socioeconomic variables:* Education level; personal income; car ownership; driver's license for car; whether or not the respondent is a workforce participant, and whether or not the respondent is a student.
- *Attitudinal variables:* Attitudes to transport issues; attitudes to environmental issues.³³
- *Other non-urban-structural variables* indicating particular activities, obligations or circumstances that may influence commuting distances: Whether or not the respondent had moved to her/his present dwelling less than 5 years ago; regular transport of children to/from kindergarten or school; whether or not the respondent has been outside Hangzhou Metropolitan Area during the week of investigation, and whether or not the respondent has stayed overnight away from home four or more nights during the week of investigation.

The multivariate analysis was carried out in two steps. First, a number of variables clearly unrelated to the commuting distances ($p > 0.250$) were eliminated, using a backward elimination process. Thereupon, the analysis was run once again with all the remaining variables.

Several respondents had missing values on the variables that turned out to be clearly unrelated to the commuting distances and were thus excluded from the first step of the analysis even if they had valid values on all the remaining variables. Using this two-step procedure allowed keeping the number of respondents as high as possible in the final analysis.

Our choice of the quite liberal significance level requirement of $p = 0.25$ is partly motivated by a wish to include all theoretically reasonable influences, also when these tendencies are somewhat weak and uncertain. A significance level of 0.25 implies that there is 25% probability that the relationship in question is a result of chance – but on the other hand, this also implies that there is 75% likelihood that the relationship is *not* a result of coincidental (provided that control has been made for other, relevant factors).

The liberal required significance level could also be considered a rule of cautiousness, helping to avoid overestimation of the effects of urban structural variables due to the exclusion of relevant control variables from the regression model.

Based on the various sets of multivariate regression analyses, calculations have been made of the controlled effects of residential location on the travel activity of each respondent. This has been done by keeping all variables with effects meeting the required significance level ($p = 0.25$) constant at mean values, while inserting the respondent's actual values for all urban structural variables included in the regression model. Based on the estimates thus derived of expected traveling patterns emanating from the locations of the various residential addresses relative to the city center of Hangzhou, curves showing expected values for traveling distances and modal shares have been calculated.

The 20 independent variables included in most our multivariate analyses might appear to be a quite high number, possibly leading to so-called multicollinearity problems (unreliable statistical analyses because of too strong mutual correlations between some of the independent variables). However, formal collinearity diagnostics do not indicate any such problems³⁴. In particular, there is low multicollinearity between the four urban structural and the non-urban structural variables.

As mentioned in Chapter 4, respondents with extreme total traveling distances have been excluded, as well as respondents who have not at all traveled during the relevant investigation period. These exclusions imply a reduction of the sample of the analyses of weekday travel

from 3154 to 2900 persons, a reduction of the sample of the analyses of travel in the weekend to 2925 persons, and a reduction of the sample of the analyses of travel during the week as a whole to 2925 persons. In addition, some people have failed to provide information about traveling distances and/or to answer other questions of the questionnaires. The number of respondents on which the figures and tables are based is therefore usually lower than the above-mentioned figures.

6.3 Travel on weekdays

Below, the results of the multivariate analyses of factors influencing travel on weekdays will be presented. First, the mean total daily traveling distances during the period Monday-Friday will be focused on. Thereupon, daily traveling distances by different modes of travel will be addressed. In the final part of the section, the results of an analysis of factors influencing the proportion of the daily traveling distance carried out by non-motorized modes will be presented.

Daily total traveling distance

Table 6.1 shows the results of the multivariate analysis of factors potentially influencing the respondents' average daily traveling distance during the investigated weekdays. The following 8 variables were excluded in the first step of the analysis and do not appear in the table (significance levels in parentheses):

Attitudes to environmental issues ($p = 0.979$); whether or not the respondent has moved to the present dwelling less than five years ago ($p = 0.947$); location of the dwelling relative to the closest second-order center ($p = 0.917$); attitudes to transport issues ($p = 0.897$); education level ($p = 0.787$); number of children aged 7 – 17 in the household ($p = 0.785$); whether or not the respondent is a workforce participant ($p = 0.637$); and whether or not the respondent is a student ($p = 0.290$).

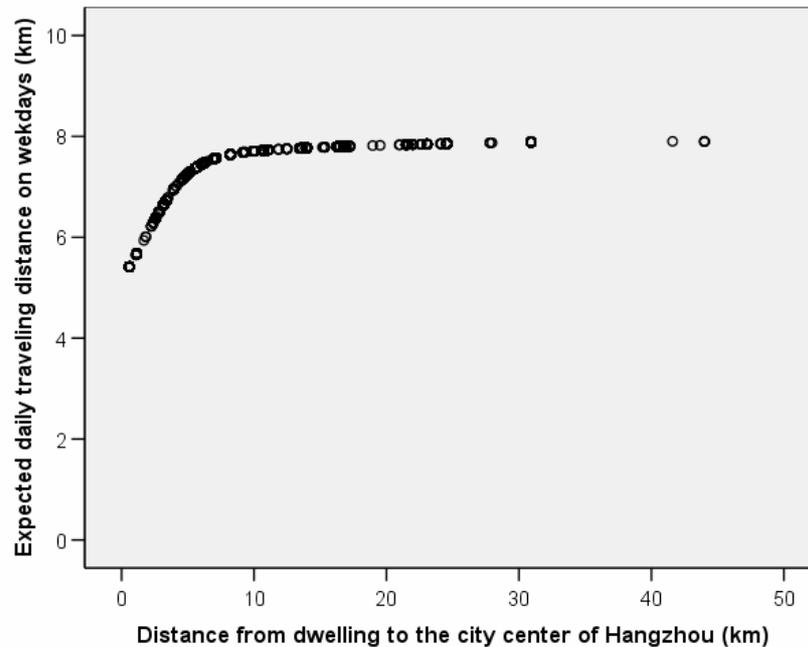
Table 6.1 *Results from a multivariate analysis of the influence from various independent variables on the mean daily traveling distance on weekdays (logarithmical transformation of distance measured in km).*

	Unstandardized coefficients		Standardized coefficients	Level of significance (p values, two-tail)
	B	Std. error	Beta	
Location of the dwelling relative to the city center of Hangzhou (non-linear distance function, values ranging from -0.23 to 1.00)	0.229	0.031	0.155	0.000
Availability of private car in the household (yes=1, no=0)	0.244	0.046	0.114	0.000
Personal annual income (1000 yuan renminbi)	0.00226	0.00054	0.089	0.000
Age	- 0.00316	0.00082	- 0.085	0.000
Sex (female = 1, male = 0)	-0.082	0.020	-0.084	0.000
Possession of driver's license for car (yes=1, no=0)	0.098	0.027	0.083	0.000
Whether or not the respondent has been outside Hangzhou Metropolitan Area during the week of investigation (yes=1, no=0)	0.143	0.040	0.079	0.000
Regular transport of children to/from kindergarten or school (yes = 1, no = 0)	0.063	0.023	0.056	0.007
Location of the dwelling relative to the closest third-order center (non-linear distance function, values ranging from -0.93 to 1.00)	-0.057	0.020	-0.059	0.004
Number of adult persons (18 years or more) in the household	0.024	0.011	0.043	0.033
More than four overnight stays away from home during the week of investigation (yes = 1, no = 0)	-0.117	0.057	-0.045	0.042
Number of preschool children (less than 7 years) in the household	-0.050	0.029	-0.037	0.081
Constant	0.568	0.061		0.000

N = 2305 respondents living in different parts of Hangzhou Metropolitan Area. Adjusted R^2 = 0.134

According to the multivariate analysis, both urban structural variables show statistically significant effects on traveling distances on weekdays. The effect of the location of the dwelling relative to the city center of Hangzhou is in line with expectations. As can be seen in Figure 6.1, the average traveling distance among those respondents living closest to the city center of Hangzhou is 5.4 km when keeping all other variables than the location of the dwelling relative to downtown Hangzhou constant at mean values. Among respondents living ten kilometers away from the city center of Hangzhou, the average daily traveling distance is about 7.8 km when keeping the other variables constant at mean values. A further increase in the distance from the dwelling to the city center of Hangzhou beyond 10 km is associated with only very slight increases in daily traveling distances.

Figure 6.1 *Expected daily traveling distances among respondents living at different distances from the city center of Hangzhou, based on the multivariate regression model providing the best fit with the data, and with the remaining variables of Table 6.1 kept constant at mean values³⁵.*



$N = 2305, p = 0.000$

Traveling distances on weekdays also seem to be influenced by the location of the dwelling relative to the closest third-order center. This effect is, however, considerably weaker than the effect of the location of the dwelling relative to the city center of Hangzhou (cf. the standardized regression coefficients, where the absolute value of the coefficient of the location of the dwelling relative to downtown Hangzhou is nearly three times as large as the coefficient of the location of the dwelling relative to the closest third-order center). Moreover, the latter coefficient has a *negative* sign, meaning that traveling distances tend to be reduced, other things equal, the further away the respondent lives from the closest third-order center. This may appear surprising, as the need for travel in order to reach local facilities will be lower among those who live close to a local center. However, residents living close to such a center usually have easier

access to bus or train services than their counterparts living far away from any center, and have thus a higher opportunity to travel to workplace concentrations and other facilities outside the local district. This effect appears to be stronger than the transport-reducing influence of living close to local shops etc. This may explain why respondents living close to one of the six third-order centers tend to travel somewhat longer on weekdays than respondents living far away from any such center and at the same distance from downtown Hangzhou tend to do.

Our analysis does not show any effect of the location of the residence relative to the closest second-order center (the town centers of Xiaoshan and Yuhang (North-east)). To an even higher extent than the third-order centers, these two towns have good connections to Hangzhou by public transport as well as via expressways. On the other hand, the concentrations of workplaces, stores and entertainment in the central parts of Xiaoshan and Yuhang are also higher than in the third-order centers. Those who live close to these centers therefore have fairly good opportunities of finding local jobs and service facilities, even if they have specialized work qualifications and sophisticated shopping and leisure preferences. Together, these opposite mechanisms appear to outweigh each other, resulting in a very weak relationship between traveling distances on weekdays and the location of the residence relative to the closest second-order center.

The influences of the non-urban-structural variables are in line with expectations. Traveling distances on weekdays tend to increase if the household has a car at its disposal, if the respondent has a high income, is male, holds a driver's license for car, and/or is responsible for regularly bringing children to/from school or kindergarten. Moreover, the amount of weekday travel tends to increase if there are other adult household members than the respondent her/himself, but tends to be reduced if there are preschool children in the household. Hardly surprising, the traveling distance also tends to increase if the respondent has been outside Hangzhou Metropolitan Area during the week of investigation. On the other hand, having stayed overnight away from home four or more nights during the investigation period tends to contribute to reduced traveling distances.

The effects of car ownership income and are in line with findings in numerous other studies. Owning a car increases people's ability to travel around and can lead to an expansion of the geographical area within which job opportunities are sought as well as more frequent and longer non-work trips. Holding a driver's license also increases

the possibility of car travel and hence expands the respondents' potential radius of action. Similarly, a high income increases people's ability to buy public transport fares, motor vehicles and fuel. The effect of income may also mirror situations where a high salary has made respondents willing to accept longer commuting distances than they would otherwise do. The effect of gender is in line with findings in several European studies and probably reflects inequalities between women and men in access to vehicles, as well as a traditionally more local job market orientation among females (see Hjorthol, 2002 and Næss, 2007a for a further discussion). Regular transport of children represents an additional trip purpose which, other things equal, will increase the daily traveling distance (in particular if the school or kindergarten is not located along the route between home and workplace). The tendency to increasing daily traveling distances if there are more than one adult household members probably reflects the higher difficulty in co-locating home and workplace if there are two or more working members of the household. The effect of preschool children probably mirrors a limitation of out-of-home activities (both in terms of workforce participation and leisure) due to childcare chores, especially among women. The final effect (reduced traveling distance among those who have stayed overnight away from home more than half of the week) is more difficult to explain. Many of those who have stayed overnight away from home have been outside Hangzhou Metropolitan Area. But as the impact of having been outside the metropolitan area has already been accounted for, the effect of overnight stays away from home refers to overnight stays within the region. Possibly, some respondents stay at factory dormitories or with friends/relatives living close to the workplace during the weekdays, and their amount of weekday travel may thus be reduced.

Traveling distances by different modes

We have also conducted analyses of factors influencing the distances traveled by different modes. However, as mentioned earlier, only non-motorized travel is the mode used by at least half of the respondents during the investigated weekdays. For car travel, bus travel as well as travel by e-bike, the traveling distance of a majority of respondents is zero. For car and e-bike travel, the proportions of non-users of the modes are very high (88% and 81%, respectively). This implies that the ideal requirement of ordinary least square regression analysis of normally distributed dependent variables is far from met. This is the case also when transforming traveling distances into logarithmic values. (For train and other modes, the proportions of non-users are even higher than for car and e-bike.)

For walk/bike, the proportion of non-users is considerably lower (less than 30%).

In order to cope with these deviations from the ideal requirements of regression analyses, we have carried out the analyses of traveling distances by different modes in two steps. First, binary logistic regression analyses have been carried out in order to identify factors influencing whether or not the mode in question has at all been used. Thereupon, ordinary regression analyses have been carried out among the users of each mode, with traveling distances transformed into logarithmic values.

Below, we shall concentrate on the effects of the three urban structural variables on

- the likelihood of using a particular travel mode as part of daily travel, and
- the distances that users of a mode travel by this particular mode

Similar to the analysis of total traveling distances, each set of analysis has first been made with all independent variables included in the model. Thereupon, a second analysis has been made, where only variables satisfying a required significance level of $p < 0.25$ have been included.

Travel by foot and by bike. Table 6.2 shows the influences of the three urban structural variables on the likelihood of having used walking or biking as a travel mode during the five investigated weekdays.

Table 6.2 *Results from a binary logistic regression analysis of the influence from the three urban structural variables on the likelihood of having traveled some of or all the traveling distance during the investigated weekdays by non-motorized modes.*³⁶

	B	Std. error	Wald	Level of significance (p value)
Location of the dwelling relative to the city center of Hangzhou (non-linear distance function, values ranging from -0.23 to 1.00)	-0.790	0.206	14.745	0.000
Location of the dwelling relative to the closest third-order center (non-linear distance function, values ranging from -0.93 to 1.00)	-0.230	0.098	5.439	0.020
Location of the dwelling relative to the closest second-order center (non-linear distance function, values ranging from -0.94 to 1.00)	-0.249	0.130	3.705	0.054

N = 2181 respondents living in different parts of Hangzhou Metropolitan Area. Nagelkerke's $R^2 = 0.135$

As we can see, the likelihood of using bike or walking as travel modes during the weekdays is influenced by all three urban structural variables. The likelihood of being a user of non-motorized modes decreases the further away the respondents live from the city center of Hangzhou, the closest second-order center as well as from the closest third-order center. This is in line with theoretical considerations. The strongest and most certain influence is from the location of the residence relative to the main center of the metropolitan area, i.e. the city center of Hangzhou. The likelihood of having used walking or biking as travel modes during the investigated weekdays is in particular high in the inner parts of Hangzhou, but is fairly high also in areas close to the centers of Xiaoshan, Yuhang and the six third-order centers.

In addition to the three urban structural variables, the likelihood of being a user of non-motorized travel modes on weekdays appears to increase if the respondent belongs to a household without a car, is concerned about environmental issues, has not got a driver's license for car, has a high age, is a non-participant of the workforce, has transport attitudes critical to urban car traffic, has not moved to the present dwelling recently, and has a low income. All these effects appear plausible from theoretical considerations. None of the remaining investigated variables appear to exert any influence worth mentioning on the likelihood of walking or biking for daily traveling purposes. The order of mentioning of the above effects reflects the strengths of their respective associations with the likelihood of being a

user of non-motorized modes. In particular, the impact of car ownership is strong.

Table 6.3 shows how the traveling *distances* by non-motorized modes among those who have used such modes on weekdays are influenced by the three urban structural variables.

Table 6.3 *Results from a multivariate analysis of the influence from various independent variables on the mean daily traveling distance on weekdays by non-motorized modes among users of these modes (logarithmical transformation of distance measured in km).³⁷*

	Unstandardized coefficients		Standardized coefficients	Level of significance (p values, two-tail)
	B	Std. error	Beta	
Location of the dwelling relative to the city center of Hangzhou (non-linear distance function, values ranging from -0.23 to 1.00)	0.130	0.035	0.098	0.000
Location of the dwelling relative to the closest third-order center (non-linear distance function, values ranging from -0.93 to 1.00)	-0.073	0.025	-0.074	0.004
Location of the dwelling relative to the closest second-order center (non-linear distance function, values ranging from -0.94 to 1.00)	-----	-----	-----	p > 0.25

N = 1619 respondents living in different parts of Hangzhou Metropolitan Area. Adjusted $R^2 = 0.037$

Among those who are users of non-motorized modes for daily travel, traveling distances by bike or by foot are, other things equal, longer the further away from the city center of Hangzhou the residence is located. At the same time, the amount of walk/bike travel also seems to increase the closer to the closest third-order center the residence is located. None of these effects are very strong, but the tendency of shorter non-motorized traveling distances when living close to the city center of Hangzhou appears to be somewhat stronger than the opposite tendency of longer traveling distances when living close to a third-order center. The location of the dwelling relative to the closest second-order center shows no effect worth mentioning on the traveling distance by non-motorized modes on weekdays. It should be noted that the investigated variables (including the demographic, socioeconomic, attitudinal and other non-urban-structural variables) can only explain a very small proportion of the variation in traveling distances by non-motorized modes.

The modest impacts of the three urban structural variables on walk/bike traveling distances reflect the fact that each of these variables influences non-motorized through oppositely working mechanisms. On the one hand, living close to a center increases the likelihood that relevant destinations are within acceptable walking or biking distances. The number of walk-bike trips is therefore likely to be higher among respondents living close to a center. This is also what is reflected in the analysis of factors influencing the likelihood of having at all used walk/bike as a mode of travel during the investigated weekdays, cf. above. But also among the users of non-motorized modes, there is likely to be a differentiation in the frequency of such trips according to the location of the residence, e.g. a higher number of shopping and leisure trips by bike when living close to a center.

On the other hand, each walk-bike trip will also on average be shorter, the closer the respondents live to the facilities found in the various centers. In particular, this is evident in the city of Hangzhou, where the zone within which the inner and central city can be reached within acceptable biking distance includes a large population. In the third-order towns, the spatial extensions of the urban areas are so small that almost all those who do at all live within acceptable walk/bike distance from the local centers live only one or two kilometers away from these centers. In the third-order center towns, thus, the higher frequency of walk/bike trips among respondents living close to these centers outweighs the tendency of longer walk/bike trips when living far away from such centers. Distinct from this, the number of respondents who live within a relative long, but still acceptable biking distance from their daily destinations is much higher in the city of Hangzhou than in the lower-order towns, and the tendency of longer traveling distances when living far away from downtown Hangzhou therefore outweighs the higher frequency of such trips when living close to the city center of Hangzhou. In the second-order centers, the two opposite tendencies seem to balance each other. Hence, our material shows no effect of the location of the residence relative to these centers on traveling distances by non-motorized modes.

Apart from the urban structural variables, traveling distances by walk-bike among the users of these modes tend to increase if the respondent is male, belongs to a household without a car, and belongs to a household with few or no pre-school children. The two former effects are in line with findings in several previous studies. The effect of preschool children probably mirrors a limitation of out-of-home activities also resulting in shorter overall traveling distances on weekdays, cf. Table 6.1. Moreover, car-oriented attitudes seem to

reduce the amount of walk/bike travel somewhat, whereas responsibility for bringing children to/from school or kindergarten tends to increase the traveling distances by non-motorized modes slightly. The latter reflects the fact that many of the trips where parents or grandparents follow children to school or kindergarten are made by foot or by bike, and such trips of course add to the overall traveling distances by these modes. There is also a very slight tendency to longer walk/bike distances among young users of these modes. Above, we noted that young people are less inclined than older people to be users of non-motorized modes (perhaps because they have been socialized into a society where biking plays a less dominant role than previously in China). Yet, when being users of non-motorized modes, young people tend to travel longer by such modes than their older counterparts, probably reflecting their on average higher physical fitness.

Similar to the analysis of overall traveling distances, we find a tendency to lower traveling distances by non-motorized modes among respondents who have stayed more than three nights away from home during the investigated week. In fact, the effect on the amount of non-motorized travel is stronger than the effect on overall traveling distances, reflecting that the trips replaced when staying away from home are to a high extent trips by foot or by bike.

It should be noted that the investigated variables – urban structural as well as control variables – can only explain a very small proportion of the variation in traveling distances by non-motorized modes, cf. the low Adjusted R squared value of Table 6.3.

Summarizing the impacts found of the urban structural variables in the two sets of analyses, we see that the likelihood of being a user of non-motorized modes increases the closer the respondents live to an urban center, in particular the city center of Hangzhou. Probably, also the frequency of non-motorized trips among users of these modes increases when living close to the downtown Hangzhou or a lower-order center. Living close to downtown Hangzhou or a lower-order center thus tends to make respondents replace some trips otherwise carried out by motorized modes with trips by bike or by foot. A comparison with Figure 6.2 suggests that the higher frequency of non-motorized trips is in particular present among respondents living in the inner city of Hangzhou (less than 3.4 km from the city center). At the same time, each trip by foot or by bike among those who live close to downtown Hangzhou tends to be shorter than among their suburban or outer-area counterparts. Apart from residents of the inner distance belt, overall, traveling distances among users of non-motorized modes

therefore tend to increase, the further away from the city center of Hangzhou the respondents live. Including all respondents (also non-users of non-motorized modes), there is still a tendency of longer total non-motorized travel among those who live in the peripheral parts of Hangzhou, but the difference is smaller than when considering only the pattern among users of non-motorized modes, and the high frequency of non-motorized trips among residents of the inner distance belt also implies a high average traveling distance by foot and by bike among these respondents.

In the third-order centers, the small size of each of these settlements implies that each resident of these towns lives close to the local center and can reach local facilities within what is normally considered acceptable walking or biking distance. Among those who live outside the third-order towns but still have such a town as their closest center, the majority live too far away from the closest center to make bike travel an attractive alternative. Together, this contributes to make the frequency of non-motorized trips higher among respondents living close to a third-order center, while the trip distances by non-motorized modes are less affected by such a residential location, with a higher traveling distance by foot and bike among respondents living close to a third-order center as the combined result. Including the total sample of respondents (also those who have not used non-motorized modes during the weekdays) weakens this relationship slightly, but not sufficiently to alter the overall pattern.

In the second-order center towns of Xiaoshan and Yuhang, distances to the closest outskirts of Hangzhou are probably within acceptable biking distance for several respondents, in particular the younger and physically fit. Especially around Xiaoshan, there are continuous areas dominated by suburban commercial developmental areas, including Xiaoshan Economical and Technological Development Zone and the districts south of the Fuxin Bridge. For residents of the second-order towns, especially Xiaoshan, there are thus a number of potential trip destinations within medium-long or long, but acceptable, biking distance, in addition to the local facilities within short biking or walking distance. This may explain why we do not find any impact of the location of the residence relative to these centers on the average traveling distances by bike or by foot.

Travel by bus. Table 6.4 shows the influences of the three urban structural variables on the likelihood of having used bus as a travel mode during the five investigated weekdays.

Table 6.4 *Results from a binary logistic regression analysis of the influence from the three urban structural variables on the likelihood of having traveled some of or all the traveling distance during the investigated weekdays by bus.*³⁸

	B	Std. error	Wald	Level of significance (p value)
Location of the dwelling relative to the city center of Hangzhou (non-linear distance function, values ranging from -0.23 to 1.00)	0.687	0.161	18.104	0.000
Location of the dwelling relative to the closest second-order center (non-linear distance function, values ranging from -0.94 to 1.00)	0.408	0.133	9.408	0.002
Location of the dwelling relative to the closest third-order center (non-linear distance function, values ranging from -0.93 to 1.00)	-----	-----	-----	P > 0.25

N = 2526 respondents living in different parts of Hangzhou Metropolitan Area. Nagelkerke's $R^2 = 0.093$

The likelihood of having traveled by bus during the investigated weekdays is influenced by two of the three urban structural variables: the location of the dwelling relative to the city center of Hangzhou, and relative to the closest second-order center. The closer the respondents live to both these center categories, the lower is the likelihood of having traveled by bus on the investigated weekdays. This reflects the findings regarding the use of non-motorized modes: When people live close to concentrations of facilities, a number of potential trip destinations will be within walking or biking distance, and the need for using bus or other motorized modes of travel will be less. The fact that the opportunities for traveling by bus are better in the inner city of Hangzhou than anywhere else in the region, due to the fine-meshed network of lines and frequent departures, does not alter this. Moreover, in the inner city of Hangzhou, and to some extent also in the central parts of Xiaoshan and Yuhang, congested streets slow down the speed of the buses, and the bike will often be a faster alternative. The stronger effect of living far away from the city center of Hangzhou than the effect of the location of the residence relative to the closest second-order center reflects the larger catchment area of a large city than of a medium-sized town, leading to a higher amount of motorized travel to and from the center of the highest order. (The lack of any significant effect of the location of the residence relative to the closest third-order center is of course another illustration of the same phenomenon.)

Apart from the urban structural variables, the likelihood of having traveled by bus during the weekdays appears to be influenced by the respondents' education level, where those with a higher educational

level (respondents having completed professional secondary school or higher levels of education) tend to be more frequent bus users than those with lower education. This is somewhat different from what has been found e.g. in Copenhagen Metropolitan Area and in Oslo, where bus passengers have on average lower income and education than the population in general. In Copenhagen, Oslo and many other larger European cities, there is a certain status difference between public transport by urban rail and by bus, where the users of metro, tramcar and urban rail lines have on average a higher education level and income than bus passengers. In Hangzhou, the role of the railway in intra-metropolitan transport is almost non-existing, and there is therefore not any base for a similar status hierarchy between different public transport modes as in the European cities. The impact of education level on the propensity of being a bus user may mirror the location pattern of different types of workplaces, where workplaces requiring a high education are typically located more centrally (in the inner city of Hangzhou or along main public transport arteries) than what is the case for e.g. workplaces within manufacturing and warehousing.

Hardly surprising, the likelihood of having traveled by bus during the investigated weekdays is lower if the respondent belongs to a household having a car at its disposal. The propensity of being a bus user also appears to be higher among people who are not workforce participants. Possibly, these respondents use their surplus of time available to make a higher number of leisure or shopping trips by bus? Moreover, our data indicate that the likelihood of having traveled by bus during the weekdays is increased somewhat if the respondent has moved to the present dwelling recently, is not a student, and is female. The effect of having moved probably reflects a wish among recent movers to visit friends and relatives at their previous place of living. If there is some distance between the old and the new address, such trips will often be made by bus. The effect of gender is in line with many European studies showing that females are generally more frequent users of public transport than men are. The effect of being a student may reflect a low need for bus transport among some of the students, e.g. if they live at dormitories close to the campus.

Table 6.5 shows how the traveling *distances* by bus among those who have used this mode on weekdays are influenced by the three urban structural variables.

Table 6.5 *Results from a multivariate analysis of the influence from various independent variables on the mean daily traveling distance on weekdays by bus among users of this mode (logarithmical transformation of distance measured in km).*³⁹

	Unstandardized coefficients		Standardized coefficients	Level of significance (p values, two-tail)
	B	Std. error	Beta	
Location of the dwelling relative to the city center of Hangzhou (non-linear distance function, values ranging from -0.23 to 1.00)	0.260	0.061	0.156	0.000
Location of the dwelling relative to the closest second-order center (non-linear distance function, values ranging from -0.94 to 1.00)	-----	-----	-----	p > 0.25
Location of the dwelling relative to the closest third-order center (non-linear distance function, values ranging from -0.93 to 1.00)	-----	-----	-----	p > 0.25

N = 752 respondents living in different parts of Hangzhou Metropolitan Area. Adjusted R² = 0.030

Among the urban structural variables, we only find any effect of the location of the dwelling relative to the city center of Hangzhou. Most bus routes are directed from the suburbs and outer-area towns toward the inner city of Hangzhou, where a number of workplaces and other facilities are located. Admittedly, bus services are much better in the inner parts of Hangzhou than in the outer districts. This might lead to a higher frequency of bus trips among those living in the inner districts – also when those who do not at all travel by bus are excluded from the analysis. On the other hand, the trip distance of each bus trip is likely to be shorter due to the higher density of facilities in the inner districts. Our material shows that the effect on the trip distances is the stronger one, resulting in longer average traveling distances by bus among bus users who live far away from the central concentration of potential destinations than among their inner-city counterparts.

The location of the residence relative to the lower-order center categories does not appear to influence the traveling distances by bus among those who use this mode. Probably, this reflects a combination of mechanisms influencing traveling distances by bus oppositely, resulting in weak net effects. On the one hand, bus services are poorer in the most peripheral parts of the metropolitan area (i.e. areas far away even from a center of the third order). This might lead to a lower frequency of bus trips among those living in the outer districts – also when those who do not at all travel by bus are excluded from the analysis. On the other hand, the trip distance of each bus trip is likely

to be longer due to the very low availability of facilities in the peripheral districts. A similar combination of opposite influences probably occurs among residents living close to the second-order centers. Here, a higher level of bus services than in the third-order centers contributes to a stronger influence of proximity to a second-order center on the frequency of bus trips. On the other hand, a high number of routes connecting the second-order towns with workplaces and service facilities in Hangzhou (and between Hangzhou and the second-order towns) contribute to a high number of outward trips in addition to the trips directed toward the town centers of Xiaoshan and Yuhang. Our material suggest that these mechanisms balance each other to a high extent, resulting in no statistically significant effect on the traveling distances by bus among users of this mode.

Among the non-urban-structural variables, environmental attitudes and income are the only ones show statistically significant relationships with traveling distances by bus, but neither of these effects is strong. There is a tendency to more bus travel the less environment-oriented are the respondents' attitudes and the higher is their income. The effect of income is hardly surprising, as a high income enables respondents to travel bus instead of by non-motorized modes. The effect of environmental attitudes suggests that public transport is hardly conceived of as a particularly environmentally friendly mode among the respondents. Given the fact that for most respondents, the main alternative to bus transport will probably be non-motorized modes, this should not be surprising.

Summarizing from the two sets of analyses, living close to the city center of Hangzhou and, to a lesser extent, the centers of Xiaoshan and Yuhang, reduces the likelihood of having at all traveled by bus during the investigated weekdays. Among those who are users of the bus mode, traveling distances by bus tend to be reduced when living close to the city center of Hangzhou. Together, these findings firstly suggest that proximity to potential trip destinations reduces the use of public transport, as trips to destinations located close to the dwelling tend to be made by bike or by foot rather than by bus. On the other hand, the higher provision of bus services in the centers counteract this tendency, and the resulting net effects of residential location on bus travel are therefore not very strong. In the peripheral parts of the metropolitan area, residents are to a higher extent than in the more central parts dependent on buses to reach workplaces and service facilities, and the proportion of non-users of buses is therefore lower in the outer areas. At the same time, those who live far away from the concentration of potential trip destinations in the inner parts of Hangzhou, have a higher need for traveling long distances by bus.

Travel by car and taxi. Table 6.6 shows the influences of the three urban structural variables on the likelihood of having used car and taxi as travel modes during the five investigated weekdays.

Table 6.6 *Results from a binary logistic regression analysis of the influence from the three urban structural variables on the likelihood of having traveled some of or all the traveling distance during the investigated weekdays by car or taxi.*⁴⁰

	B	Std. error	Wald	Level of significance (p value)
Location of the dwelling relative to the city center of Hangzhou (non-linear distance function, values ranging from -0.23 to 1.00)	0.851	0.314	7.349	0.007
Location of the dwelling relative to the closest second-order center (non-linear distance function, values ranging from -0.94 to 1.00)	-----	-----	-----	P > 0.25
Location of the dwelling relative to the closest third-order center (non-linear distance function, values ranging from -0.93 to 1.00)	-----	-----	-----	P > 0.25

N = 2246 respondents living in different parts of Hangzhou Metropolitan Area. Nagelkerke's $R^2 = 0.415$

According to our material, the likelihood of having traveled by car or taxi during the investigated weekdays is influenced by only one of the urban structural variables, viz. the location of the dwelling relative to the city center of Hangzhou. The closer to the city center of Hangzhou the respondents live, the lower is the likelihood that any of their travel during the weekdays has been carried out by car or taxi. This effect does not simply mirror a lower car ownership among inner-city dwellers, as car ownership has already been included among the 17 non-urban-structural control variables. Instead, the influence of the location of the residence relative to the city center of Hangzhou reflects a higher propensity of inner-city car owners to leave their car in the garage at home on weekdays, compared to their suburban counterparts. This is probably a result of the combined effects of short distances to a number of facilities, making motorized travel unnecessary, and the difficult driving conditions in the congested inner-city streets. Both these effects discourage the use of car for daily traveling purposes.

Compared to residents of the central parts of Hangzhou, respondents living close to the centers of the second- and third-order towns experience less congestion (the congested conditions cover considerably smaller areas than in Hangzhou), and facilities outside

the local town compete with the local facilities to a much higher extent than what is the case in Hangzhou. The effects of proximity to local facilities in the second- and third-order centers and the congestion in the central parts of these towns are therefore to a high extent counteracted by mechanisms working in the opposite direction. As a result, the net effects on car usage from the location of the residence relative to these centers are small and not statistically significant.

Not surprisingly, the likelihood of having traveled by car or taxi during the investigated weekdays is first and foremost influenced by car ownership and whether or not the respondents hold a driver's license. These effects are considerably stronger than the effect of residential location. The respondents' income level also shows a strong effect on car usage, albeit not as strong as the effects of car ownership and driver's license (but income also has an important indirect effect through its influence on people's ability to buy cars). As could be expected, car-oriented attitudes also contribute to increase the likelihood of having traveled by car or taxi. In addition, we find effects of having moved to the present dwelling during the latest five years, the number of adult household members, education level, sex, and whether or not the respondent is a workforce participant. The likelihood of being a car user on weekdays is higher among recent movers, members of households with two or more adult members, persons with a high education, male respondents, and workforce participants. The effect of having moved probably reflects situations where inner-city residents move to larger dwellings in suburban locations from which a number of relevant destinations are less accessible by non-motorized and public modes of travel. In the qualitative interviews, some such examples were encountered, where the move also involved the purchase of a car. The effect of belonging to a household including other adult members than the respondent may reflect the fact that it is more difficult for couples with specialized work qualifications than for single persons to adjust the locations of the workplace and residence in such a way that commuting distances are kept moderate. The effect of gender is in line with findings in a number of other studies in Europe and USA, showing that males have in general a more car-based traveling pattern than women have. The two final effects (of education level and employment) are a little more difficult to explain. Probably, those with a high education have a lower possibility of finding a workplace in the local neighborhood (especially if they live in suburbs or outer parts of the metropolitan area). If they have a car at their disposal, they may then be more prone to use car for the commute. Similarly, non-

participants of the workforce do not need to make journeys to work, which are usually the longest trips on weekdays. Their destinations will then to a higher extent be accessible without motorized travel, and the incentive for traveling by car on weekdays will thus be lower.

According to our material, a fairly high proportion of the variation in the likelihood of being a car or taxi user on weekdays can be explained by the investigated variables (cf. the high Nagelkerke R square coefficient). The high explanatory power, compared to the analyses of other travel modes, is mainly due to the very strong effects of car ownership and possession of driver's license.

Table 6.7 shows how the traveling *distances* by car and taxi among those who have used these modes on weekdays are influenced by the three urban structural variables.

Table 6.7 *Results from a multivariate analysis of the influence from various independent variables on the mean daily traveling distance on weekdays by car and taxi among users of these modes (logarithmical transformation of distance measured in km).⁴¹*

	Unstandardized coefficients		Standardized coefficients	Level of significance (p values, two-tail)
	B	Std. error	Beta	
Location of the dwelling relative to the city center of Hangzhou (non-linear distance function, values ranging from -0.23 to 1.00)	0.298	0.135	0.108	0.030
Location of the dwelling relative to the closest second-order center (non-linear distance function, values ranging from -0.94 to 1.00)	-----	-----	-----	p > 0.25
Location of the dwelling relative to the closest third-order center (non-linear distance function, values ranging from -0.93 to 1.00)	-----	-----	-----	p > 0.25

N = 291 respondents living in different parts of Hangzhou Metropolitan Area. Adjusted R² = 0.335

Among the urban structural variables, we only find an effect of the location of the dwelling relative to the city center of Hangzhou. The further away from downtown Hangzhou the car and taxi users live, the longer they tend to travel by these modes on weekdays. This is in line with expectations and shows that a central residential location does not only reduce the proportion of car and taxi users, but also reduces the distances the traveled by car and taxi among those who use these modes.

Neither the location of the dwelling relative to the closest second-order or third-order center appears to influence the distances traveled

by car and taxi among the respondents who have used these modes during the investigated weekdays.

The absence of any effect of the location of the dwelling relative to the closest third-order center is maybe not so surprising when taking into consideration that the analysis of traveling distances by car and taxi includes only those respondents who have actually traveled by these modes during the investigated weekdays. Most of those respondents probably use car or taxi to go to destinations way beyond their local center, and their car (or taxi) usage is thus hardly determined by the location of the dwelling relative to the closest local center (cf. also the absence of any such effect in Table 6.6). To a certain extent, this also applies to the location relative to the closest second-order center. Our material indicates that a high proportion of the residents of Yuhang and Xiaoshan (including those living close to the centers of these towns) work in the city of Hangzhou. Car ownership and usage is also higher among Xiaoshan and Yuhang respondents than among the remaining respondents. Both these phenomena counteract any tendency to shorter traveling distances by car among residents living close to a second-order center.

Among the non-urban-structural variables, we find strong effects of both car ownership and possession of driver's license. One might perhaps imagine that these variables would not be important in the analyses of traveling distances, as only persons actually using car or taxi are included. However the impacts of car ownership and driver's license firstly indicate that those who go by car usually travel longer distances than those who travel by taxi. Secondly, some of the car travelers are car passengers or occasional car drivers who sometimes borrow a car from a company or a relative. In comparison, those who own their own car and hold a driver's license are likely to make more frequent and possibly also longer trips by car.

We also find an expected tendency of shorter traveling distances by car and taxi among female than among male users of these modes, and – also in line with expectations – longer traveling distances by car among those with car-oriented attitudes. The latter effect is, however, quite weak and uncertain.

Summarizing from the two sets of analyses, inhabitants of the inner districts of Hangzhou tend to be more frequent non-users of car and taxi on weekdays than the remaining respondents. Based on the qualitative interviews, there is reason to believe that this difference between inner-city Hangzhou dwellers and the remaining respondents is first and foremost due to a lower frequency of car use among

respondents living close to downtown Hangzhou, as taxis appear to be used quite frequently among residents of the inner districts of Hangzhou. Among those respondents who actually use car and taxi on weekdays, residents living close to the city center of Hangzhou also appear to travel shorter distances by car and taxi, when controlling for the other investigated variables. Living close to the city center of Hangzhou thus contributes to reduce car and taxi travel on weekdays both by reducing the number of car and taxi users and by reducing the distances the users of these modes travel by car and taxi. In addition, the car ownership rate is affected. This latter effect is not accounted for by the difference in car usage, as car ownership has been included among the control variables. The indirect impact of residential location on car usage via car ownership has thus been 'subtracted'.

Travel by electronic bike. Table 6.8 shows the influences of the three urban structural variables on the likelihood of having used electronic bike as a travel mode during the five investigated weekdays.

According to our material, the likelihood of being an e-bike user on weekdays decreases the closer to the city center of Hangzhou the respondents live. This effect is fairly strong and has a high statistical certainty. At the same time, the likelihood of being an e-bike user appears to increase the closer the respondents live to one of the two second-order centers.

The effect of the location of the dwelling relative to the city center of Hangzhou reflects the generally lower need for motorized transport among those who live close to the city center of Hangzhou, cf. above. For people who cannot afford to buy a car or do not possess a driver's license, electronic bike is the most popular individual means of transport. It is therefore not any surprise that the probability of having traveled by e-bike during the investigated weekdays varies with the location of the dwelling relative to downtown Hangzhou in a way similar to the likelihood of being a user of car or taxi.

Table 6.8 *Results from a binary logistic regression analysis of the influence from the three urban structural variables on the likelihood of having traveled some of or all the traveling distance during the investigated weekdays by electronic bike.*⁴²

	B	Std. error	Wald	Level of significance (p value)
Location of the dwelling relative to the city center of Hangzhou (non-linear distance function, values ranging from -0.23 to 1.00)	1.137	0.248	21.097	0.000
Location of the dwelling relative to the closest second-order center (non-linear distance function, values ranging from -0.94 to 1.00)	- 0.244	0.122	3.986	0.048
Location of the dwelling relative to the closest third-order center (non-linear distance function, values ranging from -0.93 to 1.00)	-----	-----	-----	P > 0.25

N = 2314 respondents living in different parts of Hangzhou Metropolitan Area. Nagelkerke's $R^2 = 0.131$

The higher likelihood of being an e-bike user when living close to any of the town centers of Xiaoshan or Yuhang is more difficult to explain. One might instead imagine that residents living further away from these centers would have a higher need for traveling by e-bike to the facilities found in these centers, while the need for e-bike in order to reach destinations outside Xiaoshan and Yuhang could be expected to be approximately the same among those who live very close to one of the second-order centers and those who live a few kilometers away from such a center. The effect of the location of the dwelling relative to the closest second-order center is not very strong, and although it is statistically significant at the 0.05 level, there is some scope for coincidence.

Among the non-urban-structural variables, the likelihood of being an e-bike user appears to be influenced mainly by age, employment status, and car ownership, with higher propensity of using e-bike during the weekdays among young respondents, workforce participants and persons not belonging to a household with a car. Women are also less prone than men to be e-bike users, whereas respondents responsible for bringing children are more likely to use e-bike than those without such responsibilities.

Table 6.9 shows how the traveling *distances* by electronic bike among those who have used this mode on weekdays are influenced by the three urban structural variables.

Table 6.9 *Results from a multivariate analysis of the influence from various independent variables on the mean daily traveling distance on weekdays by electronic bike among users of this mode (logarithmical transformation of distance measured in km).⁴³*

	Unstandardized coefficients		Standardized coefficients	Level of significance (p values, two-tail)
	B	Std. error	Beta	
Location of the dwelling relative to the city center of Hangzhou (non-linear distance function, values ranging from -0.23 to 1.00)	-----	-----	-----	p > 0.25
Location of the dwelling relative to the closest second-order center (non-linear distance function, values ranging from -0.94 to 1.00)	-----	-----	-----	p > 0.25
Location of the dwelling relative to the closest third-order center (non-linear distance function, values ranging from -0.93 to 1.00)	-----	-----	-----	p > 0.25

N = 501 respondents living in different parts of Hangzhou Metropolitan Area. Adjusted R² = 0.049

Among the e-bike users, the distance traveled on weekdays by this mode appears to be influenced none of the urban structural variables.

The absence of any effect of the location of the residence relative to the city center of Hangzhou suggests that residents of the outer area of Hangzhou who do not have a car at their disposal (or do not want to drive a car) rather prefer bus than e-bike for trips beyond biking distance (cf. Table 6.4). Higher average trip distances among suburbanites will then be outweighed by a lower frequency of e-bike trips. In the second-order towns, a higher likelihood of being a user of electronic bike when living close to the town centers appears to be balanced by shorter average trip distances by e-bike among those living in the proximity of the town center. In the third-order centers as well as in their hinterlands, e-bikes are probably used predominantly use for travel to destinations outside the local town or village, due to the short internal distances within each settlement. Traveling distances by e-bike among users of this mode will then be more or less independent of the location of the residence relative to a third-order center.

Among the non-urban-structural variables, traveling distances by e-bike among users of this mode appear to be influenced first and foremost by gender, with longer e-bike traveling distances among male e-bike users. Employed e-bike users also tend to travel somewhat longer when controlling for other variables. Neither of these effects is surprising.

Summarizing from the two sets of analyses, the relationships between residential location and e-bike travel appear to be quite complex and diffuse. Among our urban structural variables, both the location of the dwelling relative to the city center of Hangzhou and to the closest second-order center show significant effects on the likelihood of being an e-bike user. However, these effects are opposite: Whereas living close to a second-order center appears to increase the likelihood of using e-bike as a travel mode during the weekdays, living close to Hangzhou's downtown area has the opposite effect. Furthermore, among e-bike users, traveling distances by this mode does not appear to be influenced by any of the urban structural variables. Evidently, several oppositely working mechanisms sum up to neutralize each others' effects.

Non-motorized proportion of total traveling distance

Because of the relatively low proportion of respondents who have used electronic bike, and in particular car/taxi, as travel modes during the weekdays, any analysis of the proportions of users of these modes would run into the same statistical-technical problems of non-normal distribution as an analysis of total traveling distances by these modes. The same applies to some extent to the proportion of bus travel, although the base of bus-user respondents is higher. However, the distance traveled by bus appears to vary with residential location in largely the same way as the total traveling distances, and a separate analysis of the proportion of bus travel would therefore not make any particular illustrative point. Instead, we have chosen to focus on the proportion of the total traveling distance on weekdays accounted for by non-motorized modes. As evident in Figure 6.1 and in Tables 6.1 and 6.2, total traveling distances tend to increase the further away the residence is located from downtown Hangzhou, whereas the distance traveled by non-motorized shows the opposite tendency.

Table 6.10 shows the results of the multivariate analysis of factors potentially influencing the non-motorized proportion of the respondents' traveling distances on weekdays. The following 9 variables were excluded in the first step of the analysis and do not appear in the table (significance levels in parentheses):

Whether or not the respondent is a student ($p = 0.960$); regular transport of children to/from kindergarten or school ($p = 0.955$); number of preschool children in the household ($p = 0.942$); location of the dwelling relative to the closest second-order center ($p = 0.935$); gender ($p = 0.911$); location of the dwelling relative to the closest third-order center ($p = 0.909$); number of children aged 7 – 17 in the

household ($p = 0.894$); attitudes to environmental issues ($p = 0.805$); and whether or not the respondent is a workforce participant ($p = 0.725$).

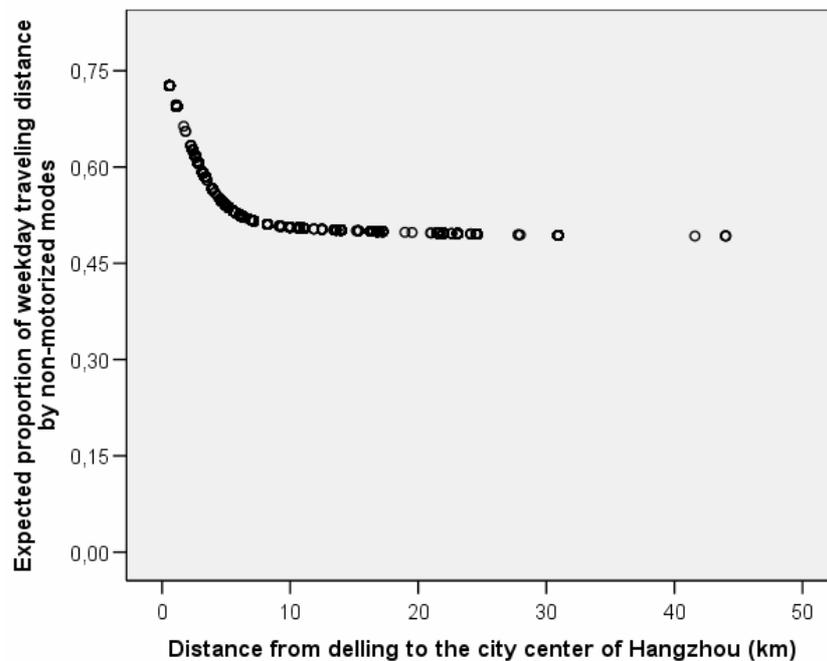
Table 6.10 *Results from a multivariate analysis of the influence from various independent variables on the proportion of traveling distance on weekdays carried out by non-motorized modes.*

	Unstandardized coefficients		Standardized coefficients	Level of significance (p values, two-tail)
	B	Std. error	Beta	
Location of the dwelling relative to the city center of Hangzhou (non-linear distance function, values ranging from -0.23 to 1.00)	-0.190	0.030	-0.135	0.000
Availability of private car in the household (yes=1, no=0)	-0.260	0.045	-0.131	0.000
Whether or not the respondent has been outside Hangzhou Metropolitan Area during the week of investigation (yes=1, no=0)	-0.117	0.040	-0.067	0.003
Personal annual income (1000 yuan renminbi)	-0.00158	0.00053	-0.066	0.003
Number of adult persons (18 years or more) in the household	-0.034	0.011	-0.062	0.003
Education level (professional secondary school or higher levels = 1, otherwise 0)	-0.057	0.020	-0.059	0.004
Possession of driver's license for car (yes=1, no=0)	-0.070	0.028	-0.062	0.008
Attitudes to transportation issues (car-oriented = high value, values ranging from -17 to 6)	-0.0084	0.030	-0.060	0.005
Whether or not the respondent has moved to the present dwelling less than 5 years ago (yes=1, no=0)	-0.066	0.025	-0.055	0.008
Age	-0.00180	0.00082	0.051	0.027
More than four overnight stays away from home during the week of investigation (yes = 1, no = 0)	-0.088	0.056	-0.035	0.118
Constant	0.793	0.056		0.000

$N = 2125$ respondents living in different parts of Hangzhou Metropolitan Area. Adjusted $R^2 = 0.141$

When controlling for other investigated potential factors of influence, the location of the dwelling relative to the city center of Hangzhou is the variable exerting the strongest influence of all on the proportion of weekday traveling distance carried out by bike or by foot. The closer to the city center of Hangzhou the respondents live, the higher their proportion of walk/bike travel tends to be. As can be seen in Figure 6.2, the proportion of the traveling distance carried out by foot or by bike is as high as 73% among the respondents living closest to the city center of Hangzhou. Among respondents living more than 10 km away from the city center of Hangzhou, the share is around 50%, with slightly higher figures among those living around 10 km from the city center than among those living in the most remote locations. The proportion of walk/bike travel increases sharply when the distance from the residence to the city center of Hangzhou decreases below some 5 – 6 km.

Figure 6.2 *Expected proportions of weekday daily traveling distance by non-motorized modes among respondents living at different distances from the city center of Hangzhou, based on the multivariate regression model providing the best fit with the data, and with the remaining variables of Table 6.10 kept constant at mean values.*



$N = 2125, p = 0.000.$

Neither the location of the residence relative to the closest second-order or third-order center appears to influence the proportion of walk/bike travel on weekdays to any extent worth mentioning. Above, we noticed that the likelihood of being a user of non-motorized modes on weekdays tended to increase somewhat the closer the respondents live to such a center. At the same time, the traveling distances by non-motorized modes among those using these modes tend to be a bit shorter the closer to a third-order center the respondents live. When at the same time the overall traveling distances on weekdays tend to increase slightly if the residence is located close to a third-order center, the joint effect of these different tendencies is too small to be statistically significant. Similarly, the location of the dwelling relative to the closest second-order center was found to show a weak influence on the likelihood of being a user of non-motorized modes, but no influence worth mentioning on neither the distance traveled by

walk/bike by users of these modes nor the total traveling distance on weekdays. The combined effect of these tendencies is too weak to result in any manifest effect of the location of the residence relative to the closest second-order center on the proportion of walk/bike travel.

Among the non-urban-structural variables, we find expected effects of car ownership, possession of driver's license, income, and transport attitudes; where respondents belonging to a household with a car, holding a driver's license, with a high income, and with car-oriented attitudes tend to carry out a lower proportion of their travel on weekdays by non-motorized modes than the remaining respondents. The proportion of walk/bike travel also tends to be reduced if the respondent has a high education level, if there is more than one adult person in the household, if the respondent has been outside the metropolitan area and/or had four or more overnight stays away from home during the investigated week, and if she/he has moved to the present dwelling less than five years ago. Neither of these effects is surprising. As discussed previously, the above-mentioned characteristics of respondents tend to increase the total traveling distances and/or the traveling distances by car, and it is therefore no surprise that they contribute to reduce the proportion of the distance traveled by non-motorized modes.

Concluding remarks

Table 6.11 summarizes the influences of the urban structural variables on the total traveling distance on weekdays, the distance traveled by different modes, and the proportion of walk/bike travel.

Table 6.11 *Main influences of residential location on total traveling distance on weekdays, travel by different modes, and the proportion of the distance traveled by non-motorized modes.*

Dependent variables		Strength of influence from residential location	Nature of influence from residential location
Total traveling distance on weekdays		Fairly strong	Considerably shorter among respondents living close to the city center of Hangzhou, but slightly longer among those who live close to a third-order center
Travel by foot and by bike	Occurrence of the modes	Strong	Especially high among respondents living close to the city center of Hangzhou, but also higher among those who live close to second- or third-order centers
	Traveling distance among users of the modes	Moderate	Longer among respondents living far from the city center of Hangzhou, but shorter among respondents living close to a third-order center
Travel by bus	Occurrence of the mode	Strong	Lowest among respondents living close to the city center of Hangzhou, but also lower among those who live close to a second-order center
	Traveling distance among users of the mode	Fairly strong	Longer among respondents living far from the city center of Hangzhou
Travel by car and taxi	Occurrence of the modes	Moderate	Lower among respondents living close to the city center of Hangzhou
	Traveling distance among users of the modes	Moderate	Longer among respondents living far from the city center of Hangzhou
Travel by electronic bike	Occurrence of the mode	Fairly strong	Lower among respondents living close to the city center of Hangzhou, but at the same time slightly higher among those who live close to a second-order center
	Traveling distance among users of the mode	None	No effects of any of the urban structural variables
Proportion of distance traveled by non-motorized modes		Strong	Considerably higher among respondents living close to the city center of Hangzhou

According to our material, residential location – in particular the location of the dwelling relative to the city center of Hangzhou – exerts a fairly strong influence on the total travel distance on weekdays, a strong influence on the proportion of this distance accounted for by non-motorized modes, and also strong influences on the likelihood of being at all a user of walk/bike and bus, respectively, on weekdays. In Hangzhou today, car ownership is still so low that the access to and use of cars seems to be more influenced by income, attitudes and possession of driver's license than by residential location, although some influences of residential location on car travel can also be traced, mainly from the location of the residence relative to the city center of Hangzhou. The influence of residential location on travel by electronic bike is limited to the likelihood of being a user of this mode, whereas traveling distances among users of the mode do not appear to be influenced.

It should be noted that many of the relationships between residential location and travel are characterized by the simultaneous operation of opposite mechanisms, sometimes resulting in a moderate or weak combined effect of a given urban structural variable and a travel behavioral variable.

Our data indicate that a residential location close to the city center of Hangzhou contributes to:

- shorter overall traveling distances on weekdays
- considerably higher likelihood of using non-motorized modes during the weekdays, but slightly shorter traveling distances by foot and bike than the average among users of these modes
- lower likelihood of traveling by bus during the weekdays, and shorter traveling distances by bus than the average among users of this mode
- lower likelihood of using car or taxi during the weekdays, and shorter traveling distances by car and taxi than the average among users of these modes
- lower likelihood of using e-bike during the weekdays
- considerably higher proportion of the total traveling distance during the weekdays carried out by non-motorized modes

Residential location close to any of the two second-order centers (Xiaoshan and Yuhang) appears to contribute to:

- higher likelihood of using non-motorized modes during the weekdays
- somewhat lower likelihood of traveling by bus during the weekdays
- slightly higher likelihood of using e-bike during the weekdays

Residential location close to any of the six third-order centers appears to contribute to:

- slightly longer overall traveling distances on weekdays
- somewhat higher likelihood of using non-motorized modes during the weekdays, but shorter traveling distances by foot and bike than the average among users of these modes.

6.4 Travel in the weekend

Similar to our investigation of travel on weekdays, we have carried out multivariate statistical analyses in order to try and sort out the separate effects of various urban structural and other characteristics that could be expected to influence the respondents' travel behavior in the weekend. Also in line with the weekday travel analyses, the original traveling distances measured in kilometers, as well as the distances from the dwelling to various types of centers, have been transformed into logarithmic values. The urban structural, demographic, socioeconomic, attitudinal and other variables were the same as in the weekday analyses. Each multivariate analysis was also, as in the analyses of weekday travel, carried out in two steps, first sorting out all variables not satisfying a required significance level of 0.25. Moreover, like in the analyses of weekday travel, the analyses of traveling distances by non-motorized modes have been carried out in another two-step procedure, investigating first factors influencing whether or not the respondents have at all used the mode in question during the weekend, and thereupon analyzing factors influencing the traveling distances by the respective modes among their users.

Total traveling distances

Table 6.12 shows the results of the multivariate analysis of factors potentially influencing the respondents' average daily traveling distance during the weekend. The following 8 variables were excluded in the first step of the analysis and do not appear in the table (significance levels in parentheses):

Attitudes to environmental issues ($p = 0.972$); whether or not the respondent is a student ($p = 0.950$); location of the dwelling relative to the closest second-order center ($p = 0.932$); location of the dwelling relative to the closest third-order center ($p = 0.904$); attitudes to transport issues ($p = 0.899$); number of children aged 7 – 17 in the household ($p = 0.884$); number of children below 7 years of age in the household ($p = 0.848$); and whether or not the respondent is a workforce participant ($p = 0.726$).

Table 6.12 *Results from a multivariate analysis of the influence from various independent variables on the mean daily traveling distance in the weekend (logarithmical transformation of distance measured in km).*

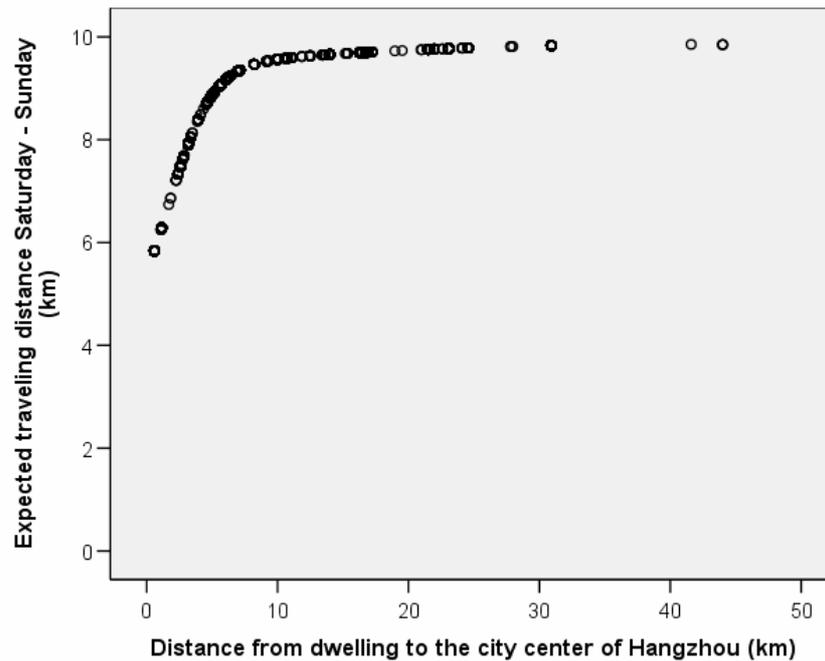
	Unstandardized coefficients		Standardized coefficients	Level of significance (p values, two-tail)
	B	Std. error	Beta	
Availability of private car in the household (yes=1, no=0)	0.282	0.060	0.099	0.000
Location of the dwelling relative to the city center of Hangzhou (non-linear distance function, values ranging from -0.23 to 1.00)	0.168	0.039	0.093	0.000
More than four overnight stays away from home during the week of investigation (yes = 1, no = 0)	-0.275	0.073	-0.087	0.000
Whether or not the respondent has been outside Hangzhou Metropolitan Area during the week of investigation (yes=1, no=0)	0.165	0.052	0.073	0.002
Possession of driver's license for car (yes=1, no=0)	0.090	0.035	0.062	0.010
Education level (professional secondary school or higher levels = 1, otherwise 0)	0.067	0.026	0.057	0.011
Regular transport of children to/from kindergarten or school (yes = 1, no = 0)	0.077	0.029	0.056	0.007
Age	- 0.00257	0.00107	- 0.056	0.016
Personal annual income (1000 yuan renminbi)	0.00171	0.00073	0.053	0.019
Sex (female = 1, male = 0)	-0.060	0.025	-0.050	0.019
Whether or not the respondent has moved to the present dwelling less than 5 years ago (yes=1, no=0)	0.057	0.032	0.037	0.078
Number of adult persons (18 years or more) in the household	0.022	0.015	0.031	0.135
Constant	0.501	0.075		0.000

$N = 2236$ respondents living in different parts of Hangzhou Metropolitan Area. Adjusted $R^2 = 0.080$.

According to the multivariate analysis, the location of the dwelling relative to the city center of Hangzhou is the only urban structural variables showing a statistically significant effect on traveling distances during the weekend. The effect is in line with expectations. As can be seen in Figure 6.3, the average traveling distance among those respondents living closest to the city center of Hangzhou is 5.8 km when keeping all other variables than the location of the dwelling relative to downtown Hangzhou constant at mean values. Among respondents living ten kilometers away from the city center of Hangzhou, the average daily traveling distance is about 9.6 km when keeping the other variables constant at mean values. A further increase in the distance from the dwelling to the city center of Hangzhou beyond 10 km is associated with only very slight increases in daily traveling distances.

Figure 6.3 *Expected daily traveling distances during the weekend among respondents living at different distances from the city center of Hangzhou, based on the multivariate regression model providing the best fit with the data, and*

with the remaining variables of Table 6.12 kept constant at mean values.⁴⁴



$N = 2236, p = 0.000.$

Our analysis does not show any effect of the location of the residence relative to the closest second-order or third-order center. As mentioned in the section on weekday travel, residents living close to second-order and third-order centers usually have easier access to bus or train services than their counterparts living far away from any center, and have thus a higher opportunity to travel to facilities outside the local district. On the other hand, living close to a second-order or third-order center reduces the need for traveling long distances to local shops and leisure facilities etc. Our material indicates that these opposite mechanisms are largely balancing each other in the weekend, as distinct from on weekdays, where the higher accessibility by public transport to workplace concentrations in the city of Hangzhou among those living close to a third-order center results in somewhat longer overall traveling distances.

The influences of the non-urban-structural variables are in line with expectations and very much the same as in the analysis of travel on weekdays. However, in the weekend, traveling distances also seem to be influenced by whether or not the respondent has moved during

recent years to her/his present dwelling, and by her/his education level. Those who have moved recently tend to travel somewhat longer in the weekend. This probably reflects visits to friends and relatives in their previous neighborhood. The fact that people with a high education level tend to travel longer in the weekend than those with a low education level is a bit more difficult to explain, but may reflect a more sophisticated and specialized cultural taste. As noted in the discussion of the qualitative interview data, this is likely to make people more often choose cultural and leisure facilities beyond those available in the local district.

Traveling distances by different modes

In the following, only the effects of the three urban structural variables will be mentioned. The influences of the non-urban-structural variables are to a high extent similar to the effects of these variables in the corresponding analyses of travel on weekdays.

Travel by foot and by bike. Table 6.13 shows the influences of the three urban structural variables on the likelihood of having used walking or biking as a travel mode during the five investigated weekdays.

As we can see, the likelihood of using bike or walking as travel modes during the weekdays is influenced by all three urban structural variables. All these effects are in line with theoretical considerations. The likelihood of being a user of non-motorized modes decreases the further away the respondents live from the city center of Hangzhou as well as from the closest second-order and third-order center. The strongest and most certain influence is from the location of the residence relative to the main center of the metropolitan area, i.e. the city center of Hangzhou. The likelihood of having used walking or biking as travel modes during the investigated weekdays is in particular high in the inner parts of Hangzhou, but is quite high also in areas close to the centers of Xiaoshan and Yuhang. We also find a certain tendency to higher likelihood of being a user of non-motorized modes among respondents living close to any of the six third-order centers, but the latter effect is weak.

Table 6.13 *Results from a binary logistic regression analysis of the influence from the three urban structural variables on the likelihood of having traveled some of or all the traveling distance during the weekend by non-motorized modes.*⁴⁵

	B	Std. error	Wald	Level of significance (p value)
Location of the dwelling relative to the city center of Hangzhou (non-linear distance function, values ranging from -0.23 to 1.00)	-0.959	0.195	23.964	0.000
Location of the dwelling relative to the closest second-order center (non-linear distance function, values ranging from -0.94 to 1.00)	-0.531	0.132	16.170	0.000
Location of the dwelling relative to the closest third-order center (non-linear distance function, values ranging from -0.93 to 1.00)	-0.126	0.091	1.890	0.169

$N = 2314$ respondents living in different parts of Hangzhou Metropolitan Area. Nagelkerke's $R^2 = 0.087$.

Table 6.14 shows how the traveling *distances* by non-motorized modes among those who have used such modes in the weekend are influenced by the three urban structural variables.

Table 6.14 *Results from a multivariate analysis of the influence from various independent variables on the mean daily traveling distance in the weekend by non-motorized modes among users of these modes (logarithmical transformation of distance measured in km).*⁴⁶

	Unstandardized coefficients		Standardized coefficients	Level of significance (p values, two-tail)
	B	Std. error	Beta	
Location of the dwelling relative to the city center of Hangzhou (non-linear distance function, values ranging from -0.23 to 1.00)	0.078	0.035	0.061	0.025
Location of the dwelling relative to the closest third-order center (non-linear distance function, values ranging from -0.93 to 1.00)	- 0.051	0.024	-0.058	0.037
Location of the dwelling relative to the closest second-order center (non-linear distance function, values ranging from -0.94 to 1.00)	-----	-----	-----	$p > 0.25$

$N = 1556$ respondents living in different parts of Hangzhou Metropolitan Area. Adjusted $R^2 = 0.028$.

Among those who are users of non-motorized modes for daily travel, traveling distances by bike or by foot are, other things equal, longer the further away from the city center of Hangzhou the residence is located, and the closer to the closest third-order center the respondents

live. These effects are similar to what was found on weekdays. The location of the dwelling relative to the closest second-order center shows no effect worth mentioning on the traveling distance by non-motorized modes on weekdays.

The modest impacts of the urban structural variables on walk/bike traveling distances reflect the fact that each of these variables influences non-motorized through oppositely working mechanisms (cf. the discussion of the corresponding relationships in the section on travel on weekdays). It should be noted that the investigated variables – urban structural as well as control variables – can only explain a very small proportion of the variation in traveling distances by non-motorized modes, cf. the low Adjusted R squared value of Table 6.14.

Summarizing the impacts found of the urban structural variables in the two sets of analyses, we see that the likelihood of being a user of non-motorized modes increases the closer the respondents live to an urban center, in particular the city center of Hangzhou. On the other hand, those who use non-motorized modes tend to travel longer distances by these modes if they live far away from downtown Hangzhou. Living close to a third-order center contributes to increase both the frequency of non-motorized travel and the distances traveled by foot or bike by the users of these modes, but neither of these effects is very strong. Living close to a second-order center increases the likelihood of being a user of non-motorized modes in the weekend, but does not seem to influence the distances traveled by foot or bike by the users of these modes. The effects of the urban structural variables are very similar to those found on weekdays. We therefore refer to the section on weekday travel for a discussion and interpretation of the effects of the location of the residence relative to various types of centers.

Travel by bus. Table 6.15 shows the influences of the three urban structural variables on the likelihood of having used bus as a travel mode during the weekend.

The likelihood of having traveled by bus during the weekend is influenced by all three urban structural variables: The closer the respondents live to the city center of Hangzhou, the closest second-order center as well as the closest third-order center, the lower is the likelihood of having traveled by bus on the investigated weekdays. This reflects the findings regarding the use of non-motorized modes:

Table 6.15 *Results from a binary logistic regression analysis of the influence from the three urban structural variables on the likelihood of having traveled some of or all the traveling distance during the weekend by bus.*⁴⁷

	B	Std. error	Wald	Level of significance (p value)
Location of the dwelling relative to the city center of Hangzhou (non-linear distance function, values ranging from -0.23 to 1.00)	0.594	0.161	13.540	0.000
Location of the dwelling relative to the closest second-order center (non-linear distance function, values ranging from -0.94 to 1.00)	0.453	0.132	11.717	0.001
Location of the dwelling relative to the closest third-order center (non-linear distance function, values ranging from -0.93 to 1.00)	0.270	0.095	8.001	0.005

N = 2371 respondents living in different parts of Hangzhou Metropolitan Area. Nagelkerke's $R^2 = 0.087$.

Table 6.16 *Results from a multivariate analysis of the influence from various independent variables on the mean daily traveling distance in the weekend by bus among users of this mode (logarithmical transformation of distance measured in km).*⁴⁸

	Unstandardized coefficients		Standardized coefficients	Level of significance (p values, two-tail)
	B	Std. error	Beta	
Location of the dwelling relative to the city center of Hangzhou (non-linear distance function, values ranging from -0.23 to 1.00)	0.192	0.051	0.132	0.000
Location of the dwelling relative to the closest second-order center (non-linear distance function, values ranging from -0.94 to 1.00)	-----	-----	-----	$p > 0.25$
Location of the dwelling relative to the closest third-order center (non-linear distance function, values ranging from -0.93 to 1.00)	-----	-----	-----	$p > 0.25$

N = 823 respondents living in different parts of Hangzhou Metropolitan Area. Adjusted $R^2 = 0.054$.

When people live close to concentrations of facilities, a number of potential trip destinations will be within walking or biking distance, and the need for using bus or other motorized modes of travel will be less. The fact that the opportunities for traveling by bus are better in centers; in particular the inner city of Hangzhou, than elsewhere in the region, does not alter this. (For a further discussion, see the section on weekday travel.)

Table 6.16 shows how the traveling *distances* by bus among those who have used this mode in the weekend are influenced by the three urban structural variables.

Among the urban structural variables, we only find any effect of the location of the dwelling relative to the city center of Hangzhou. This is similar to what was found in the analysis of weekday travel. The further away the respondents live from downtown Hangzhou, the longer they tend to travel by bus. The location of the residence relative to the lower-order center categories does not appear to influence the traveling distances by bus among those who use this mode.

Summarizing from the two sets of analyses, living close to the city center of Hangzhou reduces the likelihood of having at all traveled by bus as well as the distances traveled by bus among the users of this mode. Living close to a second- or third-order center also tends to reduce the likelihood of being a bus user, but does not appear to influence to any extent worth mentioning the distances traveled by bus among the users of this mode.

Travel by car and taxi. Table 6.17 shows the influences of the three urban structural variables on the likelihood of having used car and taxi as travel modes during the five investigated weekdays.

Table 6.17 *Results from a binary logistic regression analysis of the influence from the three urban structural variables on the likelihood of having traveled some of or all the traveling distance during the weekend by car or taxi.*⁴⁹

	B	Std. error	Wald	Level of significance (p value)
Location of the dwelling relative to the closest third-order center (non-linear distance function, values ranging from -0.93 to 1.00)	0.458	0.151	9.256	0.002
Location of the dwelling relative to the city center of Hangzhou (non-linear distance function, values ranging from -0.23 to 1.00)	0.546	0.309	3.121	0.077
Location of the dwelling relative to the closest second-order center (non-linear distance function, values ranging from -0.94 to 1.00)	-----	-----	-----	p > 0.25

N = 2275 respondents living in different parts of Hangzhou Metropolitan Area. Nagelkerke's $R^2 = 0.422$.

According to our material, the likelihood of having traveled by car or taxi during the weekend is influenced by the location of the residence relative to the closest third-order center and, to a lesser extent, by the

location of the residence relative to the city center of Hangzhou. The further away the respondents live from the closest third-order center as well as to the city center of Hangzhou, the higher is the likelihood that some of their traveling in the weekend has been carried out by car. The poor public transport facilities and low availability of facilities in the most remote parts of the region, where distances are long both to the closest third-order center and to downtown Hangzhou, imply a higher need for car travel among residents of these areas in order to reach leisure and shopping facilities.

The effect of the location of the dwelling relative to downtown Hangzhou is probably a result of the combined effects of short distances to a number of facilities, making motorized travel unnecessary, and the difficult driving conditions in the congested inner-city streets. Both these effects discourage the use of car for daily traveling purposes. The stronger effect of the location relative to third-order centers than to downtown Hangzhou suggests that car and taxi trips in the weekend are often directed to shops and leisure facilities in local centers, whereas weekend trips to the inner parts of Hangzhou are more often carried out by means of other modes than car or taxi. The absence of any effect of the location of the dwelling relative to the closest second-order center mirrors the less congested driving conditions in Xiaoshan and Yuhang and the relatively low provision of leisure and shopping facilities, compared to the city of Hangzhou, making it more attractive for residents of these towns to make weekend trips beyond acceptable walking distance (cf. the section on weekday travel).

Table 6.18 shows how the traveling *distances* by car and taxi among those who have used these modes on weekdays are influenced by the three urban structural variables.

Table 6.18 *Results from a multivariate analysis of the influence from various independent variables on the mean daily traveling distance in the weekend by car and taxi among users of these modes (logarithmical transformation of distance measured in km).⁵⁰*

	Unstandardized coefficients		Standardized coefficients	Level of significance (p values, two-tail)
	B	Std. error	Beta	
Location of the dwelling relative to the city center of Hangzhou (non-linear distance function, values ranging from -0.23 to 1.00)	0.282	0.105	0.129	0.008
Location of the dwelling relative to the closest third-order center (non-linear distance function, values ranging from -0.93 to 1.00)	0.074	0.042	0.084	0.081
Location of the dwelling relative to the closest second-order center (non-linear distance function, values ranging from -0.94 to 1.00)	-----	-----	-----	p > 0.25

N = 360 respondents living in different parts of Hangzhou Metropolitan Area. Adjusted $R^2 = 0.238$.

Similar to weekdays, the distances traveled by car and taxi among users of these modes tends to increase the further away the respondents live from the city center of Hangzhou. This effect is the strongest of the influences of the urban structural variables, but still weaker than the corresponding effect on weekdays. In addition, weekend traveling distances by car and taxi among users of these modes tend to increase slightly the further away the respondents live from the closest third-order center. This probably mirrors some of the same circumstances as discussed above regarding the impact of the location of the dwelling relative to the closest third-order center on the likelihood of being a car or taxi user in the weekend. The influence of proximity to a local center on the traveling distances of car drivers is specific to the weekend, as no similar effect was found on weekdays.

Summarizing from the two sets of analyses, inhabitants of the inner districts of Hangzhou tend to be more frequent non-users of car and taxi in the weekend than the remaining respondents. Among those who have used car or taxi as travel modes during the weekend, people living close to downtown Hangzhou also tend to travel shorter distances by car and taxi. Based on the qualitative interviews, there is reason to believe that this difference between inner-city Hangzhou dwellers and the remaining respondents is first and foremost due to a lower frequency of car use among respondents living close to downtown Hangzhou, as taxis appear to be used quite frequently among residents of the inner districts of Hangzhou, especially for trips

to leisure and entertainment facilities in weekend evenings. The proportion of their already low amount of car and taxi travel accounted for by private cars is thus even lower than indicated by Tables 6.17 and 6.18.

In addition to the lower car usage among residents of inner-city Hangzhou, our material shows that respondents who live far away from the closest third-order center are more frequent car and taxi travelers, and those among them who are users of these modes also travel longer distances by car and taxi. In other words, respondents living in the most peripheral parts of the metropolitan area are distinguished by a higher than average use of cars, whereas those living in the most central parts have a lower car usage in terms of occurrence of car travel as well as traveling distances. The location of the residence relative to the closest second-order center appears to influence car travels by oppositely working mechanisms: On the one hand, the availability of local facilities contributes to reduce the need for motorized travel among residents of the central parts of Xiaoshan and Yuhang, but on the other hand, the good road connections to Hangzhou (possibly in combination with a more widespread car culture in the second-order towns?) encourage car travel. In combination, this results in no statistically significant overall relationship between car travel and the location of the residence relative to second-order centers.

Travel by electronic bike. Table 6.19 shows the influences of the three urban structural variables on the likelihood of having used electronic bike as a travel mode during the five investigated weekdays.

Tabell 6.19 *Results from a binary logistic regression analysis of the influence from the three urban structural variables on the likelihood of having traveled some of or all the traveling distance during the investigated weekdays by electronic bike.⁵¹*

	B	Std. error	Wald	Level of significance (p value)
Location of the dwelling relative to the city center of Hangzhou (non-linear distance function, values ranging from -0.23 to 1.00)	1.395	0.242	23.306	0.000
Location of the dwelling relative to the closest third-order center (non-linear distance function, values ranging from -0.93 to 1.00)	- 0.167	0.089	3.541	0.060
Location of the dwelling relative to the closest second-order center (non-linear distance function, values ranging from -0.94 to 1.00)	-----	-----	-----	p > 0.25

N = 2627 respondents living in different parts of Hangzhou Metropolitan Area. Nagelkercke's $R^2 = 0.161$.

According to our material, the likelihood of being an e-bike user on weekdays decreases the closer to the city center of Hangzhou the respondents live. This effect is fairly strong and has a high statistical certainty. At the same time, the likelihood of being an e-bike user appears to increase the closer the respondents live to one of the two second-order centers.

The effect of the location of the dwelling relative to the city center of Hangzhou reflects the generally lower need for motorized transport among those who live close to the city center of Hangzhou, cf. above. For people who cannot afford to buy a car or do not possess a driver's license, electronic bike is the most popular individual means of transport. It is therefore not any surprise that the probability of having traveled by e-bike during the investigated weekdays varies with the location of the dwelling relative to downtown Hangzhou in a way similar to the likelihood of being a user of car or taxi.

The higher likelihood of being an e-bike user when living close to any of the town centers of Xiaoshan or Yuhang is more difficult to explain. One might instead imagine that residents living further away from these centers would have a higher need for traveling by e-bike to the facilities found in these centers, while the need for e-bike in order to reach destinations outside Xiaoshan and Yuhang could be expected to be approximately the same among those who live very close to one of the second-order centers and those who live a few kilometers away

from such a center. The effect of the location of the dwelling relative to the closest second-order center is not very strong, and although it is statistically significant at the 0.05 level, there is some scope for coincidence.

Among the non-urban-structural variables, the likelihood of being an e-bike user appears to be influenced mainly by age, employment status, and car ownership, with higher propensity of using e-bike during the weekdays among young respondents, workforce participants and persons not belonging to a household with a car. Women are also less prone than men to be e-bike users, whereas respondents responsible for bringing children are more likely to use e-bike than those without such responsibilities.

Table 6.20 shows how the traveling *distances* by electronic bike among those who have used this mode on weekdays are influenced by the three urban structural variables.

Table 6.20 *Results from a multivariate analysis of the influence from various independent variables on the mean daily traveling distance on weekdays by electronic bike among users of this mode (logarithmical transformation of distance measured in km).*⁵²

	Unstandardized coefficients		Standardized coefficients	Level of significance (p values, two-tail)
	B	Std. error	Beta	
Location of the dwelling relative to the city center of Hangzhou (non-linear distance function, values ranging from -0.23 to 1.00)	-----	-----	-----	p > 0.25
Location of the dwelling relative to the closest second-order center (non-linear distance function, values ranging from -0.94 to 1.00)	-----	-----	-----	p > 0.25
Location of the dwelling relative to the closest third-order center (non-linear distance function, values ranging from -0.93 to 1.00)	-----	-----	-----	p > 0.25

N = 548 respondents living in different parts of Hangzhou Metropolitan Area. Adjusted R² = 0.042.

According to our material, none of the urban structural variables exerts any influence worth mentioning on the traveling distances by electronic bike by users of this mode.

The absence of any effect of the location of the residence relative to the city center of Hangzhou suggests that e-bike users living in the central areas of Hangzhou make a higher number of such trips than those living in the outer areas. Although the need for an electronic

bike may be higher when living in the outskirts (a fact reflected in the higher frequency of e-bike users in these areas, cf. Table 6.19), the e-bike will, when already purchased, make up a convenient alternative to other motorized modes for inner-city residents in the congested streets in this part of the city. Lower average trip distances among inner-city e-bike users will then be outweighed by a higher frequency of e-bike trips. In the outer parts of the metropolitan area, the absence of any effect of the location of the residence relative to the closest third-order center, in combination with the higher frequency of e-bike users among those living close to such centers, suggests that the latter residents travel on average shorter distances by e-bike than e-bike users living in the more remote areas do. This is in line with expectations, given the higher need for the latter to travel long distances to reach the facilities located in the third-order centers. Similar counteracting mechanisms seem to be influencing the travel by e-bike among respondents living in and around the second-order centers.

Among the non-urban-structural variables, traveling distances by e-bike among users of this mode appear to be influenced first and foremost by gender, schoolchildren in the household, and possession of driver's license, with longer e-bike traveling distances among male users of this mode, respondents belonging to a household with one or more schoolchildren, and respondents who do not hold a driver's license for car.

Similar to travel on weekdays, the relationships between residential location and e-bike travel in the weekend appear to be quite complex and diffuse. Living close to downtown Hangzhou contributes to reduce the likelihood of being an e-bike user (probably because more destinations can be reached by bike or by foot), but does not appear to influence on the overall traveling distances in the weekend among users of the mode. Living close to a third-order center, on the other hand, seems to increase the likelihood of being an e-bike user (possibly because these residents prefer e-bike travel rather than car travel due to the availability of local facilities), but does not seem to influence the overall traveling distances among e-bike users. The location of the dwelling relative to closest second-order center appears to influence neither the occurrence of e-bike travelers nor traveling distances among users of this mode.

Non-motorized proportion of total traveling distance

Table 6.21 shows the results of the multivariate analysis of factors potentially influencing the respondents' commuting distances. The

following 6 variables were excluded in the first step of the analysis and do not appear in the table (significance levels in parentheses):

Regular transport of children to/from kindergarten or school ($p = 0.951$); number of preschool children in the household ($p = 0.928$); whether or not the respondent is a student ($p = 0.849$); number of children aged 7 – 17 in the household ($p = 0.841$); attitudes to environmental issues ($p = 0.810$); and whether or not the respondent has stayed overnight away from home more than three nights during the investigated week ($p = 0.697$).

Like on weekdays, the location of the dwelling relative to the city center of Hangzhou is the variable exerting the strongest influence of all on the proportion of weekday traveling distance carried out by bike or by foot, when controlling for other investigated potential factors of influence. In fact, this relationship is even stronger in the weekend and on weekdays. The closer to the city center of Hangzhou the respondents live, the higher their proportion of walk/bike travel tends to be. As can be seen in Figure 6.4, the proportion of the traveling distance carried out by foot or by bike is as high as 67% among the respondents living closest to the city center of Hangzhou. Among respondents living more than 10 km away from the city center of Hangzhou, the share is around 40%, with slightly higher figures among those living around 10 km from the city center than among those living in the most remote locations. The proportion of walk/bike travel increases sharply when the distance from the residence to the city center of Hangzhou decreases below some 5 – 6 km.

Distinct from weekday travel, where the location of the dwelling relative to downtown was the only urban structural variable found to influence the share of walk/bike travel, we also find effects of the location of the residence relative to the closest second- order or third-order center on the proportion of non-motorized travel in the weekend. Both these effects are in line with what could immediately be expected, as the share of walk/bike travel increases the closer the respondents live to each of these two center categories. In particular, the effect of the location relative to the closest second-order center is quite strong (although far from equally strong as the effect of proximity to the city center of Hangzhou).

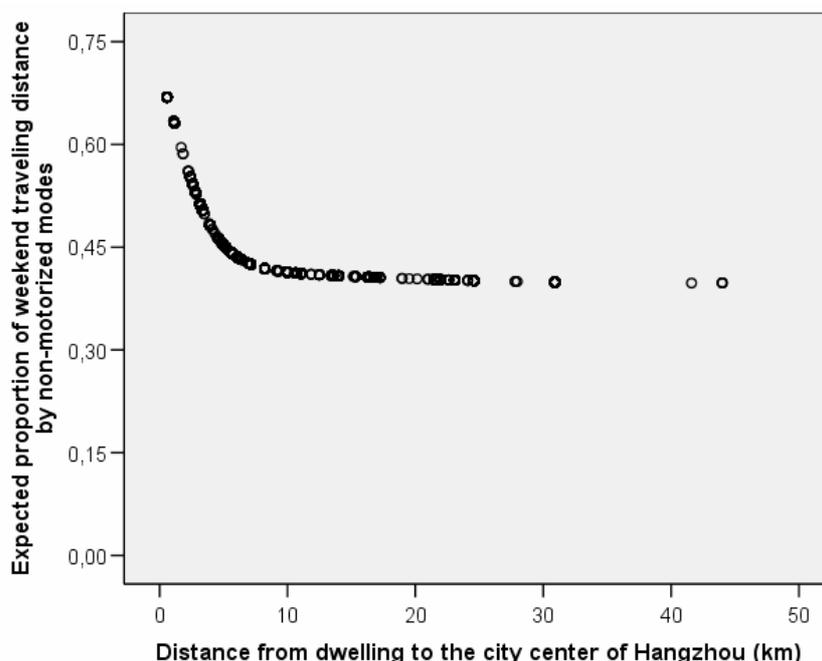
Table 6.21 *Results from a multivariate analysis of the influence from various independent variables on the proportion of traveling distance on weekdays carried out by non-motorized modes.*

	Unstandardized coefficients		Standardized coefficients	Level of significance (p values, two-tail)
	B	Std. error	Beta	
Location of the dwelling relative to the city center of Hangzhou (non-linear distance function, values ranging from -0.23 to 1.00)	-0.220	0.031	-0.164	0.000
Availability of private car in the household (yes=1, no=0)	-0.183	0.043	-0.097	0.000
Attitudes to transportation issues (car-oriented = high value, values ranging from -17 to 6)	-0.0117	0.029	-0.087	0.000
Possession of driver's license for car (yes=1, no=0)	-0.093	0.026	-0.086	0.000
Location of the dwelling relative to the closest second-order center (non-linear distance function, values ranging from -0.94 to 1.00)	-0.088	0.023	-0.081	0.000
Education level (professional secondary school or higher levels = 1, otherwise 0)	-0.062	0.020	-0.071	0.002
Age	0.00244	0.00090	0.070	0.007
Personal annual income (1000 yuan renminbi)	-0.00158	0.00053	-0.068	0.003
Whether or not the respondent has been outside Hangzhou Metropolitan Area during the week of investigation (yes=1, no=0)	-0.096	0.034	-0.059	0.005
Whether or not the respondent has moved to the present dwelling less than 5 years ago (yes=1, no=0)	-0.066	0.024	-0.057	0.006
Whether or not the respondent is a workforce participant (yes = 1, no = 0)	-0.054	0.025	-0.052	0.032
Location of the dwelling relative to the closest third-order center (non-linear distance function, values ranging from -0.93 to 1.00)	-0.040	0.019	-0.048	0.034
Sex (female = 1, male = 0)	-0.042	0.019	-0.047	0.030
Number of adult persons (18 years or more) in the household	-0.016	0.011	-0.030	0.155
Constant	0.847	0.078		0.000

$N = 2061$ respondents living in different parts of Hangzhou Metropolitan Area. Adjusted $R^2 = 0.155$.

Above, we noticed that non-motorized travel played a more important role in the weekend travel of respondents living close to the three center types (in particular the city center of Hangzhou), whereas the use of bus as well as car/taxi was less extensive among these respondents. The effects of the residential location variables on the share of walk/bike travel thus mirror the results of the analyses of travel with the each mode/group of modes.

Figure 6.4 *Expected proportions of weekend daily traveling distance by non-motorized modes among respondents living at different distances from the city center of Hangzhou, based on the multivariate regression model providing the best fit with the data, and with the remaining variables of Table 6.21 kept constant at mean values.*



$N = 2061, p = 0.000.$

Among the non-urban-structural variables, we find – like on weekdays – expected effects of car ownership, possession of driver's license, income, and transport attitudes. The proportion of walk/bike travel also tends to be reduced if the respondent has a high education level, if the respondent has been outside the metropolitan area and/or had four or more overnight stays away from home during the investigated week, and if she/he has moved to the present dwelling less than five years ago. As mentioned in the section on weekday travel, neither of the latter effects is surprising, as these characteristics tend to increase the traveling distances by motorized modes and hence reduce the share of non-motorized travel. Moreover, a high age tends to increase the proportion of non-motorized travel, reflecting the fact that the older generation is less reluctant to adopting the emerging new transport lifestyles characterized by increasing individual motorized

travel. Distinct from weekdays, where no effect of gender was found, men tend to carry out a somewhat higher proportion of their weekend travel by non-motorized modes than women do. This reflects longer average trip lengths by non-motorized modes among men, as the proportion of users of non-motorized modes is similar among male and female respondents.

Concluding remarks

Table 6.22 summarizes the influences of the urban structural variables on the total traveling distance during the weekend, the distance traveled by different modes, and the proportion of walk/bike travel. The effects of living close to the city center of Hangzhou as well as to the closest second-order center are very similar to those found on weekdays, and largely of the same order of magnitude. This is a marked difference from what has been found in European cities, where the influence of residential location on travel in the weekend is considerably weaker than on weekdays. The influences of a residential location close to a third-order center show a higher difference between weekdays and the weekend.

Our data indicate that a residential location close to the city center of Hangzhou contributes to:

- shorter overall traveling distances in the weekend
- considerably higher likelihood of using non-motorized modes during the weekend, but shorter traveling distances by foot and bike than the average among users of these modes
- lower likelihood of traveling by bus during the weekend, and shorter than average traveling distance by bus among users of this mode
- slightly lower likelihood of using car or taxi during the weekend, and shorter than average traveling distance by car and taxi among users of these modes
- considerably lower likelihood of using e-bike during the weekend
- considerably higher proportion of the total traveling distance during the weekend carried out by non-motorized modes

Table 6.22 *Main influences of residential location on total traveling distance during the weekend, travel by different modes, and the proportion of the distance traveled by non-motorized modes.*

Dependent variables		Strength of influence from residential location	Nature of influence from residential location
Total traveling distance during the weekend		Fairly strong	Shorter among respondents living close to the city center of Hangzhou
Travel by foot and by bike	Occurrence of the modes	Strong	Especially high among respondents living close to the city center of Hangzhou, and also high among those who live close to a second-order center. Slightly higher also when living close to a third-order center
	Traveling distance among users of the modes	Moderate	Shorter among respondents living close to the city center of Hangzhou, but somewhat longer among those who live close to a third-order center
Travel by bus	Occurrence of the mode	Strong	Lower among respondents living close to all three center categories, with the lowest frequencies of occurrence among those who live close to the city center of Hangzhou
	Traveling distance among users of the mode	Fairly strong	Shorter among respondents living close to the city center of Hangzhou
Travel by car and taxi	Occurrence of the modes	Moderate	Lower among respondents living close to a third-order center, and slightly lower among those who live close to the city center of Hangzhou
	Traveling distance among users of the modes	Weak	Shorter among respondents living close to the city center of Hangzhou, and slightly shorter among respondents living close to a second-order center
Travel by electronic bike	Occurrence of the mode	Strong	Considerably lower among respondents living close to the city center of Hangzhou, but at the same time slightly higher among those who live close to a third-order center
	Traveling distance among users of the mode	None	No effects from any of the urban structural variables
Proportion of distance traveled by non-motorized modes		Strong	Considerably higher among respondents living close to the city center of Hangzhou. Also higher among respondents living close to a second- or third-order center

Residential location close to any of the two second-order centers (Xiaoshan and Yuhang) appears to contribute to:

- higher likelihood of using non-motorized modes during the weekend
- lower likelihood of traveling by bus during the weekend

- higher proportion of the total traveling distance during the weekend carried out by non-motorized modes

Residential location close to any of the six third-order centers appears to contribute to:

- slightly higher likelihood of using non-motorized modes during the weekend, and somewhat longer traveling distances by foot and bike than the average among users of these modes
- lower likelihood of traveling by bus during the weekend
- lower likelihood of traveling by car or taxi during the weekend, and slightly shorter traveling distances by car and taxi than the average among users of these modes
- slightly higher likelihood of traveling by electronic bike during the weekend
- somewhat higher proportion of the total traveling distance during the weekend carried out by non-motorized modes

Compared to travel on weekdays, the influences of the location of the dwelling relative to the city center of Hangzhou are identical except for a little weaker effect on the use of car/taxi and little stronger effect on the use of e-bike in the weekend than on weekdays. The influences of proximity to a second-order center are also partly the same, but the proportion of walk/bike travel appears to be influenced only in the weekend, whereas the usage of e-bike travel is affected only on weekdays.

The location of the residence relative to the closest third-order center shows a higher number of effects in the weekend than on weekdays, and the effects are also somewhat different. Both on weekdays and in the weekend, living close to a third-order center contributes to a slightly higher likelihood of using non-motorized modes, but whereas proximity to such a center contributes to somewhat shorter walk/bike distances among users of these modes on weekdays, the effect is the opposite in the weekend. As a result, proximity to a third-order center contributes to increase the proportion of the total distance traveled by non-motorized modes in the weekend, but not on weekdays. Moreover, whereas the total traveling distances on weekdays tend to be slightly higher among respondents living close to a third-order center, no such effect is found in the weekend. Finally, proximity to a third-order center contributes to reduce the use of bus, electronic bike and in particular car/taxi in the weekend, whereas no such effects are found on weekdays. The higher number of influences in the weekend

than on weekdays suggests that the third-order centers are more important as trip destinations in the weekend than on weekdays. On weekdays, many outer-area residents travel to workplace concentrations in the city of Hangzhou or in the new economic and technological development zones, whereas local shops, teahouses, restaurants and sport and exercise facilities appear to attract a higher number of trips to the third-order centers in the weekend.

6.5 Travel during the week as a whole

Since a number of aspects have already been dealt with in the analyses of weekday and weekend travel, respectively, only a limited number of transport variables will be addressed in this section: The total weekly traveling distance, travel by car and taxi, and the proportion of non-motorized travel.

Mean daily traveling distance over the whole week

Table 6.23 shows the results of the multivariate analysis of factors potentially influencing the respondents' average daily traveling distance during the whole investigated week. The following 6 variables were excluded in the first step of the analysis and do not appear in the table (significance levels in parentheses):

Attitudes to environmental issues ($p = 0.972$); location of the dwelling relative to the closest second-order center ($p = 0.913$); attitudes to transport issues ($p = 0.892$); number of children aged 7 – 17 in the household ($p = 0.782$); whether or not the respondent is a workforce participant ($p = 0.637$); and whether or not the respondent is a student ($p = 0.253$).

According to our material, the daily traveling distance during the week as a whole is influenced by two urban structural variables: the location of the dwelling relative to the city center of Hangzhou, and the location of the dwelling relative to the closest second-order center. Among these two variables, the effect of the location of the dwelling relative to the city center of Hangzhou is by far the strongest. In fact, this variable exerts the strongest influence on the traveling distance over the week among all the investigated urban structural, demographic, socioeconomic, attitudinal and other variables. Traveling distance tend to increase, the further away from the city center of Hangzhou the dwelling is located (see figure 6.5). When the distance between the residence and downtown Hangzhou exceeds some 10 km, the effect on traveling distances from living further away

from the city center of Hangzhou is still very modest. This effect is in accordance with what could be expected from theoretical considerations and is also in line with findings in a number of other cities.

Table 6.23 *Results from a multivariate analysis of the influence from various independent variables on the mean daily traveling distance over the whole investigated week (logarithmical transformation of distance measured in km).*

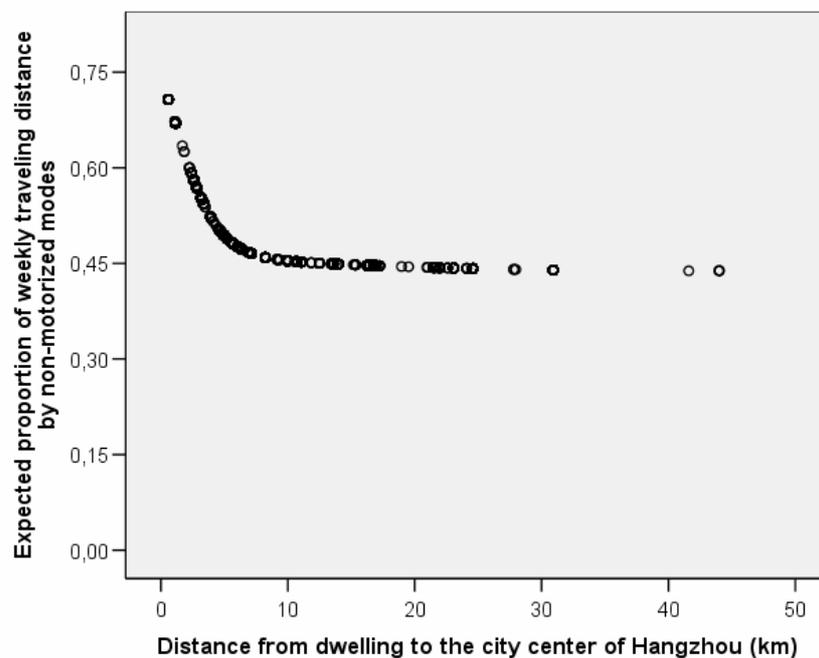
	Unstandardized coefficients		Standardized coefficients Beta	Level of significance (p values, two-tail)
	B	Std. error		
Location of the dwelling relative to the city center of Hangzhou (non-linear distance function, values ranging from -0.23 to 1.00)	0.220	0.030	0.153	0.000
Whether or not the respondent has been outside Hangzhou Metropolitan Area during the week of investigation (yes=1, no=0)	0.194	0.040	0.108	0.000
Personal annual income (1000 yuan renminbi)	0.00254	0.00055	0.099	0.000
Availability of private car in the household (yes=1, no=0)	0.207	0.046	0.098	0.000
More than four overnight stays away from home during the week of investigation (yes = 1, no = 0)	-0.224	0.057	-0.088	0.000
Possession of driver's license for car (yes=1, no=0)	0.100	0.026	0.087	0.000
Age	- 0.00316	0.00082	- 0.085	0.000
Sex (female = 1, male = 0)	-0.073	0.019	-0.077	0.000
Regular transport of children to/from kindergarten or school (yes = 1, no = 0)	0.066	0.023	0.061	0.003
Education level (professional secondary school or higher levels = 1, otherwise 0)	0.052	0.020	0.056	0.010
Location of the dwelling relative to the closest third-order center (non-linear distance function, values ranging from -0.93 to 1.00)	-0.053	0.020	-0.055	0.007
Number of adult persons (18 years or more) in the household	0.017	0.011	0.031	0.123
Whether or not the respondent has moved to the present dwelling less than 5 years ago (yes=1, no=0)	0.038	0.024	0.031	0.123
Number of preschool children (less than 7 years) in the household	-0.040	0.028	-0.030	0.153
Constant	0.578	0.061		0.000

N = 2238 respondents living in different parts of Hangzhou Metropolitan Area. Adjusted R^2 = 0.158.

Apart from the impact of the location relative to the main center of the metropolitan area, we also find an influence on the traveling distance over the week from the location of the dwelling relative to the closest third-order center. This effect is considerably weaker than the effect of the location of the residence relative to the city center of Hangzhou, but still statistically significant. Traveling distances seem to increase somewhat the closer to a third-order center the residence is located.

This effect is similar to what was found in the analysis of travel on weekdays. As mentioned in the section on weekday travel, residents living close to such a center usually have easier access to bus or train services than their counterparts living far away from any center, and have thus a higher opportunity to travel to workplace concentrations and other facilities outside the local district. This mechanism appears to be stronger than the transport-reducing influence of living close to local shops etc.

Figure 6.5 *Expected proportions of weekly traveling distance by non-motorized modes among respondents living at different distances from the city center of Hangzhou, based on the multivariate regression model providing the best fit with the data, and with the remaining variables of Table 6.23 kept constant at mean values⁵³.*



$N = 2238, p = 0.000$

The influences of the non-urban-structural variables are largely the same as on weekdays. The only difference is that in the analysis of travel over the whole week, we also find influences of education level and whether or not the respondent has moved to the present dwelling less than five years ago. People with a high education level and recent movers tend to travel somewhat longer during the week than those

who have a lower education level or who have not moved into their present dwelling during the latest years. Both these effects are theoretically plausible. The latter effect is, however, weak and quite uncertain.

Travel by car and taxi. Table 6.24 shows the influences of the three urban structural variables on the likelihood of having used car or taxi as travel modes during the five investigated weekdays.

Table 6.24 *Results from a binary logistic regression analysis of the influence from the three urban structural variables on the likelihood of having traveled some of or all the traveling distance during the investigated week by car or taxi.*⁵⁴

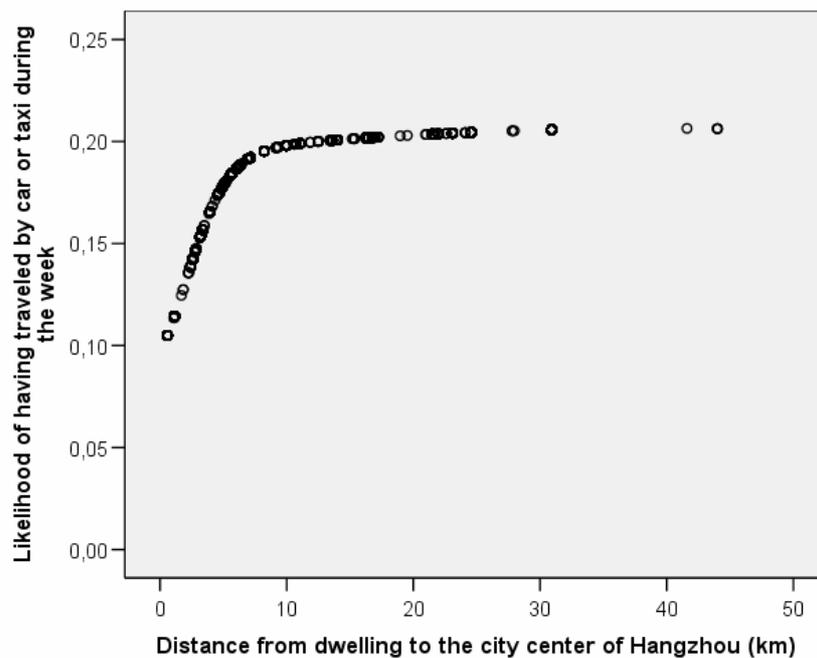
	B	Std. error	Wald	Level of significance (p value)
Location of the dwelling relative to the city center of Hangzhou (non-linear distance function, values ranging from -0.23 to 1.00)	0.855	0.286	8.946	0.003
Location of the dwelling relative to the closest third-order center (non-linear distance function, values ranging from -0.93 to 1.00)	0.280	0.138	4.128	0.042
Location of the dwelling relative to the closest second-order center (non-linear distance function, values ranging from -0.94 to 1.00)	0.222	0.173	1.644	0.200

N = 2115 respondents living in different parts of Hangzhou Metropolitan Area. Nagelkercke's $R^2 = 0.335$

According to our material, the likelihood of having used car or taxi as travel modes at least once during the investigated week increases the further away the respondents live from the city center of Hangzhou, the closest third-order center as well as the closest second-order center. The latter effect is, however, very modest and rather uncertain. Among the two other urban structural variables, the location of the residence relative to the city center of Hangzhou exerts the strongest effect. Figure 6.6 shows the relationship between the location of the residence relative to the city center of Hangzhou and the likelihood of having traveled by car or taxi, controlled for other investigated potential factors of influence. Keeping the remaining 17 investigated variables (including location of the residence relative to second- and third-order centers) constant at mean values, the likelihood of having traveled by car or taxi during the week is 10% among the respondents living closest to the city center of Hangzhou, compared to about 21% among those respondents who live more than 10 km away from downtown Hangzhou.

None of the three effects of residential location is surprising, as the public transport services are usually better and the likelihood of finding relevant facilities within acceptable walking or biking distance higher when living close to a center. The weak effect of living close to a second-order center probably reflects the high number of workplaces and stores in areas at some distance outside these towns, notably the technical and economical development zones to the north and west of Xiaoshan and to the south of Yuhang. The competition from trip destinations outside these towns counteracts the influence of living close to the local facilities in the second-order centers, which in itself contributes to reduce the need for car travel.

Figure 6.6 *Likelihood of having traveled by car or taxi during the investigated week among respondents living at different distances from the city center of Hangzhou, based on the multivariate logistic regression model providing the best fit with the data, and with the remaining 17 investigated variables (including location of the residence relative to second- and third-order centers) kept constant at mean values.*



$N = 2115, p = 0.003.$

Table 6.25 shows how the traveling *distances* by car and taxi among those who have used these modes on weekdays are influenced by the three urban structural variables.

Table 6.25 *Results from a multivariate analysis of the influence from various independent variables on the mean daily traveling distance on weekdays by car and taxi among users of these modes (logarithmical transformation of distance measured in km).*⁵⁵

	Unstandardized coefficients		Standardized coefficients	Level of significance (p values, two-tail)
	B	Std. error	Beta	
Location of the dwelling relative to the closest second-order center (non-linear distance function, values ranging from -0.94 to 1.00)	-----	-----	-----	p > 0.25
Location of the dwelling relative to the city center of Hangzhou (non-linear distance function, values ranging from -0.23 to 1.00)	-----	-----	-----	p > 0.25
Location of the dwelling relative to the closest third-order center (non-linear distance function, values ranging from -0.93 to 1.00)	-----	-----	-----	p > 0.25

N = 404 respondents living in different parts of Hangzhou Metropolitan Area. Adjusted R^2 = 0.395

None of the urban structural variables show any effect on the distances traveled by car and taxi among users of these modes. Given the fact that effects of one or more of these variables were found both on weekdays and in the weekend, this may appear a bit surprising. However, the strongest of these effects (longer car traveling distances among car users living far away from downtown Hangzhou) was only found in the weekend. On weekdays, only a tendency to longer traveling distances when living close to a second-order center was found. None of these effects is strong enough to win through when the whole week is considered. The same applies to the moderate tendency to reduced car traveling distances in the weekend found among car users living close to a third-order center.

Non-motorized proportion of total traveling distance

Table 6.26 shows the results of the multivariate analysis of factors potentially influencing the respondents' commuting distances. The following 9 variables were excluded in the first step of the analysis and do not appear in the table (significance levels in parentheses):

Regular transport of children to/from kindergarten or school ($p = 0.956$); whether or not the respondent is a student ($p = 0.956$); number of preschool children in the household ($p = 0.940$); gender ($p = 0.908$); location of the dwelling relative to the closest third-order center ($p = 0.903$); number of children aged 7 – 17 in the household ($p = 0.894$); attitudes to environmental issues ($p = 0.808$); whether or not the respondent has stayed overnight away from home more than three nights during the investigated week ($p = 0.771$); and whether or not the respondent is a workforce participant ($p = 0.729$).

Table 6.26 *Results from a multivariate analysis of the influence from various independent variables on the proportion of traveling distance during the investigated week carried out by non-motorized modes.*

	Unstandardized coefficients		Standardized coefficients Beta	Level of significance (p values, two-tail)
	B	Std. error		
Location of the dwelling relative to the city center of Hangzhou (non-linear distance function, values ranging from -0.23 to 1.00)	-0.218	0.028	-0.166	0.000
Availability of private car in the household (yes=1, no=0)	-0.225	0.042	-0.118	0.000
Education level (professional secondary school or higher levels = 1, otherwise 0)	-0.088	0.019	-0.104	0.000
Whether or not the respondent has been outside Hangzhou Metropolitan Area during the week of investigation (yes=1, no=0)	-0.151	0.034	-0.091	0.000
Age	0.00255	0.00075	0.077	0.001
Attitudes to transportation issues (car-oriented = high value, values ranging from -17 to 6)	-0.0097	0.027	-0.074	0.000
Personal annual income (1000 yuan renminbi)	-0.00164	0.00049	-0.073	0.001
Possession of driver's license for car (yes=1, no=0)	-0.063	0.024	-0.059	0.010
Number of adult persons (18 years or more) in the household	-0.025	0.010	-0.049	0.016
Whether or not the respondent has moved to the present dwelling less than 5 years ago (yes=1, no=0)	-0.054	0.023	-0.048	0.019
Location of the dwelling relative to the closest second-order center (non-linear distance function, values ranging from -0.94 to 1.00)	-0.038	0.022	-0.036	0.079
Constant	0.741	0.057		0.000

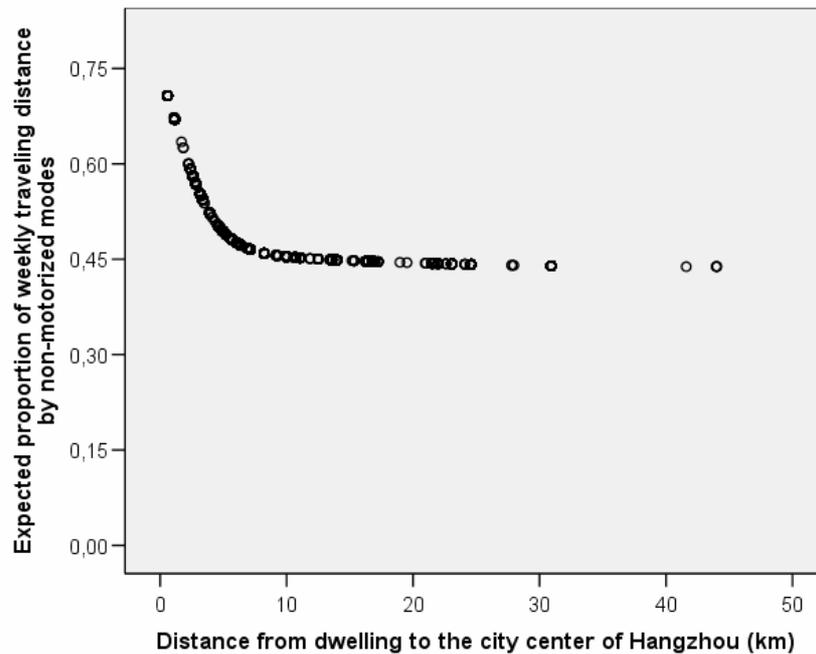
$N = 2151$ respondents living in different parts of Hangzhou Metropolitan Area. Adjusted $R^2 = 0.164$

Since the location of the dwelling relative to the city center of Hangzhou was the variable exerting the strongest influence among all investigated variables on the proportion of traveling distance carried out non-motorized modes on weekdays as well as in the weekend, it is hardly any surprise that this is also the case when considering the week as a whole. As can be seen in Figure 6.7, the proportion of the traveling distance carried out by foot or by bike is 71% among the respondents living closest to the city center of Hangzhou. Among

respondents living more than 10 km away from the city center of Hangzhou, the share is around 45%, with slightly higher figures among those living around 10 km from the city center than among those living in the most remote locations.

In addition to the influence of the location of the dwelling relative to the city center of Hangzhou, we also find a slight effect of proximity to a second-order center. Other things equal, the proportion of walk/bike travel tends to increase a bit, the closer the respondents live to the city center of Xiaoshan or Yuhang. A similar, but stronger tendency was found in the weekend, whereas no influence on the proportion of non-motorized travel from proximity to a second-order center was found on weekdays. For the week as a whole, this sums up to a weak overall effect.

Figure 6.7 *Expected proportions of weekly traveling distance by non-motorized modes among respondents living at different distances from the city center of Hangzhou, based on the multivariate regression model providing the best fit with the data, and with the remaining variables of Table 6.26 kept constant at mean values.*



$N = 2151, p = 0.000.$

The non-urban-structural variables showing effects on the proportion of non-motorized travel are the same ones as in the analysis of travel on weekdays, except overnight stays away from home, which appeared in the weekday travel analysis with a slight effect but shows no influence on the proportion of walk/bike travel during the week as a whole.

Concluding remarks

The analysis of travel during the week as a whole is highly consistent with the results of the analyses of travel on weekdays and in the weekend, respectively. In this section, we have highlighted statistical relationships between residential location and the following travel behavioral characteristics: the total traveling distance over the week, the likelihood of being a user of car or taxi, traveling distances by car and taxi among users of these modes, and the proportion of the weekly traveling distance carried out by non-motorized modes.

Our material shows that the mean daily traveling distance over the week is influenced considerably by the location of the dwelling relative to the city center of Hangzhou. Among the respondents living closest to downtown Hangzhou, the daily traveling distance is 5.8 km when controlling for the other investigated variables. Among those who live more than 10 km away from the city center of Hangzhou, the corresponding figure is about 8.4 km. Over the week, this adds up to traveling distances of 40 km among central-city residents and 59 km among respondents living more than 10 km away from the city center of Hangzhou.

Residential location also influences the likelihood of traveling by car and taxi. In particular, proximity to the city center of Hangzhou contributes to reducing the likelihood of using these modes of transport, but there are also some influences of proximity to second- and third-order centers. Other things equal, the likelihood of having traveled by car or taxi during the investigated week is 10 per cent among respondents living close to downtown Hangzhou, compared to 21% among those who live more than 10 km away from the city center of Hangzhou. It should be noted that car ownership is included among the control variables in the analysis on which these figures are based. However, car ownership may in itself be influenced by residential location, as the need for motorized transport is higher in outer areas where fewer facilities are available within walking or biking distance, and the level of public transport services is usually also lower in the outskirts. The above-mentioned analyses of the influences of residential location on the likelihood of traveling by car

or taxi must therefore be considered conservative estimates. Any indirect influences of residential location through car ownership (and possibly also attitudes to transport issues, traffic-related environmental problems and possession of driver's license) thus come in addition. Such indirect effects of residential location on travel (which may also include influences on overall traveling distances, traveling distances by car/taxi and the proportions of distance carried out by different modes) will be addressed in a separate working paper.

The omitting of indirect effects must also be borne in mind when considering the lack of statistical significant effects of any of the residential location variables on the traveling distances by car and taxi among those respondents who have used one of or both these modes of transport during the week of investigation. A number of those respondents who have used one of the two modes have actually only used taxi, and it seems plausible to assume that the latter group consists mainly of people who do not have any car available in the household. Since car ownership is less widespread among inner-city households, and car owners probably make more trips by car than the number of taxi trips carried out by those who do not own a car, the inclusion of car ownership as a control variable most likely leads to an underestimation of the traveling distance by car and taxi among users of these modes.

Residential location also exerts a considerable influence on the proportion of the weekly traveling distance accounted for by non-motorized modes. Again, proximity to the city center of Hangzhou is the residential location variable showing the strongest effect, but there is also a slight influence from the location of the residence relative to the closest second-order center. Keeping other investigated variables constant, respondents living close to downtown Hangzhou travel on average more than 70% of their weekly travel distance by foot or by bike, compared to less than 45% among those respondents living more than 10 km away from the city center.

6.6 Commuting distances

In Chapter 4, we saw that commuting distances tend to be considerably longer among respondents living in the outer than in the inner parts of the metropolitan area. A multivariate analysis shows that this holds true also when controlling for a number of demographic, socioeconomic, attitudinal and other non-urban-structural variables⁵⁶.

Table 6.27 shows the results of the multivariate analysis of factors potentially influencing the respondents' commuting distances. The following 9 variables were excluded in the first step of the analysis and do not appear in the table (significance levels in parentheses): Education level ($p = 0.980$); number of children aged 7 – 17 in the household ($p = 0.884$); car ownership ($p = 0.739$); attitudes to environmental issues ($p = 0.631$); number of children younger than 7 years of age in the household ($p = 0.495$); attitudes to transport issues ($p = 0.309$); number of adult persons in the household ($p = 0.289$); having moved during recent years to the present dwelling ($p = 0.285$); and responsibility for regularly bringing children to school/kindergarten ($p = 0.280$).

Table 6.27 *Results from a multivariate analysis of the influence from various independent variables on the daily one-way commuting distance (km measured along the road network) of respondents who are workforce participants or students.*

	Unstandardized coefficients		Standardized coefficients	Level of significance (p values, two-tail)
	B	Std. error	Beta	
Location of the dwelling relative to the city center of Hangzhou (non-linear distance function, values ranging from -0.23 to 1.00)	0.368	0.050	0.258	0.000
Location of the dwelling relative to the closest third-order center (non-linear distance function, values ranging from -0.93 to 1.00)	-0.366	0.064	-0.188	0.000
Sex (female = 1, male = 0)	-0.138	0.031	-0.152	0.000
Age	-0.0059	0.0016	-0.125	0.000
Location of the dwelling relative to the closest second-order center (non-linear distance function, values ranging from -0.94 to 1.00)	0.115	0.033	0.120	0.000
Possession of driver's license for car (yes=1, no=0)	0.088	0.037	0.084	0.017
Personal annual income (1000 yuan renminbi)	0.00140	0.00076	0.063	0.066
Being a student (yes=1, no=0)	0.152	0.119	0.042	0.201
Constant	0.826	0.117		0.000

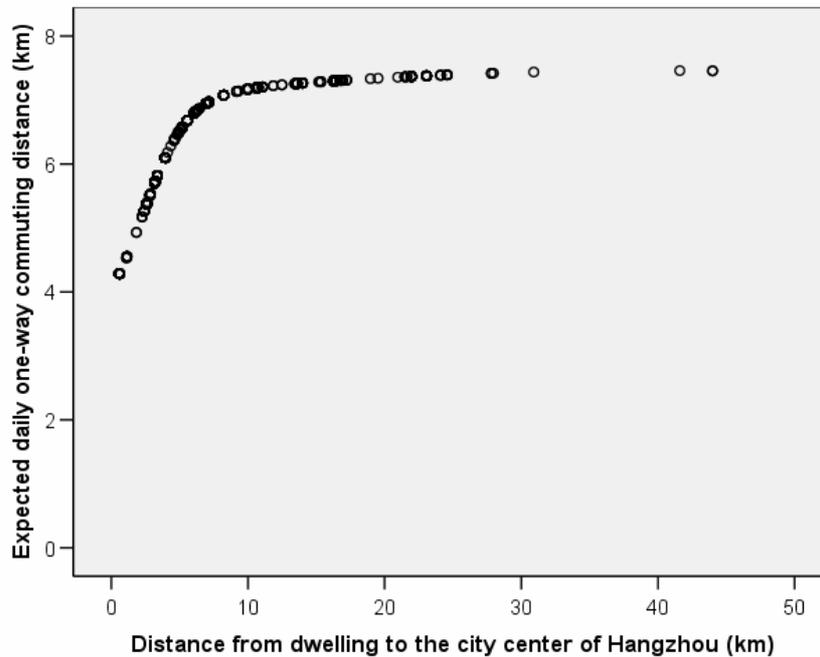
$N = 770$ respondents living in different parts of Hangzhou Metropolitan Area. Adjusted $R^2 = 0.196$

According to the multivariate analysis, all three urban structural variables show statistically significant effects on commuting distances. Two of these effects reflect the fact that commuting distances tend to increase the further away from concentrations of workplaces the residence is located (at least up to a point where the distances to a workplace concentration are so long that further

increases in these distances are outweighed by lower propensity to choose a job in this concentration of workplaces). Commuting distances tend to increase the further away the residence is located from the city center of Hangzhou as well as to the closest second-order center. Of these two effects, the influence of the location relative to the city center of Hangzhou is clearly the strongest one. Keeping the other variables of Table 6.27 constant at mean values, the average one-way commuting distance is 4.3 km among the respondents living closest to downtown Hangzhou, compared to slightly above 7 km at 10 km distance from the city center of Hangzhou, and with only slightly increasing commuting distances as the distance from the dwelling to the city center of Hangzhou increases beyond 10 km (see Figure 6.8).

The difference of 3.2 km between center and periphery in expected one-way commuting distance corresponds to a difference in daily traveling distance attributable to commuting of 6.4 km. Bearing in mind that the difference between the most central and the most peripheral locations in expected daily traveling distance on weekdays was found to be only 2.6 km, this may appear surprising. It should be noted, however, that the latter figure is an average for all respondents, whereas the figure concerning commuting distances applies to workforce participants and students only. The latter travel longer distances on weekdays, precisely because they need to go to their workplaces/places of education, and the difference between peripherally and centrally living respondents could therefore also be expected to be larger. Moreover, among the workforce participants, only about one third has actually provided information about commuting distances. This may be a cause of bias, e.g. if a high number of locally working outer-area residents work at locations not identifiable on the map and have therefore been omitted from the analysis. If we compare the mean daily overall traveling distances on weekdays between the sample who have provided acceptable information about workplace addresses with the total sample of respondents, we find that the mean daily traveling distance is 9.6 km in the two outer distance belts and 5.7 km in the innermost among the respondents included in the analysis of commuting distances, compared to 8.3 and 5.2 km, respectively, among the total sample.

Figur 6.8 *Expected commuting distances among respondents living at different distances from the city center of Hangzhou, with the remaining variables of Table 6.27 kept constant at mean values.*



$N = 770$, Adjusted $R^2 = 0.196$.

Distinct from the general traveling distances on weekdays, we find an effect of the location of the dwelling relative to the closest second-order center on the commuting distances. Not surprisingly, commuting distances tend to decrease somewhat when living close to such a center. Combined with the finding that overall traveling distances on weekdays do not appear to be influenced to any extent worth mentioning by the location of the dwelling relative to the city center of Hangzhou, this suggests that traveling distances for other purposes than journeys to work tend to increase the closer the respondents live to a second-order center. Possibly, urban lifestyles are prevailing to a high extent in the second-order centers, making the inhabitants visit typical “urban” leisure facilities to an extent similar to that of Hangzhou inhabitants. The good transport infrastructure connections between the second-order centers and Hangzhou facilitate such a frequent use of leisure and entertainment opportunities in the central parts of the metropolitan area.

In addition to the two above effects, both of which imply increasing traveling distances the further away the respondents live from centers, we find a strong effect of the location of the dwelling relative to the closest third-order center. Traveling distances tend, other things equal, to increase considerably when living close to a third-order center. There is clearly no travel-reducing influence of living in the proximity of the relatively few and not very broadly-ranging job-opportunities available in the third-order centers. Instead, the better public transport opportunities in the third-order centers than in the surrounding rural areas may enable residents of these centers to commute to non-local destinations to a higher extent than their counterparts also living in peripheral parts of the metropolitan area, but not close to any third-order center. This is still unlikely to be the main explanation of the quite substantial effect of the location of the residence relative to the closest third-order center, as the public transport services and other transport connections with the central parts of the urban region are not that very different in the third-order centers from the surrounding countryside. Another possible explanation is that mobile, educated people working in Hangzhou, who want to live in a more rural setting and perhaps in a single-family house, prefer to settle in the third-order centers rather than in purely rural surroundings.

The effects of the non-urban-structural variables are in line with what could be expected from theoretical considerations. Other things equal, commuting distances tend to be increased if the workforce participant is male, young, possesses a driver's license, has a high income, and/or is a student. Similar effects were found, e.g., in a study of residential location and travel in Copenhagen Metropolitan Area (Næss, 2006a).

A number of previous investigations in Europe and America have shown that women more often than men combine a low degree of professional specialization with non-access to a motor vehicle for daily use (Jørgensen, 1992; Hjorthol, 1998; Lee & McDonald, 2003) and hence have lower average commuting distances. The impact of sex suggests that similar tendencies are also present in a Chinese urban context. The effect of age, which is the second strongest one among the non-urban-structural variables, probably partly reflects a higher degree of work specialization among younger people, making it more difficult to find a suitable workplace close to the dwelling. In addition, old workforce participants may feel it more exhausting to make long commutes by bike or by bus (the latter in particular if it is necessary to change between different lines). A high income, on the other hand, enables respondents to spend more money on traveling and thus increases the respondents' general radius of action, including the possibility of choosing workplaces and residences spaced a long

distance apart. The effect of income may also be due to the choice of some respondents to accept longer commuting distances in order to obtain the most well-paid employment. Possession of a driver's license may enable workers to accept longer commuting distances, e.g. because can themselves drive the family's car (if the family has one) or use a company car for commuting.

6.7 Concluding remarks

Overall, our analyses show that the location of the dwelling relative to the center structure of Hangzhou Metropolitan Area has a considerable influence on the travel behavior of the respondents. Table 6.28 shows the effects of the three urban structural variables on selected travel behavior variables: total traveling distances and the proportion of non-motorized travel on weekdays as well as in the weekend, and commuting distances. The strengths of the effects are indicated by the absolute values of their standardized regression coefficients, and the degree of statistical certainty by the significance levels.

The location of the residence relative to the city center of Hangzhou exerts relatively strong effects on all these aspects of travel behavior, with shorter overall traveling distances and higher proportions of non-motorized travel both on weekdays and in the weekend and shorter commuting distances the closer to the city center of Hangzhou the respondents live. Proximity between the dwelling and a second-order center tends to reduce commuting distances and increase the proportion of non-motorized travel in the weekend, but does not appear to exert any influence worth mentioning on the overall traveling distances neither on weekdays nor in the weekend. The location of the dwelling relative to the closest third-order center has some quite surprising influences, as proximity to such a center tends to increase commuting distances and to some extent also the overall traveling distances on weekdays. More in line with expectations is the slight tendency to a higher proportion of non-motorized travel in the weekend when living close to a third-order center.

Table 6.28 *Results from multivariate analyses of the influences of the three urban structural variables on total traveling distances and the proportion of non-motorized travel on weekdays and in the weekend, and on commuting distances. Standardized regression coefficients. Significance levels (p-values, two-tailed tests) in parentheses, (n.s.) = not significant at the 0.25 level*

Urban structural variables	Traveling distances		Proportion of non-motorized travel		Commuting distances
	Weekdays	Weekend	Weekdays	Weekend	
Location of the dwelling relative to the city center of Hangzhou	0.155 (0.000)	0.093 (0.000)	- 0.135 (0.000)	- 0.164 (0.000)	0.258 (0.000)
Location of the dwelling relative to the closest second-order center	(n.s.)	(n.s.)	(n.s.)	- 0.081 (0.000)	0.120 (0.000)
Location of the dwelling relative to the closest third-order center	- 0.059 (0.004)	(n.s.)	(n.s.)	- 0.048 (0.034)	- 0.188 (0.000)

The influences of residential location on travel are considerable both on weekdays and in the weekend. There is a tendency that traveling distances are affected by the location of the dwelling to a higher extent on weekdays than in the weekend, whereas the proportions of travel carried out by different modes are influenced by residential location to a higher extent in the weekend than on weekdays. Interestingly, we cannot find any tendency to “compensatory travel” in the form of longer traveling distances in the weekend among respondents living at locations making it possible to manage on a low amount of travel on weekdays. In Europe, a hypothesis of compensatory travel (Vilhelmson, 1990; Kennedy, 1995; Tillberg, 2001) has gained much attention, and in our investigation in Copenhagen Metropolitan Area, certain indications of such travel could be found among residents of dense urban districts (Næss, 2006 a and c). In Hangzhou Metropolitan Area, there is even in the weekend a fairly strong and certain tendency to longer traveling distances the further away the respondents live from downtown Hangzhou.

Our data indicate that a residential location close to the city center of Hangzhou contributes to:

- shorter overall traveling distances on weekdays as well as in the weekend
- considerably higher likelihood of using non-motorized modes during the weekdays as well as in the weekend, but somewhat

shorter traveling distances by foot and bike than the average among users of these modes

- lower likelihood of traveling by bus both during the weekdays and in the weekend, and shorter traveling distances by bus than the average among users of this mode
- lower likelihood of using car or taxi during the weekdays and to some extent also in the weekend, and shorter traveling distances by car and taxi than the average among users of these modes
- lower likelihood of using e-bike, especially in the weekend but also during the weekdays
- considerably higher proportion of the total traveling distance carried out by non-motorized modes during the weekdays as well as in the weekend
- considerably shorter commuting distances

Residential location close to any of the two second-order centers (Xiaoshan and Yuhang) appears to contribute to:

- higher likelihood of using non-motorized modes during the weekdays as well as in the weekend
- lower likelihood of traveling by bus in the weekend and to some extent also during the weekdays
- slightly higher likelihood of using e-bike during the weekdays
- higher proportion of the total traveling distance during the weekend carried out by non-motorized modes
- somewhat shorter commuting distances

Residential location close to any of the six third-order centers appears to contribute to:

- slightly longer overall traveling distances on weekdays
- somewhat higher likelihood of using non-motorized modes during the weekdays as well as in the weekend
- shorter traveling distances by foot and bike than the average among users of these modes on weekdays, but somewhat longer in the weekend
- lower likelihood of traveling by bus during the weekend
- lower likelihood of traveling by car or taxi during the weekend, and slightly shorter traveling distances by car and taxi than the average among users of these modes

- slightly higher likelihood of traveling by electronic bike during the weekend
- somewhat higher proportion of the total traveling distance during the weekend carried out by non-motorized modes
- longer commuting distances

Most of these tendencies are in line with what could be expected from theoretical considerations and are also in line with the mechanisms and rationales identified in Chapter 5. There are, however, some effects that may appear surprising, notably the tendencies to longer commuting distances and overall traveling distances on weekdays when living close to a third-order center. In the previous sections, we have speculated on some possible explanations of these effects. More research is still needed in order to uncover the reasons for the tendencies found towards a higher amount of travel on weekdays – for commuting as well as in general – when living close to a third-order center.

7 Non-work activities and related travel: activity participation, location of activities and trip lengths

7.1 Introduction

In the previous chapters we saw that clear, statistical relationships exist between residential location and travel behavior, also when controlling for demographic, socioeconomic, attitudinal and a number of other relevant differences between the respondents. In this chapter we shall take a closer look at the ways different partial aspects of travel behavior contribute to the differences in the amount of travel found between respondents living in the central and peripheral parts of Hangzhou Metropolitan Area. The focus of the chapter is on non-work activities and trips, i.e. activities other than income-generating work and trips other than journeys to and from the workplace/place of education and occupational journeys. Most of the activities and trips addressed thus belong to the less bounded categories, although some of them may be carried out more or less routinely.

The chapter provides a concretizing and a more detailed account of some of the relationships shown in the previous chapters. Thus, by drawing a more detailed picture of the ways the different transportation rationales, in combination with the situation of the residence, produce some characteristic patterns regarding frequency of activity participation, location of activities and trip lengths for non-work trips, the chapter aims to contribute to improved insight into the mechanisms through which urban structure influences the amount of transport.

The chapter focuses primarily on the aspects of travel behavior determining the amount of transportation. Aspects included in the respondents' choices of travel modes are discussed to a higher extent in the next chapter, where indirect effects of urban structure through, among others, car ownership and transport attitudes are addressed. Below, we shall first take a look at the relationships between residential location and the frequency of participation in different non-work activities. Thereupon follow analyses of the extent to which the respondents locate certain non-work activity types to the local neighborhood around the dwelling and/or to downtown Hangzhou, respectively. In the final part of the chapter, we shall take a brief look at variations in trip-lengths for non-work trips among travel diary investigation respondents living in different parts of the metropolitan area.

7.2 Activity participation

Several authors have pointed to the fact that trip frequencies may increase if the distances to the relevant destinations are short (e.g. Crane, 1996). Conversely, if the distance from the residence to the facilities is very long, many people will find it too time-consuming, cumbersome and expensive to visit these locations regularly. Therefore, there will be "distance decay" in the attractiveness of a large center (Maddison et al., 1996). The range of attraction will vary with the type of facility, cf. above. Beyond that range, most people will orient themselves to smaller, more local centers, even if the job opportunities and selection of service facilities are narrower than in the big city. The phenomenon of "distance decay" could thus be expected to result in lower participation in activities that can only be performed far away from the dwelling. This might form a basis for the development of more local lifestyles and activity patterns among people living in the peripheral parts of a region.

In order to investigate this, questions about activity participation were asked in the questionnaire survey. Activity participation was also a topic of the qualitative interviews, cf. Chapter 5.

However, our survey data do not provide any clear evidence of distance decay in the sense described above. On the contrary, for several activity types, the frequency of performing the activities in question tends to increase the further away the respondents live from various types of centers where facilities for such activities are located. Most clearly, this is the case for shopping. Below, relationships

between residential location and activity participation will first be presented with related activities grouped together in four groups: shopping, cultural performances, social contacts, and physical exercise. Thereupon, relationships between residential location and separate activity categories will be addressed.

Considering purchases of daily necessities and selected special commodities together, the frequency of shopping tends to increase the further away the respondents live from the city center of Hangzhou, the closest second-order center as well as the closest third-order center (cf. Table 7.1). There is also a slight tendency to more frequent visits to cinemas, theaters or concerts the further away the respondents live from the closest third-order center, whereas no effects are found on the frequency of visits to such cultural performances of proximity to downtown Hangzhou or the closest second-order center.

Table 7.1 *Effects of three urban structural variables on the frequency of participation in four groups of activities. Multivariate regressions including 15 demographic, socioeconomic and other control variables⁵⁷.*

	Location of the dwelling relative to the city center of Hangzhou (non-linear distance function)	Location of the dwelling relative to the closest second-order center (non-linear distance function)	Location of the dwelling relative to the closest third-order center (non-linear distance function)
Shopping (daily necessities and cd's, books or clothes)	0.048 (p = 0.035)	0.052 (p = 0.014)	0.057 (p = 0.007)
Attending cultural performances (cinema, theater, concert)	(p > 0.25)	(p > 0.25)	0.040 (p = 0.044)
Social contacts (being visited by friends, visiting family members, inviting neighbor in for a chat or coffee, and participation in organizations)	0.059 (p = 0.011)	(p > 0.25)	0.056 (p = 0.010)
Physical exercise (walks in the neighborhood, walking/cycling in natural areas, team sports, jogging/running, and other exercise and outdoor activities)	(p > 0.25)	(p > 0.25)	- 0.048 (p = 0.022)

Standardized regression coefficients (shown only for effects with p values less than 0.25) and levels of significance (in parentheses). N = 2230-2561.

Moreover, our material suggests that the overall frequency of social contacts (measured as the sum of the frequencies of being visited by friends, visiting family members, inviting neighbors in for a chat or coffee, and participation in organizations) tends to increase the further away the respondents live from the city center of Hangzhou as well as

from the closest third-order center. The only activity group where we find a slight tendency to lower frequency of participation when living far away from centers is physical exercise. Here, our material shows a tendency to more frequent exercise activities when living close to a third-order center.

Looking more closely at the 17 separate investigated activity types (cf. Table 7.2), we see that proximity to centers tends to reduce the frequency of shopping both regarding everyday necessities and clothes, sports outfit, cosmetics etc, although we do not find any effect of the location of the dwelling relative to the closest second-order center in the latter shopping category. Among the cultural activities, the more detailed analysis shows that visits to concerts tend to increase somewhat when living close to a second-order center, whereas visits to cinemas tend to decrease the closer the respondents live to a third-order center.

Among the social contacts, the tendency to reduced frequencies when living close to centers applies first and foremost to visits by friends and chats or coffee with neighbors. Both these activity types tend to be performed less frequently when living close to downtown Hangzhou or a third-order center. In the case of chats or coffee with neighbors, also proximity between the dwelling and the closest second-order center tends to reduce the frequency of contacts. On the other hand, participation in organizations tends to occur more frequently when living close to downtown Hangzhou or the closest second-order center. The impact of a central vs. a peripheral dwelling on visits to family members is more ambiguous, as the frequency of such visits tends to increase when living close to a second-order center, but decrease when living close to downtown Hangzhou or a third-order center.

The frequency of participation in different types of physical exercise is also influenced in different ways by residential location. The frequencies of walks in the neighborhood, participation in team sports and jogging or running exercise tend to increase when living at more peripheral locations. Jogging and running as well as team sports participation tends to be carried out less frequently when living close to the city center of Hangzhou. There are also slight tendencies to less frequent jogging/running and walks in the neighborhood when living close to town centers of Xiaoshan or Yuhang.

Table 7.2 *Effects of four urban structural variables on the frequency of participation in 17 different activity categories.*

	Location of the dwelling relative to the city center of Hangzhou (non-linear distance function)	Location of the dwelling relative to the closest second-order center (non-linear distance function)	Location of the dwelling relative to the closest third-order center (non-linear distance function)
Purchasing everyday necessities (on average 47 times annually)	0.042 (p = 0.062)	0.049 (p = 0.018)	0.047 (p = 0.026)
Purchasing clothes, sports outfit, cosmetics etc. (on average 9 times annually)	0.048 (p = 0.030)	(p > 0.25)	0.052 (p = 0.011)
Going to the cinema (on average 2.5 times annually)	(p > 0.25)	(p > 0.25)	0.029 (p = 0.131)
Repair/maintenance of house, car and garden (on average 3 times annually)	0.035 (p = 0.105)	- 0.065 (p = 0.002)	(p > 0.25)
Going to restaurant, café etc. (on average 6 times annually)	(p > 0.25)	(p > 0.25)	0.058 (p = 0.007)
Going to discotheques etc. (on average 2 times annually)	(p > 0.25)	- 0.042 (p = 0.041)	(p > 0.25)
Theater performances, musicals, rock concerts etc. (on average 1.7 times annually)	(p > 0.25)	- 0.036 (p = 0.068)	(p > 0.25)
Being visited by friends (on average 20 times annually)	0.093 (p = 0.000)	(p > 0.25)	0.056 (p = 0.007)
Visiting family members (on average 20 times annually)	0.067 (p = 0.003)	- 0.062 (p = 0.003)	0.029 (p = 0.126)
Inviting a neighbor in for a chat or coffee (on average 31 times annually)	0.085 (p = 0.000)	0.049 (p = 0.024)	0.033 (p = 0.139)
Participation in organizations (on average 20 times annually)	- 0.068 (p = 0.002)	- 0.051 (p = 0.015)	(p > 0.25)
Walks in the neighborhood (on average 144 times annually)	(p > 0.25)	0.032 (p = 0.105)	(p > 0.25)
Walking/cycling in natural areas (on average 24 times annually)	- 0.065 (p = 0.002)	(p > 0.25)	- 0.065 (p = 0.001)
Team sports (on average 11 times annually)	0.047 (p = 0.016)	(p > 0.25)	(p > 0.25)
Jogging or running exercise (on average 41 times annually)	0.074 (p = 0.001)	0.026 (p = 0.218)	(p > 0.25)
Other exercise and outdoor activities (on average 73 times annually)	(p > 0.25)	(p > 0.25)	- 0.045 (p = 0.030)
Watching athletic contests (on average 38 times annually)	- 0.079 (p = 0.000)	(p > 0.25)	(p > 0.25)

Multivariate regressions including 15 demographic, socioeconomic and other control variables⁵⁸. Standardized regression coefficients (shown only for effects with p values less than 0.25) and levels of significance (in parentheses). For each activity type the average annual frequency of participation is also shown. N = 2042-2751.

On the other hand, the frequency of walking or cycling in natural areas tends to increase the closer the respondents live to the city center of Hangzhou or a third-order center. Proximity between the residence and a third-order center also appears to contribute to a slight increase in the frequency of other exercise and outdoor activities than the ones mentioned above.

In addition to the activities included in the four groups of Table 7.1, a few other activity types were also analyzed. According to our material, repair/maintenance of house, car and garden tends to be carried out more frequently when living close to a second-order center but slightly less frequently when living close to the city center of Hangzhou. Visits to restaurants tend to take place somewhat less frequently if the residence is located close to a third-order center, whereas living close to a second-order center appears to contribute to somewhat more frequent visits to discotheques etc. Finally, respondents living close to the city center of Hangzhou tend to watch athletic contests more frequently than those living at a longer distance from downtown Hangzhou.

Several of the above-mentioned tendencies may appear a bit surprising, for example when comparing with the results of a similar study of relationships between residential location and activity participation in Copenhagen Metropolitan Area (Næss, 2006 a and b). For example, in Copenhagen Metropolitan Area there was a clear tendency of lower frequency of walking/cycling in natural areas when living in dense, inner-city districts. In Hangzhou Metropolitan Area, there is, as already mentioned, and opposite tendency, with higher frequency of walking or cycling in natural areas the closer the dwelling is located to the city center of Hangzhou as well as to the closest third-order center. However, unlike most cities, the largest, and arguable most attractive natural areas (the West Lake and surrounding hills) are located quite close to the city center, with parts of the forested landscape (notably Baoshi Hill) starting only about a kilometer from the city center. The inner-city residents therefore have easier access to large and more or less continuous natural areas than most residents of the outer and suburban districts.

The general tendency to more frequent shopping activities – in terms of purchasing daily necessities as well as clothes, sports outfits, cosmetics etc. – the further away from various types of centers the respondents live, is also surprising. Given the location pattern of different kinds of shops, this implies that the respondents tend to go shopping more often the further away they live from the stores. One possible explanation could be a tendency among peripheral residents

of doing purchases in connection with the daily journey to work (for example in shops close to the bus stops), whereas inner-city residents more often make separate shopping trips as the distances to the shops are anyway quite short. In particular, if such shopping in well-assorted downtown shops in connection with commuting trips is combined with buying the most basic daily necessities in small local shops, the result might be a higher frequency of shopping among outer-area residents. A tendency among outer-area interviewees of “hitching” shopping to the journey home from work was encountered in the qualitative interviews of the Copenhagen investigation, where also a statistical tendency of less frequent shopping of everyday necessities was found among respondents living close to a second-order center (yet with more frequent shopping among those who live close to the city center of Copenhagen).

The tendency of less frequent visits to cafes, restaurants etc. among respondents living close to a third-order center is also difficult to explain, given the fact that the location relative to the city center of Hangzhou and the closest second-order center have already been controlled for. Possibly, the function of small local cafes as arenas for social contact is more important in the peripheral than in the more central parts of the metropolitan area. In the qualitative interviews, a number of examples were given of interviewees going to cafes, teahouses or mah-jong houses primarily for the sake of socializing with friends.

Such a higher frequency of visits to cafes etc. in order to socialize with friends and neighbors when living in peripheral areas is consistent with the above-mentioned finding that respondents living peripherally tend to be visited more often by friends and neighbors than their counterparts living close to downtown Hangzhou and, to somewhat lesser extent, close to lower-order centers. Again, Hangzhou differs from Copenhagen Metropolitan Area, where respondents living in dense inner-city areas tended to be visited more frequently than their low-density counterparts by friends as well as by neighbors. A plausible explanation of this fact lies in the overall much higher population density levels in Hangzhou Metropolitan Area than in Copenhagen Metropolitan Area. In the latter urban region, large parts of the suburbs are dominated by single-family homes and other low-density development, giving rise to longer distances between neighbors as well as a poor population base for local cafes etc. Single-family houses are also designed in order to increase the residents’ feeling of privacy, and the access to such dwellings usually provides fewer opportunities of randomly meeting neighbors than what is the case in more dense forms of housing. In contrast, the outer districts of

Hangzhou as well as the second-order towns of Yuhang and Xiaoshan are quite densely built, with very few single-family houses. The third-order center towns and villages are also much more densely populated than what usually characterizes suburbs and outer-area settlements in European metropolitan areas. In the rural, agriculture-dominated parts of Hangzhou metropolitan area too, overall population densities are much higher than what is typical for the countryside surrounding Scandinavian cities. The privacy-oriented housing types and developmental patterns typical for Scandinavian suburbs and metropolitan outskirts are thus much less common in Hangzhou Metropolitan Area. Instead, our data suggest that residents of the inner city of Hangzhou have less contact than suburbanites with neighbors and friends. This should be seen in the light of the very high densities in many of these residential areas, combined with quite low amounts of public open space around the dwellings. Possibly, higher levels of alienation between neighbors and more blasé attitudes may develop in such areas than in medium-density residential areas (cf. the classical sociologist Simmel's (1903) theorizing on the metropolis and mental life).

7.3 Location of activities

The questionnaire survey also included questions about the location of the following activities: daily necessities shopping, purchasing clothes, books, CD's etc., visits to cafés or restaurants, visits to movie theaters, and going to visit sights. The answering alternatives were: closer to the dwelling than approx. 1 km, downtown Hangzhou, and elsewhere. It should be noted that some respondents have ticked for more than one answering alternative. In particular, this is the case for daily necessities shopping, where 6% of the respondents have ticked for two alternatives. For purchase of clothes, books, CD's etc. and visits to cafés or restaurants, the proportions that have ticked for two equally important location alternatives are 4%. For movie theaters and sites for sightseeing, only 2% have ticked for more than one alternative.

Overall proportions using downtown, local or other facilities

The answers to these questions show that purchases of clothes, books, CD's etc., visits to movie theaters and visits to restaurants are taking place to a high extent in the downtown area of Hangzhou. For these activities, between 67% and 79% of the respondents point at downtown Hangzhou as the usual location. Compared to the proportion of respondents living close to the city center of Hangzhou,

the proportion preferring downtown Hangzhou when going to see sights (52%) must also be considered high. In contrast, the proportion using downtown shops for daily necessities purchases is 21%. The difference in percentages using downtown as locations for, on the one hand, daily necessities purchases and, on the other hand, purchases of clothes, books, CD's etc., visits to movie theaters and visits to restaurants, illustrates – in accordance with central place theory – the far more centralized location pattern for specialized stores, movie theaters and restaurants than for grocery stores. The relatively high proportion of visits to the downtown area of Hangzhou in order to visit sights probably reflects the location of the picturesque West Lake and several historical monuments (including pagodas) close to the downtown area. In addition, it may reflect the “atmospheric” qualities of the city center (Albertsen, 1999), which may attract people to the downtown area beyond the reasons discussed in transport economy and transport geography.

Conversely to the proportions usually choosing downtown Hangzhou as locations for the investigated activities, daily necessities shopping is the activity most often taking place locally. 81% of the respondents state that they usually carry out such shopping within a distance of one kilometer from the dwelling. In contrast, the proportions choosing local facilities when purchasing clothes, books, CD's etc., visit cafés or restaurants and go to movie theaters are 30%, 35% and 21%, respectively. Only 14% usually prefer the local area when going to see sights.

Apart from locations for sightseeing, few respondents usually choose other locations for the investigated activities than the local area around the dwelling or downtown Hangzhou. For both categories of shopping and visits to restaurants and movie theaters, the proportions who have ticked for “other” varies between 1.5% and 3.5%. In contrast, 37% of the respondents usually choose other locations than the local neighborhood when going to visit sights. This reflects the location of many attractive landscapes and sites in less populated areas, e.g. the western shore of the West Lake and adjacent hills, the Lingyin Temple and the Qiantang River.

The proportion of respondents who use facilities in the downtown area of Hangzhou in spite of living far away may be seen as an indicator of the attraction of the downtown area (due to range of commodities supplied, quality, “atmosphere” etc.), compared to facilities of the same categories located elsewhere in the metropolitan area. Among our activity categories, the attraction of downtown appears to be highest for special commodity shopping, visits to restaurants, and

visits to cinemas (and probably also other cultural facilities). The friction of distance generally implies a reduced propensity of using the broad supply of facilities existing in the downtown area the further away from the city center of Hangzhou the residence is located. However, as we have seen, many outer-area respondents seem to compensate this by “hitching” shopping and leisure activities on commuting trips to the inner parts of the metropolitan area.

The proportion using downtown Hangzhou as a location for purchases of everyday necessities is considerably lower than for the investigated special commodities, but still many times higher than the corresponding proportion in Copenhagen Metropolitan Area, where only 3% of the respondents stated that they were buying everyday necessities in the downtown area. Compared to the proportion of respondents living in the downtown area, the number of respondents purchasing daily necessities in the closest surroundings of the city center of Hangzhou is remarkably high. This relatively high proportion of everyday necessities purchases in the downtown area is consistent with the above tentative explanation of the higher frequency of shopping among respondents living in peripheral than central areas. If outer-area respondents compensate for a low availability of shops in their local area by buying everyday necessities in connection with commuting to Hangzhou, a high proportion of such shopping could be expected to occur in the downtown area of Hangzhou, where there is a high concentration of well-assorted stores. From our qualitative interviews we also know that it is quite common among outer-area residents to go to the inner city of Hangzhou in the weekend for combined shopping and leisure trips.

Influences of residential location on the location of activities

There are very small (less than 2 percentage points) variations between respondents living within different distance belts in the propensities of shopping daily necessities in the local area or downtown Hangzhou. However, for the remaining four activity categories, there are some characteristic differences. Both regarding purchases of clothes, books, CD's etc., visits to cafés or restaurants, visits to movie theaters and sightseeing, the lowest proportions of respondents using local facilities are found in the second outer distance belt (between 6.2 and 13.6 km from the city center of Hangzhou). And for all these activities types except sightseeing, this distance belt is also the one with the highest proportion of respondents preferring downtown facilities. For sightseeing, the respondents from the innermost of the four distance belts are the one who most often

prefer downtown facilities, but the difference to the next two distance belts is small.

Typical for purchases of clothes, books, CD's etc. and visits to cafés or restaurants as well as movie theaters is a pattern where the use of local facilities is fairly high among inner-city respondents, then decreasing sharply as the distance between the dwelling and the city center of Hangzhou increases until a bottom level is reached at some 10 km (clothes, books, CD's etc., and cafés/restaurants) or 15 km (movie theaters) from downtown. Beyond this point, local facilities tend to be used to an increasing extent with increasing distances between the residence and downtown Hangzhou. The highest frequencies of use of local facilities for these activity categories are found at some 35 – 40 km distance from the city center of Hangzhou, with propensities slightly above those found among inner-city respondents. The relationships between the use of local facilities for these activities and the location of the dwelling relative to downtown Hangzhou are thus not linear, but appear to follow S-shaped curves. According to our data, these curves could best be calculated from cubic equations. The relationship between the use of local sites for sightseeing and the location of the dwelling relative to downtown Hangzhou resembles the relationships found for the three above-mentioned activities in that the curve is S-shaped in this case too, but the propensity of choosing local sites is now clearly higher among inner-city than among outer-area respondents.

The propensities of using downtown facilities follow a pattern that is roughly spoken the inverse of the curves describing the propensities of using local facilities. For purchases of clothes, books, cd's etc. and visits to cafés/restaurants and cinemas, the likelihood of choosing downtown locations is moderate among inner-city residents, rising to a peak at some 10 or 15 km distance from the city center of Hangzhou, and then decreasing to a level at 35 – 40 km from downtown Hangzhou slightly lower than in the inner city. Regarding sightseeing, the propensity of choosing downtown location is highest among inner-city residents, decreasing gradually to a level at some 35 – 40 km from the city center of Hangzhou where less than 10% of the respondents are likely to choose downtown Hangzhou as sites for sightseeing.

However, none of the relationships between residential location and the location of the investigated facilities are very strong. As already mentioned, the propensities of using local or downtown facilities when purchasing everyday necessities are practically spoken unrelated to the distance between the dwelling and the city center of Hangzhou.

Among the remaining activity categories, the influence of residential location is highest on the choices of locations for restaurants/cafes and movie theaters, with the former relationship a bit stronger than the latter. Figure 7.1 shows the curve that, according to our data, gives the best fit to the relationship between the location of the dwelling relative to the city center of Hangzhou and the likelihood of using local cafes/restaurants. As mentioned above, the curves of the relationships between residential location and the locations for purchases of clothes, books, cd's etc. and visits to movie theaters have shapes similar to the one shown in the figure.

Figure 7.1 *Propensities among respondents living at different distances from the city center of Hangzhou of usually choosing local facilities (closer than approx. 1 km from the dwelling) when going to cafes or restaurants.*



$N = 1179, R^2 = 0.047.$

In the inner parts of Hangzhou, the local area (defined as the area within a kilometer distance from the dwelling) often has almost equally broad supply of facilities as the downtown area proper. Respondents living in these areas could therefore be expected to use local-area facilities to a high extent. In the outer districts of Hangzhou, the local areas include fewer facilities within each category, and more

specialized facilities may only exist in a few of the local areas. At the same time, the distance to the concentration of facilities found in the downtown area of Hangzhou and its nearest surroundings is relatively short. In the outer districts of Hangzhou, the facilities available in the local areas are thus exposed to a higher extent to competition from non-local facilities. Even further out towards the periphery of the metropolitan area, some of the investigation areas are located close to the second-order centers Yuhang and Xiaoshan, both with a broad supply of activities, while some of the other investigation areas in this zone are located in smaller towns and villages (notably the third-order centers) which are after all the largest centers within a relatively wide circumference. At the same time the relatively long distance to the city center of Hangzhou makes up a deterrent against choosing facilities in the downtown area of Hangzhou. The respondents from this distance belt could therefore be expected to use local facilities to a higher extent than the respondents living in the two middle distance belts.

Our material suggests that the propensity for using local facilities depends partly on which facilities *exist* in the proximity of the dwelling, and partly on the *competition* from non-local facilities. This conclusion is similar to what was found in Copenhagen Metropolitan Area (Næss, 2006 a and b) In the districts next to the downtown area, a relatively broad supply of local facilities often exists, but at the same time there is a strong competition from facilities in the city center. Conversely, the local supply of facilities is often more modest in the outer parts of the metropolitan area, but the long distance to the concentration of facilities found in central Hangzhou at the same time weakens the competition from the latter facilities.

The two above-mentioned factors reflect the rationales for location of activities identified in Chapter 5. The wish to limit geographical distances and time consumption for travel motivates respondents to use local facilities, while the wish to choose the best facility (judged against the instrumental purpose of the trip as well as the atmosphere and esthetic qualities of the facility) pull them out of the local area and inward to downtown Hangzhou. The mutual prioritization between the rationales, as well as the actual occurrence of local and competing external facilities, varies between different facility categories. Which of the two factors of influence – the occurrence of local facilities or the competition from external facilities – is the stronger thus varies between the different facility categories as well as between the different distance belts from downtown Hangzhou.

7.4 Length of trips for non-work purposes

In the travel diary investigation, questions were asked about, among others, the length of the respondents' trips carried out for different purposes during the investigated period from Saturday to Tuesday. Unfortunately, the number of respondents of the travel diary investigation is very low (27 persons), and only five residential locations are represented. These locations are almost the same as the areas in which the qualitative interviews were made, except for the most central area, where the travel diary respondents live in Beishan Road whereas the interviewees of the qualitative interviews live in Xixi Road. The low number of residential locations represented implies that the possibilities of drawing conclusions about, e.g., the influence on trip distances from the location of the dwelling relative to downtown Hangzhou is much more limited than in the analyses based on the main survey. Still, some interesting geographical variations in trip lengths may be found.

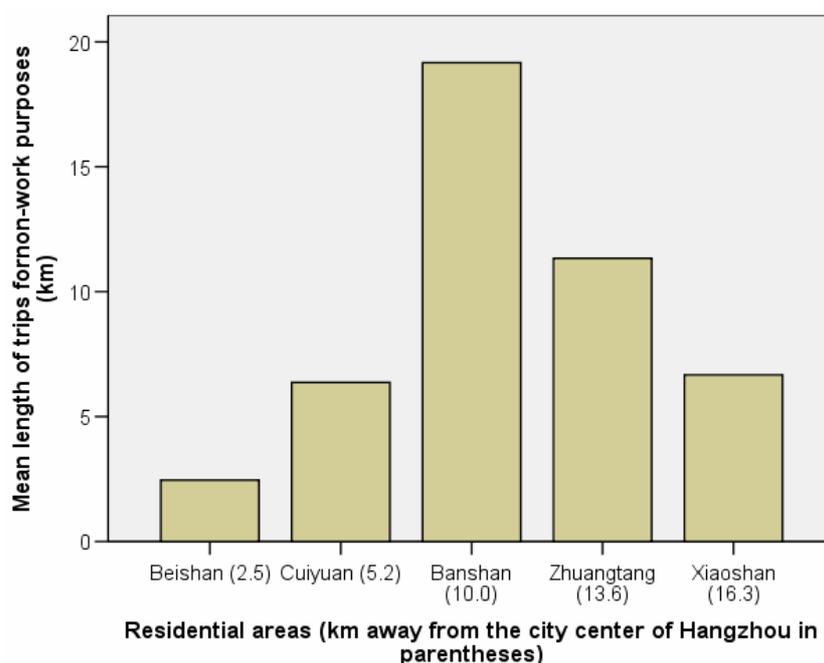
Altogether, the 27 respondents made 423 trips during the four investigated days, i.e. a daily average of 3.9 trips. However, for a quite large proportion of the trips, important information was missing. Among other things, for more than half of the trips, there was no information about the length. Our sample includes only 161 trips with valid information about trip lengths, trip purposes and residential location. Out of these 161 trips, 13 were more than 50 km long and have been excluded, as their destinations are outside Hangzhou Metropolitan Area. The analysis below is therefore based on a total sample of only 148 trips.

In the travel diary investigation, the respondents recorded journeys to workplace or place of education, trips in order to bring or pick up children, shopping/errand trips, trips in order to visit friends or relatives, leisure trips and occupational trips. The respondents were also asked to indicate whether the trip had only one purpose or two or more purposes. In the latter case, the respondents were asked to state which purpose was the primary and which were secondary purposes. However, among the 148 trips of our sample, only ten had combined purposes, and seven of these ten trips involved bringing or picking up children (5 cases) or shopping (2 cases) on the way to and/or from the workplace or place of education. We have therefore chosen to base the below analysis of trip purposes only on the main purposes of the trips.

Among the 148 trips for which sufficient information has been given, 80 are journeys to workplace or place of education, 2 are trips in order to ring or pick up children, 30 shopping/errand trips (including trips in

order to carry out shopping and visits to doctor, library, public offices etc), 5 trips to visit friends or relatives, 16 leisure trips (including trips to outdoor recreation, club activities, sport, movie theater, restaurant, etc), and 12 occupational trips. Relationships between residential location and journeys to work are addressed elsewhere (chapter 6.6). Here, we will therefore confine the analysis to trip purposes other than work. Moreover, because the number of recorded trips for most of the non-work purposes is very low, all these trip categories have been combined into one category. Still, only 52 trips are included in the analysis below.

Figure 7.2 *Mean length of trips for non-work purposes among respondents living in residential areas located at different distances from the city center of Hangzhou.*



N = 52 trips for non-work purposes carried out by 24 respondents. Among the 52 trips, 11 were made by respondents from Beishan, 11 by respondents from Cuiyuan, 12 by respondents from Banshan, 6 by respondents from Zhuangtang, and 12 by respondents from Xiaoshan.

Although Figure 7.2 is based on a low the number of trips, the graph shows some quite remarkable differences between the inner-city residential areas of Beishan and Cuiyuan on the one hand, and the outer suburbs of Banshan and Zhuangtang on the other hand. Whereas

average trip lengths for non-work purposes are short in the two most central residential areas, especially among the respondents of Beishan, the average length of non-work trips is considerably longer in Zhuangtang and in particular in Banshan. These differences reflect the much higher number of potential destinations for non-work trips in the proximity of the inner than the outer residential areas. In particular, the availability of leisure facilities is relatively poor in Banshan, where there is, for example, no teahouse or café in the local area, and a relatively poor assortment in the few shops. Among the respondents from Xiaoshan, the average length of non-work trips is moderate, at a level comparable to the Cuiyan area in Hangzhou. This reflects the quite high availability of shops and leisure facilities in the second-order center town of Xiaoshan. On the other hand, the respondents of Xiaoshan are distinguished by considerably longer commuting distances than the respondents from the other four areas. This is a bit different from the general tendency found in the main survey, where living close to one of the second-order centers was found to contribute to reduce the distance between home and workplace. With only 12 Xiaoshan residents represented in the analysis of non-work trip distances, there is of course a considerable scope for random influences on the average value.

In spite of the uncertainty caused by the small sample of trips, the data suggest that living close to the concentration of leisure, shopping and other service facilities found in the inner districts of Hangzhou and, to a lesser extent, in the second-order centers, contributes to reduce trip distances for non-work purposes. It should be noted that similar patterns to the one indicated by Figure 7.2 are found when making separate analyses of shopping/errand trips and leisure trips, respectively.

7.5 Concluding remarks

According to our material, “distance decay” in the form of reduced activity participation when living far away from relevant facilities is not very pronounced among our respondents. In general, the relationships between residential location and the frequencies of activity participation are relatively weak, and usually weaker than the relationships between residential location and traveling distances found in Chapter 6. Moreover, the analysis shows some quite surprising tendencies of more frequent activity participation the further away the respondents live from the various types of centers where the activities in question can usually be performed. Notably,

this is the case for shopping, where the frequency of visiting shops tends to increase the further away the respondents live from downtown Hangzhou as well as from the closest second- or third-order center. A plausible explanation might be that peripheral residents sometimes combine purchases of the most basic daily necessities in local stores (e.g. vegetable markets, fruit stands and small supermarkets) with shopping in larger and more well-assorted stores in Hangzhou in connection with commuting trips. In the qualitative interviews, we also saw that some of the interviewees living in peripheral areas used to go to the city center of Hangzhou for combined leisure and shopping trips in the weekend.

We also find a tendency of less frequent social contacts among respondents living in central than in peripheral parts of the metropolitan area. This too might seem surprising, seen in the light of opposite findings in Copenhagen Metropolitan Area and the American sociologist Robert Putnam's (2001) claim that urban sprawl reduces the number of social ties between people. However, the outer residential areas of Hangzhou Metropolitan Area have a much higher population density than typical North American or Scandinavian suburbs, and the suburbs and outer-area settlements of Hangzhou Metropolitan Area hardly possess the same characteristics as may generate suburban social isolation and privacy-orientation in Europe and the USA. Instead, the very high densities in certain parts of Hangzhou may contribute to higher levels of alienation between neighbors and more blasé attitudes than in medium-density residential areas (cf. Simmel, 1903).

Our material shows that the propensity for using local facilities depends partly on which facilities *exist* in the proximity of the dwelling, and partly on the *competition* from non-local facilities. In the districts next to the downtown area, a relatively broad supply of local facilities often exists, but at the same time there is a strong competition from facilities in the city center. Conversely, the local supply of facilities is often more modest in the outer parts of the metropolitan area, but the long distance to the concentration of facilities found in central Hangzhou at the same time weakens the competition from the latter facilities.

The two above-mentioned factors reflect the rationales for location of activities identified in Chapter 5. The wish to limit geographical distances and time consumption for travel motivates respondents to use local facilities, while the wish to choose the best facility pull them out of the local area and inward to the city of Hangzhou and in particular its inner districts. The mutual prioritization between the

rationales, as well as the actual occurrence of local and competing external facilities, varies between different facility categories. The same applies to the geographical distribution of facilities, where there tends to be a higher concentration to the central parts of the metropolitan area, the more specialized are the facilities. Which of the two above-mentioned factors of influence – the occurrence of local facilities or the competition from external facilities – is the stronger thus varies between the different facility categories as well as between the different distance belts from downtown Hangzhou.

In the previous chapter, we saw that commuting distances tend to increase the further away the respondents live from the concentrations of workplaces found in the central parts of Hangzhou and, to a lesser extent, the second-order center towns of Xiaoshan and Yuhang. In general, the strong concentration of service and leisure facilities in the inner and central parts of the metropolitan area also implies that average trip distances for non-work purposes increase the more peripherally the residence is located. For non-work trips, the length-reducing effect of living close to one of the second-order centers seems to be stronger than the corresponding effect on commuting distances. There is, however, a considerable uncertainty associated with this finding, as the number of trips recorded in the travel diary investigation is low.

8 Differences between population groups

8.1 Introduction

Studies of relationships between urban form and travel have usually addressed the situation among the urban population at large. However, theoretical considerations as well as previous empirical studies indicate that differences exist between population groups in the ways that urban structure influences travel behavior.

Splitting up the sample between different population groups according to gender, demographics and socioeconomic characteristics, we find some interesting differences in the ways that residential location influences commuting distances. These variations are presented below, with a somewhat more detailed account of gender differences than household structure and education level. Since a number of aspects have already been dealt with in the analyses travel among the population as a whole, the number of transport variables addressed in this section will be limited to the following: The mean traveling distances on weekdays and in the weekend, commuting distances, the likelihood of being a user of car or taxi, and the proportion of non-motorized travel.

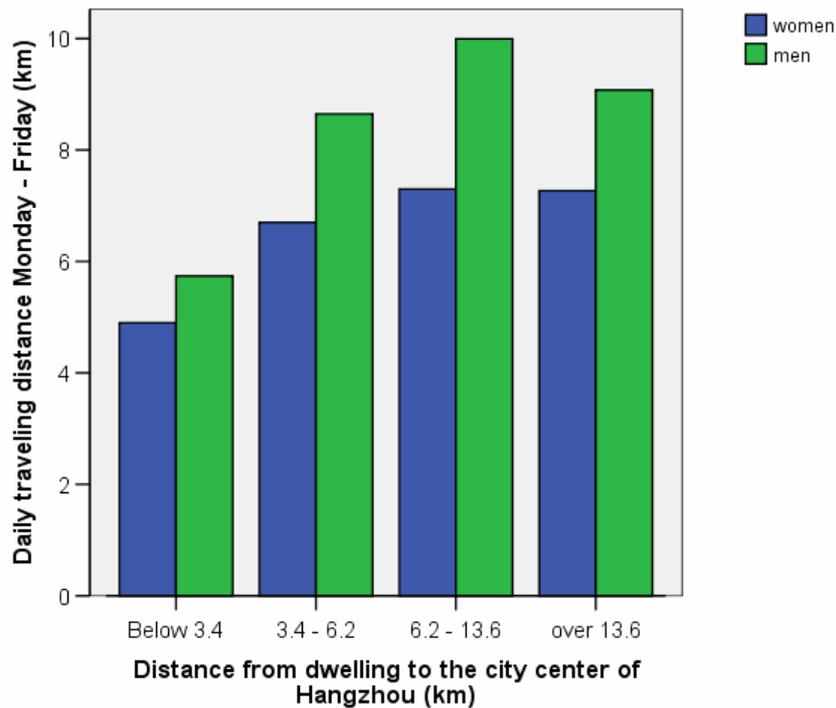
8.2 Differences between women and men

Traveling distances on weekdays and in the weekend

Similar to what has been found in several other studies (e.g. Jørgensen, 1992; Hjorthol, 2002; Næss, 2006a and 2007), female respondents travel on average shorter on weekdays (6.4 km) than their male counterparts do (8.4 km). As can be seen in Figure 8.1, this is also the case among respondents living within each of the four

distance belts from the city center of Hangzhou. Both among women and men, average traveling distances on weekdays are longer in the peripheral than in the central parts of the metropolitan area.

Figure 8.1 *Mean daily traveling distances on weekdays (Monday-Friday) among female and male respondents living within different distance belts from the city center of Hangzhou.*



N = 1649 women and 1060 men, with 526, 392, 373 and 358 female and 246, 269, 274 and 261 male respondents, respectively, in the innermost, second inner, second outer and outermost distance belt. 247 respondents with zero or extreme traveling distances (above 34.5 km daily) have been excluded from the analysis.

In the inner distance belt, the difference between women's and men's traveling distance is quite modest. In the suburbs, there is a larger difference between men and women in the distances traveled. To some extent, thus, women seem to limit their action of radius, compared to men, when they live in outer parts of the metropolitan area. These differences between men and women in traveling patterns resemble those found in Copenhagen Metropolitan Area (Næss 2007, forthcoming), although the differences between the genders in the way

that traveling distances vary with residential location are somewhat less pronounced in Hangzhou Metropolitan Area than in the Copenhagen region. Given the lower concentration of facilities – workplaces, shops as well as leisure opportunities – in the suburbs than in the city center, the smaller radius of action among women implies that their choices both on the job market and regarding leisure opportunities are limited, compared to men. The most common response among men to the lower local provision of facilities in the outer areas thus seems to be increased travel, whereas women's response to these conditions seems to be reduced activity participation and/or limitation of choices among different opportunities for performing an activity. Distinct from that, the radius of action on weekdays appears to be more equal among women and men living less than 3.4 km from the city center of Hangzhou. From a gender equality perspective, women living in the inner districts of the metropolitan area thus seem to be in a better position than their outer-area fellow sisters.

Table 8.1 shows the results of the multivariate analysis of factors potentially influencing the female and male respondents' average daily traveling distance during the investigated weekdays. The following 3 variables failed to meet a required significance level of $p > 0.25$ among women as well as among men and do therefore not appear in the table: Attitudes to environmental issues, attitudes to transport issues, location of the dwelling relative to the closest second-order center.

Both among women and men, the location of the residence relative to the city center of Hangzhou is the variable showing the strongest influence of all investigated variables on the daily traveling distance. However, the strength of this relationship is considerably stronger among men than among women (cf. the standardized and unstandardized regression coefficients, which is nearly twice as high among men as among women). This is illustrated in Figure 8.2, where the upper curve shows how the daily traveling distances among male respondents vary with the distance from the dwelling to the city center of Hangzhou when keeping all other variables than the location of the dwelling relative to downtown Hangzhou constant at mean values. The lower curve shows the corresponding, expected traveling distances on weekdays among female respondents. Among men, the difference between inner-city and outer-suburban residents in expected daily traveling distance on weekdays is about four and a half kilometer, compared to only about one and a half kilometer among women.

Table 8.1 *Results from a multivariate analysis of the influence from various independent variables on the total distance traveled (km) over the weekdays (Monday – Friday) among female and male respondents.*

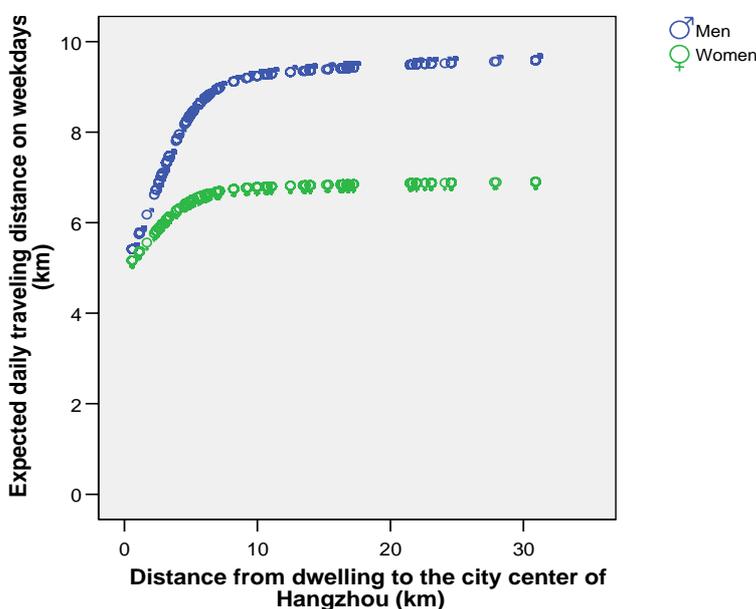
	Women			Men		
	Regression coefficients		Level of significance (p values, two-tail)	Regression coefficients		Level of significance (p values, two-tail)
	Unstandardized (B)	Standardized (Beta)		Unstandardized (B)	Standardized (Beta)	
Location of the dwelling relative to the city center of Hangzhou (non-linear distance function, values ranging from -0.23 to 1.00)	0.170	0.118	0.000	0.346	0.228	0.000
Availability of private car in the household (yes=1, no=0)	0.196	0.085	0.003	0.299	0.154	0.000
Regular transport of children to school or kindergarten (yes = 1, no = 0)	0.091	0.082	0.002	----	----	P > 0.25
Possession of a driver's license (yes = 1, no = 0)	0.095	0.082	0.016	0.063	0.060	0.088
Personal annual income (1000 yuan renminbi)	0.00218	0.076	0.008	0.00231	0.105	0.001
Education level (professional secondary school or higher levels = 1, otherwise 0)	0.058	0.061	0.025	----	----	P > 0.25
Has moved to the present dwelling less than five years ago (yes = 1, no = 0)	0.060	0.049	0.066	----	----	P > 0.25
Number of adult persons (18 years or more) in the household	0.026	0.044	0.096	0.024	0.046	0.145
Location of the dwelling relative to the closest third-order center (non-linear distance function, values ranging from -0.93 to 1.00)	- 0.071	- 0.070	0.009	----	----	P > 0.25
Number of household members below 7 years of age	----	----	P > 0.25	- 0.081	- 0.058	0.060
Overnight stays away from home more than three nights during the investigated week (yes = 1, no = 0)	----	----	P > 0.25	-0.173	- 0.078	0.022
Whether or not the respondent has been outside Hangzhou Metropolitan Area during the week of investigation (yes=1, no=0)	----	----	P > 0.25	0.187	0.116	0.001
Being a student (yes = 1, no = 0)	----	----	P > 0.25	- 0.340	- 0.092	0.004
Number of household members aged 7 - 17	----	----	P > 0.25	----	----	P > 0.25
Being a workforce participant (yes = 1, no = 0)	----	----	P > 0.25	----	----	P > 0.25
Age	----	----	P > 0.25	- 0.060	- 0.171	0.000
Constant	0.360		0.000	0.583		0.000

N = 1381 female and 887 male respondents living in different parts of Hangzhou Metropolitan Area. Adjusted R² = 0.089 for women and 0.196 for men. The variables have been ordered according to the absolute values of the standardized regression coefficients among women. Only variables with effects meeting a required significance level of 0.25 are included in the table.

Moreover, among women, living close to a third-order center contributes to increase the traveling distance on weekdays somewhat,

whereas no such effect appears among male respondents. Thus, the difference in traveling distances between respondents living in the most central parts of the metropolitan area (close to the city center of Hangzhou) and the most peripheral parts (far from any type of center) differs more between men and women than indicated solely by the difference in the effects of the location of the residence relative to the city center of Hangzhou.

Figure 8.2 *Expected daily traveling distances among male (the upper curve) and female (the lower curve) respondents living at different distances from the city center of Hangzhou, based on the multivariate regression models providing the best fit with the data, and with the remaining variables of Table 8.1 kept constant at mean values⁵⁹.*



$N = 1381$ female and 887 male respondents, $p = 0.000$ among male as well as among female respondents.

It should also be noted that the differences shown in Figure 8.2 have been controlled for, among others, differences between men and women in income, car availability and possession of driver's license. However, there are considerable differences between men and women regarding all these characteristics. Among female respondents, the mean annual income is 18.500 yuan renmimbi, the proportion having

access to a private car is 4.7%, and the proportion possessing a driver's license is 15%. Among male respondents, the corresponding figures are 25.400 yuan renminbi, 8.7% and 32%, respectively. The real gender differences are thus even larger than indicated by the two curves of Figure 8.2.⁶⁰

In the weekend, the gender difference in the influence of residential location on traveling distances is even larger than on weekdays. This can be seen in Table 8.2, where only the effects of the three urban structural variables are shown. Among women, there is only a weak influence of the location of the dwelling relative to the city center of Hangzhou on the traveling distance. Among men too, the location of the residence relative to the city center of Hangzhou is the only urban structural variable showing any effect on the daily traveling distance in the weekend, but the effect is considerably stronger than among women, with a standardized regression coefficient 2.2 times higher.

Table 8.2 *Results from a multivariate analysis of the influences from various independent variables on the mean daily traveling distance in the weekend among female and male respondents (logarithmical transformation of distance measured in km).*

	Women			Men		
	Regression coefficients		Level of significance (p values, two-tail)	Regression coefficients		Level of significance (p values, two-tail)
	Unstandardized (B)	Standardized (Beta)		Unstandardized (B)	Standardized (Beta)	
Location of the dwelling relative to the city center of Hangzhou (non-linear distance function, values ranging from -0.23 to 1.00)	0.131	0.070	0.011	0.320	0.153	0.000
Location of the dwelling relative to the closest second-order center (non-linear distance function, values ranging from -0.94 to 1.00)	----	----	P > 0.25	----	----	P > 0.25
Location of the dwelling relative to the closest third-order center (non-linear distance function, values ranging from -0.93 to 1.00)	----	----	P > 0.25	----	----	P > 0.25

Only the effects of the three urban structural variables are shown in the table.⁶¹ N = 1399 female and 940 male respondents living in different parts of Hangzhou Metropolitan Area. Adjusted R² = 0.073 among women and 0.110 among men.

Commuting distances

Several studies (e.g. Hjorthol, 1998; Næss, 2006a and 2007; Hjorthol & Kjørstad, 2007) have reported that commuting distances tend to be

considerably influenced by gender. It might therefore be interesting to see if residential location affects commuting distances differently among men and women. Such differences might make up an important part of the explanation of the gender-related differences found in the influences of residential location on overall traveling distances on weekdays. We have therefore carried out separate analyses where the sample has been split into sub-samples according to gender.

Table 8.3 shows the influences of our three urban structural variables on commuting distances among men and women. The comparison between the genders shows that the commuting distances among men are influenced by the location of the dwelling relative to the city center to a considerably higher extent than what is the case among women. At the same time, the tendency to longer commuting distances when living close to a third-order center is clearly weaker among men than among women. In combination this implies that the center-periphery dimension of residential location is associated with larger differences in commuting distances among men than among women. Evidently, journeys to work account for a large proportion of the difference found between men and women in the influence of a central vs. a peripheral residential location on the overall traveling distances on weekdays. The influence of the location relative to the closest second-order center is fairly similar among men and women.

The stronger influence of the distance to the city center of Hangzhou on commuting distances among men than among women suggests that women stick to local job opportunities to a higher extent than men do. Given the lower concentration of workplaces in the suburbs than in the city center, the smaller radius of action among women implies that their choices on the job market are limited, compared to men. Among inner-city respondents, however, there do not appear to be any difference worth mentioning between men and women in terms of commuting distances (median values of 2.7 km for both sexes, yet with a somewhat higher arithmetic mean among male than among female respondents). From the perspective of equal job opportunities for women and men, living in the central part of the metropolitan area thus seems more favorable than living in the suburbs. This is in line with the general conclusion drawn in the analysis of overall traveling distances.

Table 8.3 *Results from a multivariate analysis of the influences from various independent variables on one-way commuting distances among female and male respondents (logarithmical transformation of distance measured in km).*

	Women			Men		
	Regression coefficients		Level of significance (p values, two-tail)	Regression coefficients		Level of significance (p values, two-tail)
	Unstandardized (B)	Standardized (Beta)		Unstandardized (B)	Standardized (Beta)	
Location of the dwelling relative to the city center of Hangzhou (non-linear distance function, values ranging from -0.23 to 1.00)	0.292	0.212	0.000	0.449	0.320	0.000
Location of the dwelling relative to the closest second-order center (non-linear distance function, values ranging from -0.94 to 1.00)	0.098	0.107	0.024	0.078	0.078	0.141
Location of the dwelling relative to the closest third-order center (non-linear distance function, values ranging from -0.93 to 1.00)	-0.388	-0.232	0.000	-0.329	-0.123	0.017

Only the effects of the three urban structural variables are shown in the table.⁶² N = 423 female and 322 male respondents living in different parts of Hangzhou Metropolitan Area. Adjusted R² = 0.187 among women and 0.182 among men.

The stronger tendency among women than among men to longer commuting distances when living close to a third-order center suggests that female respondents to a higher extent than their male counterparts increase their mobility resources when living close to the public transport opportunities available in the third-order centers, and hence get access to a wider job market by such a residential location, compared to rural settings. Or maybe it should rather be put the other way round: Female respondents' choices on the job market are to a higher extent than men's choices limited by living in outer areas far from the closest third-order center. Probably, this reflects a higher access to private motor vehicles among men than among women, as well as a tighter time budget among female than among male workers, as women still usually carry out more childcare and household chores than men do.

Travel by car and taxi

Distinct from what has been found with respect to the overall traveling distances on weekdays and in the weekend, we find only small gender differences in the likelihood of being a user of car or taxi during the investigated weekdays (Table 8.4). Admittedly, male respondents tend

to be users of these modes to a somewhat higher extent than female respondents do, but the difference is quite small. Given the considerable differences between men and women in terms of car availability and possession of driver's license, this may seem a bit surprising. The fact that both taxi and car travel are included in the category may be part of the explanation, as people who do not have a car at their disposal may sometimes compensate for this by traveling by taxi, in particular if the trip distance is not very long. Moreover, female spouses belonging to a car-owning household where the husband is the one who normally uses the car may occasionally drive the car or be a car passenger. Since the variable "car user" neither distinguishes between drivers and passengers nor differentiates between frequent and non-frequent users among those who have at all traveled by car or taxi during the investigated period, the gender differences in the relationships between residential location and use of car or taxi should therefore not be expected to be very large.

Table 8.4 *Results from a binary logistic regression analysis of the influence from the three urban structural variables on the likelihood of female and male respondents having traveled some of or all the traveling distance during the investigated weekdays by car or taxi.*⁶³

	Women			Men		
	Regression coefficient (B)	Wald	Level of significance (p values, two-tail)	Regression coefficient (B)	Wald	Level of significance (p values, two-tail)
Location of the dwelling relative to the city center of Hangzhou (non-linear distance function, values ranging from -0.23 to 1.00)	0.734	3.202	0.074	1.033	3.759	0.053
Location of the dwelling relative to the closest second-order center (non-linear distance function, values ranging from -0.94 to 1.00)	----	----	P > 0.25	----	----	P > 0.25
Location of the dwelling relative to the closest third-order center (non-linear distance function, values ranging from -0.93 to 1.00)	----	----	P > 0.25	----	----	P > 0.25

N = 1377 female and 814 male respondents living in different parts of Hangzhou Metropolitan Area. Adjusted R² = 0.073 among women and 0.110 among men.

Similar to the situation among the population as a whole, we do not find any influences among any of the sexes on the likelihood of being

a user of car or taxi on weekdays from the location of the dwelling relative to the closest second- or third- order center.

In the weekend, the somewhat stronger influence among men than among women on the likelihood of being a car or taxi traveler is reversed. In the weekend, female respondents are more likely to travel by car or taxi; the further away they live from the closest third-order center as well as from the city center of Hangzhou. Among men, only an effect of the distance to the closest third-order center is found, and the effect is weaker than among women.

Proportions of non-motorized travel

As can be seen in Table 8.5, there are virtually no gender differences in the influences of the residential location variables on the proportion of non-motorized travel on weekdays. Among both sexes, the location of the residence relative to the city center of Hangzhou is the only urban structural variable showing a significant effect on the proportion of non-motorized travel. Moreover, the size of this effect is very similar among women and men. Thus, the generally stronger increase in traveling distances on weekdays among men than among women when living far away from the city center of Hangzhou (cf. figure 8.2) applies to motorized as well as to non-motorized travel, resulting in similar influences of residential location on the shares of non-motorized travel among men and women.

In the weekend, we find slightly stronger influences on the proportion of walk/bike travel among female than among male respondents. Whereas the proportion of the traveling distance during the weekend among female respondents tends to be influenced by all three urban structural variables, we only find effects of the location of the dwelling relative to the city center of Hangzhou and the closest second-order center among men. Both among men and women, proximity to the city center of Hangzhou appears to exert the strongest influence on the proportion of non-motorized travel. This effect is slightly stronger among the male respondents, but the difference is very small. The effects of the location relative to the closest second-order center are similar among men and women. The effect of proximity to a third-order center, appearing only among women, is modest and somewhat uncertain ($p = 0.070$).

Table 8.5 *Results from a multivariate analysis of the influences from various independent variables on the proportion of the traveling distance on weekdays accounted for by non-motorized modes among female and male respondents.*

	Women			Men		
	Regression coefficients		Level of significance (p values, two-tail)	Regression coefficients		Level of significance (p values, two-tail)
	Unstandardized (B)	Standardized (Beta)		Unstandardized (B)	Standardized (Beta)	
Location of the dwelling relative to the city center of Hangzhou (non-linear distance function, values ranging from -0.23 to 1.00)	- 0.202	- 0.147	0.000	- 0.223	- 0.155	0.000
Location of the dwelling relative to the closest second-order center (non-linear distance function, values ranging from -0.94 to 1.00)	----	----	P > 0.25	----	----	P > 0.25
Location of the dwelling relative to the closest third-order center (non-linear distance function, values ranging from -0.93 to 1.00)	----	----	P > 0.25	----	----	P > 0.25

Only the effects of the three urban structural variables are shown in the table.⁶⁴ N = 1291 female and 821 male respondents living in different parts of Hangzhou Metropolitan Area. Adjusted R² = 0.126 among women and 0.181 among men.

Activity participation and location of activities

There are certain differences between men and women in their frequencies of participation in different types of non-work activities. Women do shopping more often, participate more frequently in organizations, and go for walks in the local neighborhood or in natural areas slightly more often than men do, whereas male respondents participate in team sports, running/jogging exercise and go to cafes or restaurants somewhat more frequently than women do, and are spectators to athletic competitions considerably more often. One might imagine that activity participation would be influenced by residential location in different ways among female than among male respondents, due to generally lower mobility resources among women than among men. However, we find very few such differences. The vast majority of the effects of the urban structural variables on the 17 activity variables have the same sign for both sexes. In a few cases, there is a slight, but uncertain effect of a residential locational variable among one of the genders, with no effect of the same variable among the opposite gender. The only activity where we find a difference worth mentioning in the influence of a residential location variable on activity frequency, is participation in team sports, where living close

to a third-order center appears to contribute to somewhat higher frequency of team sport activity among men, whereas there is a very slight, opposite tendency among women.

The generally very similar relationships between residential location and activity participation among women and men might suggest that women's lower mobility resources manifest themselves rather in choosing closer locations for the performance of the activities in which they are interested, rather than abandoning activities altogether. However, the proportions choosing facilities within a kilometer from the dwelling when purchasing daily necessities, purchasing cd's, clothes, books etc., going out for a meal, going to watch movies or going to see sights are very similar among men and women. There are also very small differences between male and female respondents in the proportions choosing downtown facilities for the five above-mentioned activities. The influences of residential location on the propensities of using local and downtown facilities, respectively, are also very similar across genders. The only difference worth mentioning is a somewhat higher proportion of female than of male residents of the outermost distance belt who use local movie theaters.

Thus, our data indicate that the lower mobility resources among women than among men primarily tend to limit suburban women's opportunities to choose among workplaces, compared to their inner-city counterparts. Whereas women living in the suburbs tend to choose more local workplaces than male suburbanites do, we do not find any similar gender difference in neither the frequency of participation nor the location of the investigated non-work activities.

Discussion

Summarizing the analyses of gender differences, we see that the location of the residence relative to the main center of the metropolitan area tends to influence the overall traveling distances more strongly among men than among women. This applies to weekday travel as well as travel in the weekend. The gender differences on weekdays reflect a stronger influence of proximity to downtown Hangzhou on the commuting distances of men than among women. The difference between men and women in the influence of residential location on traveling distances in the weekdays is a bit more difficult to explain, as we do not find any stronger tendency among female than among male respondents of choosing local shopping or leisure facilities. The roles of different modes of travel seem to be influenced by residential location quite similarly among women and men. There are some slight gender differences in the

proportions of walk/bike travel as well as in the likelihood of traveling by car or taxi, but these differences do not seem to be influenced by residential location to any extent worth mentioning.

The stronger influence of the distance to the city center of Hangzhou on traveling distances among men than among women is in line with similar findings in the Copenhagen area, and suggests that women stick to local facilities – in terms of jobs as well as leisure activities – to a higher extent than men do. More family responsibilities combined with lower mobility resources are likely explanations of this tendency; possibly women have also on average a somewhat lower degree of job specialization and hence less difficulties in finding local jobs. The fact that living close to a third-order center contributes to increase traveling distances somewhat among women, but not among men, suggests that outer-area female respondents, who have lower accessibility to individual motorized means of transport than men have and probably also somewhat less physical ability to travel long distances by foot or by bike, improve their mobility when living close to the public transport opportunities available in the third-order centers.

8.3 Differences between demographic groups

The influences of residential location on travel have been compared between respondents above the median age and respondents at median age or below, and between single persons, families with at least two adults but no children, and families with at least two adults and at least one child.

Differences between young and old respondents

On average, respondents with age above the median travel *shorter distances both on weekdays and in the weekend* than do their counterparts whose age is at or below the median. Within these two groups, mean daily traveling distances on weekdays are 6.2 km and 8.2 km, respectively. In the weekend, the corresponding means are 7.0 km and 9.6 km. The younger half of the respondent are also more frequent users of car or taxi and carry out a lower proportion of their travel by non-motorized than the older half of the respondents do. This applies to weekdays as well as in the weekend.

Within both age groups, respondents living closer to the city center of Hangzhou are distinguished by considerably shorter average traveling distances, lower proportions of car or taxi users and higher shares of

non-motorized travel than the remaining respondents. The differences across the three outer distance belts are comparatively smaller in both age groups.

A multivariate analysis taking into account the influences of a number of demographic, socioeconomic, attitudinal and other control variables indicates that the daily traveling distance on weekdays is influenced by residential location in very similar ways among both age groups. Among the younger as well as among the older half of the respondents, we find a quite strong tendency of shorter traveling distances the closer the respondents live to the city center of Hangzhou. At the same time, we find a tendency among both age groups of somewhat longer traveling distances on weekdays if the dwelling is situated close to a third-order center. The effects of proximity to a third-order center are considerably smaller than the effects of proximity to the city center of Hangzhou. Thus, within both age groups, the overall pattern is one of longer traveling distances on weekdays among residents of outer parts of the metropolitan area than among those who live in the central parts. In the weekend too, the influences of residential location on traveling distances are quite similar in the two age groups. Both among young and old respondents, the only urban structural variable showing any effect on the daily distance traveled in the weekend is the location of the dwelling relative to the city center of Hangzhou. This effect is somewhat stronger among the older respondents, but it is fairly strong and highly certain also in the younger group.

Distinct from traveling distances, the influences of urban structural conditions on the *occurrence of car or taxi travel* are clearly different among old and young respondents.

Multivariate logistic regression analyses among the younger half of the respondents shows no influence from any of the three urban structural variables on the likelihood of being a user of car or taxi neither on weekdays nor in the weekend. Within the older group, we find statistically significant effects of the location of the dwelling relative to both the city center of Hangzhou and to the closest third-order center both on weekdays and in the weekend. In the weekend, we also find an effect of proximity to a second-order center. The likelihood of being a user of car or taxi at least once during the investigated weekdays increases the further away the respondents live from all these center categories. On weekdays, the strongest effect is exerted by the location of the residence relative to the city center of Hangzhou. In the weekend, the location of the dwelling relative to the

city center of Hangzhou and to the closest third-order center show equally strong effects.

The lack of any influence of urban structural conditions on the likelihood of being a car or taxi user among the younger half of the respondents may reflect a more frequent use of taxis among this group, e.g. in connection with social gatherings in the evenings. As noticed in the qualitative interviews, young inner-city respondents often go by taxi to restaurants and entertainment activities, even if they live in the central city. The older half of the respondents are probably involved to a lesser extent in the typical taxi-trip-generating activities, and may also be generally less inclined to use taxi for short trips. As shown below, older respondents tend to stick to the traditional, non-motorized modes of travel to a higher extent than younger respondents do.

The *proportion of the traveling distance carried out by non-motorized modes* is considerably higher among the older half of the respondents than among the younger half. On weekdays, the proportion of walk/bike travel is 63% among respondents older than the median (41 years), compared to 48% among those aged 41 years or younger. In the weekend, the corresponding shares are 58% and 42%, respectively.

On weekdays, the proportion of walk/bike travel appears to be influenced by residential location to somewhat higher extent among the older than among the younger groups of respondents. In the former group, we find statistically significant effects of all the three urban structural variables, with increasing shares of non-motorized travel the closer the respondents live to the city center of Hangzhou, the closest second-order center as well as the closest third-order center. Among these effects, the influence of the location of the dwelling relative to the city center of Hangzhou is the strongest one. Within the younger group of respondents, the location of the residence relative to downtown Hangzhou is the only urban structural variable showing a statistically significant effect. This effect is still quite strong (approximately the same strength as the corresponding effect in the older group of respondents).

In the weekend there is a somewhat different pattern. During the Saturday-Sunday period, we find effects of all three urban structural variables among the younger group of respondents. In the older group, effects are found of the location of the dwelling relative to downtown Hangzhou and the closest second-order center, but not of proximity to a third-order center. The effect of proximity to the city center of

Hangzhou on the share of non-motorized travel in the weekend is somewhat stronger in the younger than in the older group. On the other hand, the effect of the location of the dwelling relative to the closest second-order center among the older group of respondents is considerably stronger than any of the two effects of location relative to second- and third-order centers in the younger group.

Our material suggests that the proportion of non-motorized travel among young respondents is influenced by urban structure to a higher extent in the weekend than on weekdays, whereas the influence of residential location on the share of walk/bike travel among the older group of respondents appears to be slightly stronger on weekdays than in the weekend. Possibly, this may mirror a more widespread use of non-motorized modes (notably bike) for commuting trips among older respondents, whereas younger respondents to a higher extent travel by bike in connection with leisure activities at times when bus services are less extensive (i.e. in the weekend) and/or to destinations not so easily reached by bus (e.g. sports grounds, swimming pools etc). They may also to a higher extent go by taxi or car in connection with dinner visits to parents or parents-in-law in the weekend – a phenomenon also encountered in some of the qualitative interviews.

Differences between household types

On average, respondents belonging to a childless household with at least two grownup members travel somewhat shorter both on weekdays and in the weekend than single respondents and respondents belonging to a household with at least two adult members and at least one child. They also are less frequent users of car or taxi and carry out a larger proportion of their travel by non-motorized modes. These differences probably partly reflect age differences, with a higher proportion of pensioners among the respondents belonging to a childless household with at least two grownup members. (The latter group has an average age 7 years higher than among the two other household type groups.)

Among all the three household type groups, respondents living close to the city center of Hangzhou travel shorter distances, are less frequent users of car or taxi, and carry out a higher share of their transport by non-motorized modes than the respondents living in suburban or exurban locations do. In particular, such differences are pronounced among singles. However, it should be noted that the single respondents living in the innermost distance belt are on average considerably older than their counterparts in the remaining three distance belts. Among persons belonging to households with two or

more adult members, the age differences between the distance belts are much smaller.

Multivariate analyses among each household type group show that residential location exerts a considerably stronger influence on traveling distances on weekdays among single respondents and respondents belonging to a household with at least two adults and at least one child, than among respondents belonging to a childless household with at least two adult members. Within the latter household type group, we find a moderate tendency to increasing traveling distances the further away the respondents live from the city center of Hangzhou, but at the same time an almost equally strong tendency to longer traveling distances the closer the respondents live to a third-order center. Thus, among this household type group, traveling distances on weekdays tend to be shortest among those who live close to downtown Hangzhou, longest among those who live in the outer parts of the metropolitan area close to a third-order center, and medium-long among those living in the outer area far away from the closest third-order center. The transport-generating effect of living close to a third-order center has been commented on previously and is probably due to the better mobility opportunities provided by the higher level of public transport services typically offered in such centers, compared to the more rural parts of the metropolitan area.

It should also be remembered that this household type includes a higher proportion of pensioners than the other two groups. This implies that the respondents belonging to a childless household with at least two adult members are less prone than respondents belonging to the remaining household groups to travel to the concentration of workplaces in the city of Hangzhou. This may explain the weaker effect of the location of the dwelling relative to downtown Hangzhou in this group.

In the other two household type groups, we find strong effects of the location of the dwelling relative to the city center of Hangzhou. In particular, the influence of proximity to downtown Hangzhou is strong among singles. None of the other two urban structural variables show any effects worth mentioning on weekday traveling distances among the respondents belonging to these two household groups.

Table 8.6 *Results from a multivariate analysis of the influences from various independent variables on the mean daily traveling distance on weekdays among respondents belonging to different household types (logarithmical transformation of distance measured in km).*

	Singles			Respondents belonging to a household with at least two adults and no children			Respondents belonging to a household with at least two adults and at least one child		
	Regression coefficients		Level of significance (p values, two-tail)	Regression coefficients		Level of significance (p values, two-tail)	Regression coefficients		Level of significance (p values, two-tail)
	Unstandardized (B)	Standardized (Beta)		Unstandardized (B)	Standardized (Beta)		Unstandardized (B)	Standardized (Beta)	
Location of the dwelling relative to the city center of Hangzhou (non-linear distance function, values ranging from -0.23 to 1.00)	0.472	0.274	0.000	0.126	0.094	0.005	0.315	0.197	0.000
Location of the dwelling relative to the closest third-order center (non-linear distance function, values ranging from -0.93 to 1.00)	----	----	P > 0.25	- 0.087	- 0.083	0.010	----	----	P > 0.25
Location of the dwelling relative to the closest second-order center (non-linear distance function, values ranging from -0.94 to 1.00)	----	----	P > 0.25	----	----	P > 0.25	----	----	P > 0.25

Only the effects of the three urban structural variables are shown in the table.⁶⁵ $N = 194$ single respondents, 950 respondents belonging to a household with at least two adults and no children, and 1075 respondents belonging to a household with at least two adults and at least one child. Adjusted $R^2 = 0.181$ among singles, 0.111 among respondents belonging to a household with at least two adults and no children, and 0.167 among respondents belonging to a household with at least two adults and at least one child.

In the weekend, we find fairly similar differences between the household type groups. Again, the strongest influences of residential location on traveling distances are found among singles and respondents belonging to households with two or more adult members and at least one child. And again, the location of the residence relative to downtown Hangzhou is the dominant urban structural variable. However, among the group with one or more children in the household, we also find weak impacts of the location of the dwelling

relative to the two lower-order center categories, with slightly longer traveling distances the further away the respondents live from the closest second-order as well as third-order center. And unlike the situation on weekdays, we do not find any tendency among the respondents belonging to childless households with at least two grownup members to increasing traveling distances when living close to a third-order center. This suggests that the public transport opportunities offered in such center contribute mainly to enable local residents to expand their choices on the job market, but does not seem to expand the radius of action for leisure trips, compared to the rural surroundings. (Those who commute out of a third-order center to workplace concentrations in Hangzhou may also have a lower need for traveling to Hangzhou to do shopping in the weekend than respondents who do not travel to workplaces outside the local district on weekdays.)

The influences of residential location on *the likelihood of being a user of car or taxi* vary somewhat between the household type groups. In general, though, the location of the dwelling relative to different categories of centers exerts only moderate and often rather uncertain influences on the likelihood of having traveled at least once by car or taxi during the investigated period. Among single persons, we do not find significant effects from any of the three urban structural variables. It should be noted that the number of single respondents is considerably lower than the number of respondents belonging to the two other household groups. Stronger effects are therefore required to obtain statistically significant effects within this group than among the other household type groups. Among households with at least two adult members – both the group without and the group with children living at home – we find weak effects of the location of the dwelling relative to the city center of Hangzhou, but these effects are fairly uncertain (significance levels of 0.15 and 0.12, respectively). None of the other urban structural variables show any influence on the likelihood of having traveled by car or taxi during the investigated weekdays.

In the weekend, we find weak and uncertain effects of residential location within both the household groups without children living at home. Among singles, there is a somewhat higher likelihood of being a user of car or taxi if the dwelling is located close to downtown Hangzhou. This may reflect frequent use of taxi in connection with visits to restaurants, teahouses, cinemas, dancing etc. on Saturday evenings – activities that are probably more common among single persons than among the respondents in general. Among childless couples, we instead find a slight effect of the location of the dwelling

relative to the closest third-order center. This effect may reflect a tendency among people living at some distance from the closest local center to go by taxi or car when shopping in the weekend, as it may sometimes be inconvenient to bring the commodities back home by bike or bus. Among respondents belonging to a household with two or more adults and at least one child, we find effects of all three urban structural variables, with approximately equally strong effects exerted by the location of the residence relative to the city center of Hangzhou and to the closest third-order center, and with a weaker and more uncertain effect of the distance to the closest third-order center. The likelihood of being a user of car or taxi increases the further away the respondents within this group live from all the three categories of centers.

According to our material, the *share of non-motorized travel* on weekdays is influenced by one urban structural variable, viz. the location of the residence relative to the city center of Hangzhou, among all three household type groups. The effects are also of quite similar order of magnitude and are fairly strong. The proportion of walk-bike travel on weekdays tends to increase the closer to downtown Hangzhou the respondents live.

In the weekend too, we find clear effects on the share of walk/bike travel from the location of the dwelling relative to the city center of Hangzhou. Among singles and families with at least one child, these effects are even stronger than on weekdays. In both household type groups with two or more adult members, we also find influences from the location of the residence relative to the two lower-order center categories. These effects are still considerably weaker than the effects of the location relative to downtown Hangzhou. In particular, the effects of the location relative to the closest third-order center are modest and somewhat uncertain.

The fact that the location of the dwelling relative to lower-order centers appears to influence the share of walk/bike travel only in the weekend suggests that such centers are more important as destinations for shopping and leisure trips in the weekend than for the commuting trips of weekdays. Living far away from a second-order center will then imply a higher need for motorized travel, and hence a lower share of walk/bike travels.

8.4 Differences between socioeconomic groups

The influences of residential location on travel have also been compared between respondents with different levels of education and (less thoroughly) between high- and low-income respondents.

Differences between respondents with different education levels

On average, respondents with education level above the median travel somewhat longer on weekdays as well as in the weekend than do their counterparts whose education level is at or below the median. Within these two groups, mean *traveling distances on weekdays* are 8.3 km and 6.2 km, respectively. Among the approximate half of the respondents who have completed professional secondary school or higher levels of education, the mean traveling distance on weekdays is approximately 30% higher in the three outer distance belts than in the among respondents living less than 3.4 km from the city center of Hangzhou, with only small differences between the three outer distance belts (the highest mean traveling distance found among those who live between 6.2 and 13.6 km from the city center of Hangzhou). Within the group with education level at the median or below, the mean traveling distance is nearly 65% higher among the respondents living in the three outer distance belts, compared to those living in the innermost distance belt (less than 3.4 km from the city center of Hangzhou). Traveling distances on weekdays thus seem to be influenced by residential location to a higher extent among people with a low education level than among those with a high education level.

A multivariate analysis taking into account the influences of a number of demographic, socioeconomic, attitudinal and other control variables indicates that the daily traveling distance on weekdays is influenced by residential location to a somewhat higher extent among respondents with a low education level than among those with an education level above the median (see Table 8.7). Among both groups of respondents, daily traveling distances on weekdays are influenced first and foremost by the location of the dwelling relative to the city center of Hangzhou, but there is also an influence of proximity to the closest third-order center. Traveling distances tend to increase the further away the respondents live from the city center of Hangzhou, but at the same time they tend to increase the closer the respondents live to the closest third-order center. Both these effects are stronger among those with a low than those with a high education. Seen

together, the difference in daily traveling distances on weekdays between residents of outer and inner parts of the metropolitan area tends to be somewhat larger among respondents with a low education level than among those with a high education level.

Table 8.7 *Results from a multivariate analysis of the influences from various independent variables on the mean daily traveling distance on weekdays among respondents with high and low education level (logarithmical transformation of distance measured in km).*

	Education level above the median			Education level at the median or below		
	Regression coefficients		Level of significance (p values, two-tail)	Regression coefficients		Level of significance (p values, two-tail)
	Unstandardized (B)	Standardized (Beta)		Unstandardized (B)	Standardized (Beta)	
Location of the dwelling relative to the city center of Hangzhou (non-linear distance function, values ranging from -0.23 to 1.00)	0.159	0.092	0.002	0.245	0.182	0.000
Location of the dwelling relative to the closest third-order center (non-linear distance function, values ranging from -0.93 to 1.00)	- 0.040	- 0.042	0.143	- 0.077	- 0.073	0.008
Location of the dwelling relative to the closest second-order center (non-linear distance function, values ranging from -0.94 to 1.00)	----	----	P > 0.25	----	----	P > 0.25

Only the effects of the three urban structural variables are shown in the table.⁶⁶ N = 1208 respondents with education at the median level or below and 1085 respondents with education level above the median. Adjusted R² = 0.135 in the low-education group and 0.098 in the high-education group.

In the weekend, the mean traveling distance among respondents with higher than median education level living in the three outer distance belts is about 20% higher than among those living in the innermost distance belt (less than 3.4 km from the city center of Hangzhou). Within the group of respondents with education level at the median or below, traveling distances in the three outer distance belts are nearly 70% higher than in the innermost distance belts, and with somewhat longer mean traveling distances in the two outer distance belts than in the second inner distance belt (3.4 to 6.2 km from the city center of Hangzhou).

Multivariate analyses confirm that similar differences between respondents with high and low education levels exist as to traveling distances in the weekend as regarding weekday travel. In the group with higher-than median education, we find effects of all three

residential location variables, with tendencies of increasing traveling distances in the weekend the further away the respondents live from the city center of Hangzhou as well as from the closest second- or third-order center. However, none of the two latter effects are very strong. Among respondents with an education level at the median or below, the impact of proximity to the city center of Hangzhou is the strongest of all the effects of the investigated variables, and the only urban structural variable showing any effect on the traveling distance in the weekend.

The stronger influence of the center-periphery dimension of residential location on the traveling distances on weekdays among respondents with a low education level than among those with a high education level may appear a bit surprising, since people with a high education generally have more specialized job qualifications and interests and hence could be expected to have larger difficulties in finding a workplace close to the residence if they live in a suburb. Our data suggest that the unskilled and less specialized workplaces (e.g. as salespersons in shops, lower office clerks etc) are to an even higher extent centralized than the workplaces requiring a high education level. The location of several of university branches in the outskirts of Hangzhou and the establishment of economical and technological developmental zones in the outer parts of the metropolitan area may also be part of the explanation.

The fact that the location of the dwelling relative to the city center of Hangzhou appears to exert a stronger influence on weekend traveling distances among respondents with a low than with a high education is more difficult to explain. One might expect that those with a high education would be more frequent users of the specialized leisure and cultural facilities predominantly located in the inner parts of Hangzhou (cf. the discussion below on the proportion of walk/bike travel). Instead, the material suggests that the high-education group is more oriented towards weekend trip destinations in second- or third-order centers than their counterparts with education at the median level or below. One might speculate that this could reflect a tendency to more concern about local organizational life among the high education group, possibly resulting in a higher number of weekend activities (e.g. in sports clubs or cultural organizations) located to more local centers.

Our material shows that the *commuting distances* among respondents with a low education level is influenced by the location of the dwelling relative to downtown Hangzhou to a considerably higher extent than what is the case among respondents with a high education

level (Table 8.8). On the other hand, living close to a third-order center contributes to increase commuting distances to a considerably higher extent among those with an education level above the median than among those with a low education level. There are smaller differences between the education level groups in the influences of the location relative to the closest second-order center.

Table 8.8 *Results from a multivariate analysis of the influences from various independent variables on one-way commuting distances among respondents with high and low education level (logarithmical transformation of distance measured in km).*

	Education level above the median			Education level at the median or below		
	Regression coefficients		Level of significance (p values, two-tail)	Regression coefficients		Level of significance (p values, two-tail)
	Unstandardized (B)	Standardized (Beta)		Unstandardized (B)	Standardized (Beta)	
Location of the dwelling relative to the city center of Hangzhou (non-linear distance function, values ranging from -0.23 to 1.00)	0.292	0.202	0.000	0.492	0.352	0.000
Location of the dwelling relative to the closest third-order center (non-linear distance function, values ranging from -0.93 to 1.00)	0.085	0.101	0.029	0.157	0.137	0.006
Location of the dwelling relative to the closest second-order center (non-linear distance function, values ranging from -0.94 to 1.00)	-0.385	-0.247	0.000	-0.337	-0.120	0.012

Only the effects of the three urban structural variables are shown in the table.⁶⁷ N = 355 respondents with education at the median level or below and 414 respondents with education level above the median. Adjusted R² = 0.205 in the low-education group and 0.198 in the high-education group.

The differences across education levels are thus quite similar to the differences between men and women, with women equivalent to the respondents with a high education level. Actually, the education level is on average higher among the female than among the male respondents for whom data on workplace addresses are available, with 59% in the high-education group among females compared to 52% among male respondents. The stronger tendency to longer commuting distances when living close to a third-order center within the high-education than in the low-education group suggests that the third-order centers may be attractive residential locations for high-skilled respondents working, e.g., in the new economical and technical development zones or have high-qualified in the city of Hangzhou.

There is a considerable difference between the high and the low education level group in the *proportions that have used car or taxi* as travel modes during the investigated weekdays. In the high education group, 18.5% of the respondents have used car or taxi at least once during the period from Monday to Friday, whereas only 7% among the low education group have used these modes. In the latter group, very few (less than 2%) among the respondents living in the innermost of the distance belts have traveled by car or taxi during the period. In the high-education group too, the lowest proportion of car or taxi users (13%) is found in the innermost distance belt, but the relative differences between the distance belts are smaller than among those with a low education level.

Multivariate logistic regression analyses confirm the impression of a higher influence of residential location on the occurrence of car or taxi travel among respondents with a low education level than among those with an education level above the median. In the latter group, none of the three urban structural variables show any effect worth mentioning on the propensity of being a car or taxi user during the investigated weekdays. In the low-education group, we find an effect of the location of the dwelling relative to the city center of Hangzhou ($p = 0.004$), with lower likelihood of being a user of car or taxi the closer the respondents live to the city center of Hangzhou.

In the weekend, there is less difference between respondents with a high and low education level in the influences of residential location on the propensity of being users of car or taxi as travel modes. In both groups, we find only quite weak influences of residential location. Proximity to the city center of Hangzhou appears to influence the use of car and taxi slightly more among those with a low than among those with a high education. In addition, we find a weak tendency in both groups of lower likelihood of being a user of car or taxi among respondents living close to a third-order center.

The *proportion of the traveling distance carried out by non-motorized modes* on weekdays is considerably higher (64%) among the respondents with an education level at the median or below than among those with a higher education level (46%). The proportion of non-motorized travel also seems to be more strongly influenced by residential location in the former group. In the low education group, the proportion of walk/bike travel is 81% among those respondents living closer than 3.4 km to the city center of Hangzhou, compared to approximately 55% on average in the remaining three distance belts. In the high-income group, the corresponding figures are 61% and 42%, respectively. In both education level groups, the proportion of

walk/bike travel is somewhat lower in the second-inner than in the two outer distance belts. This probably reflects the fact that the respondents living in this zone have a considerable part of their destinations at a fairly long distance from home, while at the same time the public transport services are good enough to make the bus an attractive alternative to the bike for many of those trips. In the outer distance belts, the poorer public transport services make it necessary for residents to accept longer trip distances by bike, and the proportion of walk/bike travel will hence be higher than in the second inner distance belt.

Multivariate regression analyses confirm the stronger influence of residential location on the share of walk/bike travel among respondents in the low-education than in the high-education group. Among both groups of respondents, the location of the dwelling relative to the city center of Hangzhou is the only urban structural variable showing a statistically significant effect on the share of non-motorized travel on weekdays. But the effect is considerably stronger (Beta = -0.186, $p = 0.000$) in the low-education group than in the group with an education level above the median (Beta = -0.096, $p = 0.001$).

However, in the weekend, this pattern seems to be reversed, as the influences of residential location on the proportion of walk/bike travel on Saturday and Sunday tend to be slightly stronger among those with a high than with a low education level. In the high-education group, the proportion of walk-bike travel tends to increase the closer the respondents live to the city center of Hangzhou as well as to the closest second- or third-order center. In the low-education group, we find no effect of proximity to a third-order center. The effects of proximity to downtown Hangzhou and the closest second-order center are also somewhat stronger in the high-education group.

The difference between weekdays and weekend in the influence of education level on the relationships between residential location and the proportion of non-motorized travel may reflect a stronger centralization of specialized leisure facilities than specialized workplaces in Hangzhou Metropolitan Area. If, as discussed above, a relatively high proportion of the workplaces requiring a high education are located in outer parts of Hangzhou or in development zones outside the city of Hangzhou, the proportion of inner-city residents with a high education who can easily reach their workplace by foot or by bike will be reduced. The higher influence on the non-motorized share of weekend travel among the high-education than among the low-education group is consistent with the difference found

between these groups in the influence of residential location on weekend traveling distances. If, as suggested above, those with a high education have a higher propensity than respondents with lower education of participating actively in local sports and cultural organizations in the weekend, their possibility of using non-motorized modes during the weekend will be influenced to a higher extent by the location of the dwelling relative to the local centers where such organizational activities take place.

Differences between income groups

The differences between respondents with high and low income levels in the influences of residential location on travel are fairly similar to the differences between respondents with high and low education levels. This may hardly be surprising, as there is quite some overlap (Pearson's $r = 0.234$) between the high-income and high-education groups (and between the groups with low income and low education). According to our material, *traveling distances on weekdays* among respondents with income at the median level or below are influenced by both the location of the dwelling relative to the city center of Hangzhou and the distance to the closest third-order center. These effects have opposite signs, implying that traveling distances tend to increase the further away from the city center of Hangzhou and the closer to a third-order center the respondents live. Of these effects, the influence of the location relative to the city center of Hangzhou is the strongest one. The overall tendency is thus longer traveling distances on weekdays among high-income respondents living in the outer than in the inner parts of the metropolitan area. This overall tendency exists among the respondents with income level above the median too. Within the latter group the only urban structural variable showing any effect is the location of the residence relative to the city center of Hangzhou. This effect is, however, weaker than the corresponding effect in the low-income group. The occurrence of an influence from proximity to a third-order center only in the low-income group may reflect the fact that the public transport facilities found in such centers contribute to increase the mobility resources in particular among low-income respondents, who have less possibilities to choose other types of motorized transport (such as taxi or e-bike).

In the weekend, we find similar differences across income groups as on weekdays. Again, traveling distances among the low-income respondents tend to be influenced by the distance from the dwelling to the city center of Hangzhou as well as to the closest third-order center. In the weekend, the difference in the strengths of these oppositely directed effects is even larger, implying a somewhat larger difference

between central and peripheral residential locations in traveling distances than what was found on weekdays. In the high-income group, we also find effects of these two urban structural variables, but among these respondents both effects are positive, implying that traveling distances in the weekend tend to increase the further away the residence is located from downtown Hangzhou as well as the closest third-order center. The latter effect is very weak, and the difference in traveling distances between residential locations in central and peripheral parts of the metropolitan area is therefore pretty much the same as on weekdays among high-income respondents.

According to our material, the likelihood of *being a user of car or taxi* on weekdays is influenced by residential location only among the respondents with income level at the median or below. Among those with income above the median, none of the urban structural variables show any effects on the likelihood of having used car or taxi at least once during the five investigated weekdays. In the low-income group, we find an effect of the location of the residence relative to the city center of Hangzhou; with higher likelihood of car or taxi travel the further away from downtown Hangzhou the dwelling is located. This difference across income groups probably reflects the fact that high-income respondents can afford to take taxi to a higher extent, and prefer to do so sometimes, even to destinations that could be reached within acceptable walking or biking distance. Among high-income people, car or taxi will then be used occasionally even if the dwelling is centrally located. Our qualitative interviews support this explanation, as several interviewees told that taxi was often preferred for trips in the evenings, e.g. when friends meet at a teahouse.

A similar difference between the income groups in the influence of residential location on the likelihood of being a user of car or taxi is found in the weekend as on weekdays. In the weekend too, we only find an effect of the location of the dwelling relative to downtown Hangzhou among the low-income group. In addition, we find effects of proximity to third-order centers within both income groups.

The influences of residential location on the *proportion of non-motorized travel* do not differ much between the income groups. On weekdays as well as in the weekend, we find strong effects among both income groups of the location of the residence relative to the city center of Hangzhou; with higher proportions of walk/bike travel the closer the respondents live to downtown Hangzhou. These effects are slightly stronger among the respondents with income above the median. On weekdays, we also find a weak tendency among the high-income group of higher shares of walk/bike travel when living close to

a second-order center. However, this effect is very modest and quite uncertain. In the weekend, we find effects of the location of the dwelling relative to the closest second-order as well as third-order center among both income groups. The closer the respondents live to such centers, the higher share of their weekend travel tends to be carried out by non-motorized modes. Compared to the effects of the location of the dwelling relative to downtown Hangzhou, the effects of proximity to second- and third-order centers are considerably weaker among both income groups.

8.5 Concluding remarks

Table 8.9 summarized the main differences between population groups in the influences of residential location characteristics on different aspects of travel behavior. Due to space constraints, only education level has been included in the table among the socioeconomic characteristics, as the differences related to income levels are quite similar to those found between respondents with different levels of education.

The analyses where the respondents have been divided into subgroups according to gender, age, household type or socioeconomic characteristics show that residential location influences travel behavior among all these groups. In particular, this applies to traveling distances and the proportion of travel accounted for by non-motorized modes. There are, however, some interesting variations between different population groups in the way that residential location affects travel behavior.

Traveling distances are influenced by residential location to a higher extent among men than among women; among singles as well as households with two or more adults and at least one child than among childless households with two or more adults. This applies to travel on weekdays as well as in the weekend. Men's traveling distances tend to increase considerably when living far away from the city center of Hangzhou, while women's amount of travel also is influenced by the location of the dwelling relative to the closest third-order center, where proximity to such a center tends to increase their traveling distances. There are also somewhat stronger influences of residential location on traveling distances among respondents with a low education level and income than among those with a high education or

Table 8.9 *Comparison of the main travel behavioral effects of residential location among different population groups.*

	Gender		Age		Household types			Education level	
	Women	Men	Yong	Old	Singles	Households with at least two adults and no children	Households with at least two adults and at least one child	High	Low
Travel distance on weekdays	Shorter when living close to downtown Hangzhou, but somewhat longer when living close to a third-order center	Considerably shorter when living close to downtown Hangzhou	Considerably shorter when living close to downtown Hangzhou, but somewhat longer when living close to a third-order center	Considerably shorter when living close to downtown Hangzhou, but somewhat longer when living close to a third-order center	Considerably shorter when living close to downtown Hangzhou	Somewhat shorter when living close to downtown Hangzhou, but also somewhat longer when living close to a third-order center	Considerably shorter when living close to downtown Hangzhou	Somewhat shorter when living close to downtown Hangzhou, but slightly longer when living close to a third-order center	Considerably shorter when living close to downtown Hangzhou, but somewhat longer when living close to a third-order center
Travel distance in the weekend	Somewhat shorter when living close to downtown Hangzhou	Considerably shorter when living close to downtown Hangzhou	Shorter when living close to downtown Hangzhou	Considerably shorter when living close to downtown Hangzhou	Considerably shorter when living close to downtown Hangzhou	Somewhat shorter when living close to downtown Hangzhou	Considerably shorter when living close to downtown Hangzhou, and slightly shorter also when living close to a second- or third-order center	Shorter when living close to downtown Hangzhou, but also slightly shorter when living close to a second- or third-order center	Considerably shorter when living close to downtown Hangzhou
Likelihood of being a user of car/taxi on weekdays	Somewhat lower when living close to downtown Hangzhou	Somewhat lower when living close to downtown Hangzhou	No influence from any of the urban structural variables	Lower when living close to downtown Hangzhou, and slightly lower when living close to a third-order center	No influence from any of the urban structural variables	Slightly lower when living close to downtown Hangzhou	Slightly lower when living close to downtown Hangzhou	No influence from any of the urban structural variables	Lower when living close to downtown Hangzhou
Likelihood of being a user of car/taxi in the weekend	Somewhat lower when living close to a third-order center as well as to downtown Hangzhou	Slightly lower when living close to a third-order center	No influence from any of the urban structural variables	Lower when living close to downtown Hangzhou or a third-order center, and slightly lower when living close to a second-order center	Slightly lower when living close to downtown Hangzhou	Slightly lower when living close to a third-order center	Somewhat lower when living close to downtown Hangzhou or a third-order center, and slightly lower when living close to a second-order center	Slightly lower when living close to downtown Hangzhou as well as to the closest third-order center	Slightly lower when living close to downtown Hangzhou as well as to the closest third-order center

Table 8.9 (Continued)

	Gender		Age		Household types			Education level	
	Women	Men	Young	Old	Singles	Households with at least two adults and no children	Households with at least two adults and at least one child	High	Low
Proportion of week-day travel by non-motorized modes	Considerably higher when living close to downtown Hangzhou	Considerably higher when living close to downtown Hangzhou	Higher when living close to downtown Hangzhou	Higher when living close to downtown Hangzhou (the strongest effect) as well as to a second- or third-order center	Considerably higher when living close to downtown Hangzhou	Higher when living close to downtown Hangzhou	Considerably higher when living close to downtown Hangzhou	Somewhat higher when living close to downtown Hangzhou	Considerably higher when living close to downtown Hangzhou
Proportion of week-end travel by non-motorized modes	Higher when living close to downtown Hangzhou (the strongest effect) as well as to a second- or third-order center	Higher when living close to downtown Hangzhou (the strongest effect) as well as to a second-order center	Higher when living close to downtown Hangzhou or a second-order center, and slightly higher when living close to a second-order center	Higher when living close to downtown Hangzhou or a second-order center	Considerably higher when living close to downtown Hangzhou	Higher when living close to downtown Hangzhou, and also somewhat higher when living close to a second- or third-order center (the latter effect weak)	Considerably higher when living close to downtown Hangzhou, and also somewhat higher when living close to a second- or third-order center	Higher when living close to downtown Hangzhou (the strongest effect) as well as to a second- or third-order center	Higher when living close to downtown Hangzhou (the strongest effect) as well as to a second-order center

income. There are only small differences in the influences of residential location on traveling distances between young and old respondents.

Similar to the situation among men, traveling distances among singles and respondents belonging to a household with two or more adult members and at least one child tend to be influenced by the location of the residence relative to downtown Hangzhou as the only urban structural variable. On the other hand, tendencies of increasing traveling distances on weekdays when living close to a third-order center, similar to those found among female respondents, are also found among members of childless households with at least two adult persons. Such influences are also found in each age and education level group, although not as strong as among the female respondents.

On weekdays, there is hardly any difference at all between men and women in the *likelihood of having used car or taxi* during the investigated period. There are, however, certain differences according to age, household type and education level, where no influence of residential location whatsoever was found on the likelihood of being a car or taxi user during the five weekdays among the younger half of the respondents, single persons and respondents with education level

above the median. Among respondents above the median age, respondents belonging to households with at least two adult members, and respondents with education level at the median or below, a slight tendency to lower likelihood of being a user of car or taxi was found when living close to the city center of Hangzhou, and among the older half of the respondents also when living close to a third-order center. In the weekend, there are no differences worth mentioning across population groups in the influences of residential location on the likelihood of being a user of car or taxi, except for a difference between younger and older respondents. Among the younger half of the respondents, we find no influence at all of the urban structural variables, whereas the likelihood of being a car or taxi user during the weekend is somewhat lower among older respondents living close to any of the three categories of centers.

There are only small differences between the investigated population groups in the influences of residential location on the *share of non-motorized travel*. Whereas proximity to downtown Hangzhou contributes to increase the proportion of walk/bike travel on weekdays among all investigated population groups, this tendency is stronger among respondents with education level at the median or below than among those with a higher education, and also higher among singles and respondents belonging to households with two or more adults and at least one child than among members of childless households with at least two adults. Among respondents older than the median age, we find influences of proximity to second- and third-order centers in addition to the effect of living close to downtown Hangzhou (the latter influence still being the strongest one).

In the weekend, the only difference worth mentioning is found across household types. Here, the influence of proximity to downtown Hangzhou is higher among singles and members of households two or more adult household member and at least one child than among respondents belonging to a childless household with two or more adult members. In both the household groups with at least two adult members, there is also some influence on the share of walk-bike travel in the weekend from the location of the residence to lower-order centers, distinct from the situation among singles, where only proximity to downtown Hangzhou seems to matter.

Neither on weekdays nor in the weekend, have we found any differences worth mentioning between men and women in the influences of residential location on the proportion of non-motorized travel.

The above-mentioned differences between population groups do not point in any clear and unambiguous direction in terms of the nature of the relationships between residential location and travel in Hangzhou in the future. On the one hand, education levels as well as income could be expected to continue to rise. This means that more inhabitants will belong to the high income and education groups. According to our material, this could be expected to contribute to a slight reduction of the influence of proximity to downtown Hangzhou on travel behavior. The same may be the case if the differences found between young and old respondents represent cohort effects (i.e. lifestyles that the young generation will continue to practice also when they get older) as distinct from mere life-phase effects. On the other hand, if the development towards an increasing proportion of one-person households continues (like it has done in Western countries for several decades), the influence of the location of the dwelling relative to the city center of Hangzhou on travel behavior may increase. The same applies if – as has been the case in Western countries – women increasingly adopt traditionally male types of travel behavior.

9 Are there additional, indirect effects of residential location on travel?

9.1 Introduction

In the international research into urban structure and travel it has been common to include car ownership among the control variables. In the multivariate statistical analyses in chapters 6 and 7 car ownership was thus one of the control variables. However, in recent years several authors have called attention to the fact that car ownership is in itself influenced by urban structural conditions (Guiliano & Narrayan, 2003; Fosli & Lian, 1999; Næss, 2003). Among other things, it may be argued from a time-geographical perspective that the location of the dwelling influences the residents' need for having private motor vehicles at their disposition. If you live far away from the destinations of the "bounded trips" and are compelled to travel by foot, bike or public transport, these trips will consume a large proportion of the time budget. The time tied up in the necessary everyday travel may then easily supersede other, desired doings, e.g. being together with the children, participating in organized leisure activities, or managing full-time employment. By providing oneself with a car, higher travel speeds are obtained, and more time will be available for other everyday activities.

The inclusion of car ownership among the control variables may thus be considered a kind of "over-control", as car ownership may be influenced by the distance from the dwelling to destinations for daily travel purposes and by the level of public transport services. The same can be said about some of our other control variables, notably transport attitudes. Arguably, those who live in an area where they feel strongly dependent on car travel in daily life will develop more

positive attitudes towards the car. Conversely, inner-city residents who do not at all need to use the car in their daily life, but are exposed to traffic noise and emissions in their neighborhoods, might develop more negative attitudes to private motoring and a higher awareness about urban environmental problems. Similar arguments could be advanced about certain other characteristics of the respondents partially susceptible to influence from the urban structural situation of the dwelling, among others possession of a driver's license: You want to drive a car, and in order to realize this wish you decide both to submit to the driving test and to buy a car.

Since car ownership is included in most multivariate studies on the topic, and because several authors have suggested that the relationships between urban structure and travel may vanish or be reduced if attitudinal factors and driver's license holding are taken into regard, we still decided to include these "gray-zone" control variables in our main analyses. It should, however, be noted that this probably produces conservative estimates of the influences of urban structural variables. When controlling for the above-mentioned "gray zone" control variables, we should therefore at the same time take the possible indirect effects of residential location via these variables into consideration. At least, supplementary analyses should be made in order to assess the extent to which the results are influenced by the inclusion of the "gray-zone" control variables.

In this chapter an assessment will be made of the indirect effects of the urban structural variables via the above-mentioned "gray zone" control variables into consideration. Below (chapter 9.2) we shall first take a look at the relationships between our urban structural variables and, respectively, car availability, possession of driver's license, transport attitudes and environmental attitudes. Here, material from the qualitative interviews as well as the questionnaire survey will be drawn on. Thereupon (chapter 9.3) follows a comparison of the effects of the three urban structural variables on selected travel behavioral variables with and without the "gray zone" control variables included among the independent variables. Due to space constraints, only the influences on five travel behavioral variables will be discussed: mean daily traveling distances on weekdays and in the weekend, commuting distances, and the proportion of travel carried out by non-motorized modes on weekdays and in the weekend.

9.2 Influences of residential location on car ownership and other “gray zone” control variables

In the international research literature, the influence of residential location on car ownership is a contested issue. In the following, this relationship will be dealt with in some more length than the influences of residential location on the other three “gray zone” control variables.

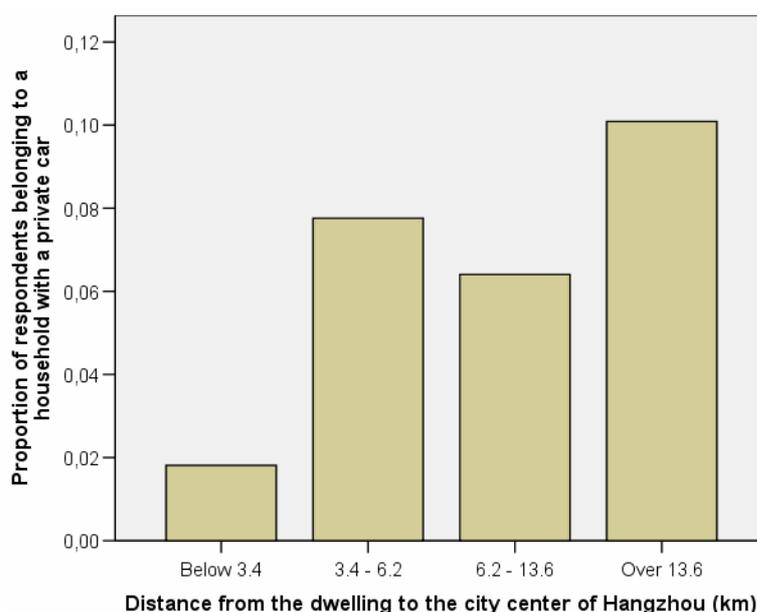
In Chapter 4, we saw that the proportion of respondents who felt dependent on private car transport in order to reach daily activities was considerably lower in the inner city of Hangzhou than among the remaining respondents. This reflects the availability of a high number and a wide range of workplaces and service facilities within short distance from the dwellings in the inner distance belt, making motorized travel unnecessary for a large proportion of the residents. In addition, the accessibility to different parts of the suburban and outer parts of the metropolitan area is generally good from the inner city of Hangzhou. In the qualitative interviews (cf. chapter 5.11), we did not encounter any examples of strong car dependency, except for some interviewees who had to use a car as part of their job. Some interviewees still had patterns of leisure activities and social contacts that would be difficult to maintain without car travel. Not surprisingly, these interviewees lived in the outer parts of the metropolitan area.

As can be seen in Figure 9.1, the proportions of respondents who belong to a household with a private car at its disposal follow a geographical distribution similar to the pattern found regarding perceived car dependency. In the inner distance belt, less than 2% of the respondents belong to a household with a private car. In the three outer distance belts, the corresponding proportions vary between 6% and 10%.

In order to assess whether any relationship between residential location and car ownership still exists when influences from demographic and socioeconomic characteristics are taken into account, multivariate analyses have been carried out. In these analyses, statistical control has been made for the same variables as in the previous chapters, except the four “gray zone” variables. The results of these analyses are shown in the upper part of Table 9.1, where also the controlled effects of the urban structural variables on possession of driver’s license, transport attitudes and environmental attitudes can be seen. The lower part of Table 9.1 shows the effects of the “gray zone” control variables on five on the mean daily traveling

distances on weekdays and in the weekend, commuting distances, and the proportion of travel carried out by non-motorized modes on weekdays and in the weekend. By combining information from the upper and lower parts of Table 9.1 it is possible to get an impression of extent to which the “gray zone” variables influenced by residential location also exert influences on the travel behavioral variables, and hence an impression of the occurrence and magnitude of indirect effects of residential location⁶⁸.

Figure 9.1 *Proportions of respondents living within different distance belts from the city center of Hangzhou who belong to a household with a private car at its disposal.*



N = 2850, with 773, 696, 687 and 694 respondents, respectively, in the innermost, second inner, second outer and outermost distance belt.

According to our material, a relationship between residential location and car availability persists after controlling for a number of the demographic and socioeconomic characteristics that, according to previous research, are likely to influence car availability. The likelihood of belonging to a household with a car is clearly lower among respondents living close to the city center of Hangzhou. The finding of a statistically significant relationship between residential location and car availability in the household does of course not in itself prove that the higher proportions of households with a car in outer than inner areas are caused by residential location. Probably, the

influence goes in both directions. People who have got access to a car, find out that they may as well settle in an area where a number of destinations are beyond acceptable biking distance. Such self-selection of car owners to outer districts of the metropolitan area has, however, already been taken into account through the inclusion of car availability as a control variable in the ordinary analyses. Unless the influence goes solely in the direction from car ownership to residential location, this will lead to an underestimation of the impact of residential location on travel. However, through our theoretical discussion, the examples from the qualitative interviews and the results from the analysis of perceived car dependency, a strong case has been made that residential location exerts at least some influence on car ownership. The same applies, at least to some extent, to the other “gray zone” variables.

From the lower part of Table 9.1, we see that none of the five travel behavioral variables are influenced by the respondents’ environmental attitudes. Among the “gray zone” variables, car availability and possession of driver’s license are the clearly most influential ones. The respondents’ transport attitudes exert some influence on the proportions of walk/bike travel, but do not show any effects on neither commuting distances nor the total daily traveling distances.

For all the three “gray zone” control variables showing influence on any of the five travel behavioral variables, the location of the residence relative to the city center of Hangzhou is the main influential urban structural variable. The location of the dwelling relative to the closest third-order center shows a slight influence on the respondents’ environmental attitudes, but as already mentioned these attitudes do not appear to exert influence on any of the five transport variables. The location of the dwelling relative to the closest second-order center shows influences both on environmental attitudes and transport attitudes, but neither of these effects is strong, and only the effect on transport attitudes translates into an indirect effect on travel modes. The indirect effects on the proportions of walk/bike travel from the location of the residence relative to the closest second-order center via transport attitudes are therefore weak.

The main indirect effects of residential location on the five selected travel behavioral variables therefore stem from the location of the dwelling relative to the city center of Hangzhou. Through its influences on car ownership, residential location close to downtown Hangzhou contributes indirectly to shorter daily traveling distances and a higher proportion of walk/bike travel on weekdays as well as in the weekend.

Table 9.1 *Effects of the three urban structural variables on four “gray zone” control variables, and the effects of these “gray zone” control variables on selected travel variables.*

<i>Intermediate variables:</i> <i>Independent variables:</i>	Availability of private car in the household	Possession of driver's license for car	Attitudes to transport issues	Attitudes to environmental issues
Location of the dwelling relative to the city center of Hangzhou	B = 2.058 <i>Wald</i> = 17.008 (p = 0.000)	B = 1.547 <i>Wald</i> = 33.944 (p = 0.000)	B = 1.689 <i>Beta</i> = 0.165 (p = 0.000)	B = -0.363 <i>Beta</i> = -0.035 (p = 0.103)
Location of the dwelling relative to the closest second-order center	p > 0.25	p > 0.25	p > 0.25	B = -0.378 <i>Beta</i> = -0.046 (p = 0.022)
Location of the dwelling relative to the closest third-order center	p > 0.25	p > 0.25	p > 0.25	B = 0.189 <i>Beta</i> = 0.031 (p = 0.132)
<i>Dependent variables:</i>				
Total daily traveling distance on weekdays (logarithmically measured)	B = 0.244 <i>Beta</i> = 0.114 (p = 0.000)	B = 0.098 <i>Beta</i> = 0.083 (p = 0.000)	p > 0.25	p > 0.25
Total daily traveling distance in the weekend (logarithmically measured)	B = 0.282 <i>Beta</i> = 0.099 (p = 0.000)	B = 0.090 <i>Beta</i> = 0.062 (p = 0.000)	p > 0.25	p > 0.25
Commuting distance (one-way, logarithmically measured)	p > 0.25	B = 0.088 <i>Beta</i> = 0.084 (p = 0.017)	p > 0.25	p > 0.25
Non-motorized share of travel on weekdays	B = -0.260 <i>Beta</i> = -0.131 (p = 0.000)	B = -0.070 <i>Beta</i> = -0.062 (p = 0.008)	B = -0.084 <i>Beta</i> = -0.060 (p = 0.005)	p > 0.25
Non-motorized share of travel in the weekend	B = -0.183 <i>Beta</i> = -0.097 (p = 0.000)	B = -0.093 <i>Beta</i> = -0.086 (p = 0.000)	B = -0.117 <i>Beta</i> = -0.087 (p = 0.000)	p > 0.25

The effects the urban structural variables on the availability of private car in the household and possession of driver's license are based on multivariate logistic regression analyses; the remaining effects in the table are based on ordinary, least square multivariate regressions. Significance levels are based on two-tailed tests.

In addition, residential location close to the city center of Hangzhou influences travel behavior in similar ways through its effect on the likelihood of holding a driver's license. However, these effects are not as strong as the effects via car ownership. On the other hand, the indirect effects of proximity between the dwelling and downtown Hangzhou via possession of driver's license also include an influence – albeit not very strong – on commuting distances. In addition, living close to the city center of Hangzhou appears to contribute to less car-

oriented attitudes, and hence indirectly to higher proportions of non-motorized travel. The proportions of walk/bike travel on weekdays and in the weekend also seem to be influenced by the location of the dwelling relative to the closest second-order center. However, as mentioned above, these indirect effects are weak, as neither of their components is particularly strong.

9.3 Comparison of the effects of urban structural variables with and without “gray zone” control variables included

In order to give an indication of the possible magnitude of the indirect effects of residential location via the “gray zone” control variables, a set of analyses has been conducted where the “gray zone” variables have been omitted as control variables. In these analyses, the effects of the “gray zone” control variables have not been “subtracted” from the effects of the residential location variables. If the influences of residential location on the “gray zone” control variables equally strong as or stronger than the influences in the opposite direction, analyses without these control variables will produce the best estimate of the impacts of residential location on travel.

As can be seen in Table 9.2, the inclusion or exclusion of the “gray zone” control variables causes only very slight changes in the estimated effects of the residential location variables on the total traveling distances on weekdays. The same applies to the effects on commuting distances. The inclusion or exclusion of the “gray zone” control variables has somewhat stronger impacts on the estimates of the influences of residential location on traveling distances in the weekend and the proportion of non-motorized travel on weekdays and in the weekend.

Regarding the total daily distance traveled on weekdays, the exclusion of car availability and the other three “gray zone” control variables causes virtually no change in the effect of the location of the dwelling relative to the city center of Hangzhou, and the standardized regression coefficient is identical. The transport-generating effect of living close to a third-order is slightly increased. Thus, the exclusion of “gray zone” control variables tends to *reduce* the center-periphery difference in traveling distances a little bit, which may appear surprising. However, it should be noted that this difference from the original analysis is very small.

Distinct from the situation on weekdays, the exclusion of “gray zone” control variables tends to increase the difference between central and peripheral areas in traveling distances in the weekend. The effect of the location of the residence relative to downtown Hangzhou increases quite a bit, and in addition we find a slight effect of the location of the dwelling relative to the closest second-order center. Both these effects are positive, implying that traveling distances tend to increase the further away the respondents live from the city center of Hangzhou as well as from the closest second-order center.

Exclusion of “gray zone” control variables also tends to increase the difference between central and peripheral areas in commuting distances somewhat, as the two effects contributing to this difference (the effects of the location of the dwelling relative to the city center of Hangzhou and to the closest second-order center) are slightly increased, whereas the counteracting effect of proximity to a third-order center is slightly reduced. It should still be noted that these changes generated from the exclusion of “gray zone” control variables are very small.

Both on weekdays and in the weekend, exclusion of “gray zone” control variables implies that the differences between central and peripheral parts of the metropolitan area in shares of non-motorized travel are somewhat increased. The effect of the location of the residence relative to downtown Hangzhou increases somewhat both on weekdays and in the weekend. For weekend travel, we also see a very slight increase in the effect of the location relative to the closest second-order center, combined with a slight decrease in the already weak effect of proximity to a third-order center.

Table 9.2 *Effects of the three urban structural variables on selected travel variables, based on multivariate regression analyses with and without the following “gray zone” control variables included: Car availability in the household, driver’s license, transport attitudes, and environmental attitudes.*

	Location of the dwelling relative to the city center of Hangzhou	Location of the dwelling relative to the closest second-order center	Location of the dwelling relative to the closest third-order center
Total daily traveling distance on weekdays (log)			
With ‘gray zone’ control variables included	0.229 <i>0.155</i> (0.000)	p > 0.25	-0.057 <i>-0.059</i> (0.004)
Without ‘gray zone’ control variables	0.226 <i>0.155</i> (0.000)	p > 0.25	-0.069 <i>-0.069</i> (0.001)
Total daily traveling distance in the weekend (log)			
With ‘gray zone’ control variables included	0.168 <i>0.093</i> (0.000)	p > 0.25	p > 0.25
Without ‘gray zone’ control variables	0.235 <i>0.159</i> (0.000)	0.039 <i>0.032</i> (0.117)	p > 0.25
Commuting distance (one-way, log)			
With ‘gray zone’ control variables included	0.368 <i>0.258</i> (0.000)	0.115 <i>0.120</i> (0.000)	-0.366 <i>-0.188</i> (0.000)
Without ‘gray zone’ control variables	0.397 <i>0.277</i> (0.000)	0.121 <i>0.125</i> (0.000)	-0.361 <i>-0.183</i> (0.000)
Non-motorized share of travel on weekdays			
With ‘gray zone’ control variables included	-0.190 <i>-0.135</i> (0.000)	p > 0.25	p > 0.25
Without ‘gray zone’ control variables	-0.226 <i>-0.167</i> (0.000)	p > 0.25	p > 0.25
Non-motorized share of travel in the weekend			
With ‘gray zone’ control variables included	-0.220 <i>-0.164</i> (0.000)	-0.088 <i>-0.087</i> (0.000)	-0.040 <i>-0.048</i> (0.034)
Without ‘gray zone’ control variables	-0.258 <i>-0.193</i> (0.000)	-0.098 <i>-0.087</i> (0.000)	-0.033 <i>-0.038</i> (0.065)

The remaining independent variables are the same as in the corresponding analyses in Chapter 6. Unstandardized and standardized regression coefficients (the latter in italics), with significance levels (p-values, two-tailed tests) in parentheses.

Among the effects on the five transport variables, the exclusion of the “gray zone” control variables implies the largest changes in the effects of residential location on travel distances in the weekend. Apparently, outer-area residents who have a car at their disposal make a considerable amount of leisure travel by car in the weekend. In the ordinary analyses, this location-dependent impact of car availability was “subtracted” from the effects of residential location. When this car travel is no longer “subtracted”, the effects of the location of the residence on the proportions of non-motorized travel will also increase. The fact that the effects of residential location on the share of non-motorized travel are increased not only in the weekend but also on weekdays, when no corresponding increase in traveling distances was found, mirrors the fact that the influence of car ownership on the choice of travel modes is not limited to the impact through longer traveling distances. Availability of a private car also affects the modal choice for short trips that might otherwise be carried out by bike or by foot. Controlling for the “gray zone” variables implies that such changes in travel mode due to location-influenced car ownership are not included in the calculated effects of residential location.

The generally moderate differences in the calculated effects of residential location on travel with an without the “gray zone” control variables included implies that the results found in the ordinary analyses probably give a fairly realistic, albeit a little conservative estimate of the impacts of residential location in Hangzhou Metropolitan Area. Here, the Hangzhou analysis differs from the similar study in Copenhagen Metropolitan Area, where considerable differences were found in the effects of urban structural variables, depending on whether or not “gray zone” control variables were included. This difference between the Danish and the Chinese study reflects the far higher car ownership rates in the Copenhagen region than in Hangzhou Metropolitan Area. Although exerting a considerable influence on the traveling patterns of the affected individuals, car availability is a phenomenon confined to a small proportion of the Hangzhou region respondents. The impacts on the overall relationships between residential location and travel from including or excluding the “gray zone” control variables are therefore modest, compared to Copenhagen Metropolitan Area.

10 Conclusions and comparison with other studies

10.1 Introduction

In this chapter we will try to draw together the threads from the previous chapters. First, the main empirical results from the qualitative and quantitative material of the Hangzhou Metropolitan Area study will be summarized. This summarizing will be structured around the five research questions formulated in Chapter 3.1

Thereupon, the conclusions of the Hangzhou Metropolitan Area study will be compared first to the results of our recent study in Copenhagen Metropolitan Area (section 10.3) and then to other research studies (section 10.4). In these comparisons, an attempt will be made to explain what might be the causes of any deviations between our findings in Hangzhou Metropolitan Area and the findings of other studies. The purpose of this is, among other things, to examine whether there is a basis for drawing more general conclusions about relationships between residential location and travel than the ones that can be drawn based solely on the Hangzhou Metropolitan Area study.

10.2 Main conclusions of the study

In Chapter 3, the following research questions were formulated for the investigation of residential location and travel in Hangzhou Metropolitan Area:

- Which relationships exist between the location of the residence within the urban structure and travel behavior (amount of transport and modal split), when taking into consideration demographic, socioeconomic as well as attitudinal factors?

- Does the location of the residence within the urban structure influence the range and frequency of activities in which people engage?
- On which rationales do people base their choices of activity locations and travel modes?
- Are the relationships between residential location and travel behavior different among different subgroups of the population?
- Is the effect of a residential situation where the need for weekday transportation is low, offset by a tendency to compensate this by traveling more during weekends?

The Hangzhou Metropolitan Area study shows that residential location affects travel behavior, also when taking into consideration socioeconomic and attitudinal differences among the inhabitants. Although the specific influences of urban structure vary between population groups, the location of the residence in the urban structure of the Hangzhou metropolitan area affects travel behavior within all our investigated subgroups.

Overall, our analyses show that the location of the dwelling relative to the center structure of Hangzhou Metropolitan Area has a considerable influence on the travel behavior of the respondents. On average for all our respondents, living close to downtown Hangzhou contributes to less travel, a lower share of car driving and more trips by bike or on foot. Conversely, living in the peripheral parts of the metropolitan area contributes to a higher amount of transport and a lower share of travel by non-motorized modes. In particular, the length and travel mode of journeys to work are influenced by the location of the dwelling relative to the city center of Hangzhou. In general, the strong concentration of service and leisure facilities in the inner and central parts of the metropolitan area also implies shorter average trip distances for non-work purposes the closer to downtown Hangzhou the residence is located. The location of the dwelling relative to the closest second-order and third-order center also influence travel behavior, but not to the same extent as the location of the residence relative to the city center of Hangzhou.

Our data indicate that a residential location close to the city center of Hangzhou contributes to:

- shorter overall traveling distances on weekdays as well as in the weekend

- considerably higher likelihood of using non-motorized modes during the weekdays as well as in the weekend, but somewhat shorter traveling distances by foot and bike than the average among users of these modes
- lower likelihood of traveling by bus both during the weekdays and in the weekend, and shorter traveling distances by bus than the average among users of this mode
- lower likelihood of using car or taxi during the weekdays and to some extent also in the weekend, and shorter traveling distances by car and taxi than the average among users of these modes
- lower likelihood of using e-bike, especially in the weekend but also during the weekdays
- considerably higher proportion of the total traveling distance carried out by non-motorized modes during the weekdays as well as in the weekend
- considerably shorter commuting distances

Residential location close to any of the two second-order centers (Xiaoshan and Yuhang) appears to contribute to:

- higher likelihood of using non-motorized modes during the weekdays as well as in the weekend
- lower likelihood of traveling by bus in the weekend and to some extent also during the weekdays
- slightly higher likelihood of using e-bike during the weekdays
- higher proportion of the total traveling distance during the weekend carried out by non-motorized modes
- somewhat shorter commuting distances

Residential location close to any of the six third-order centers appears to contribute to:

- slightly longer overall traveling distances on weekdays
- somewhat higher likelihood of using non-motorized modes during the weekdays as well as in the weekend
- shorter traveling distances by foot and bike than the average among users of these modes on weekdays, but somewhat longer in the weekend
- lower likelihood of traveling by bus during the weekend

- lower likelihood of traveling by car or taxi during the weekend, and slightly shorter traveling distances by car and taxi than the average among users of these modes
- slightly higher likelihood of traveling by electronic bike during the weekend
- somewhat higher proportion of the total traveling distance during the weekend carried out by non-motorized modes
- longer commuting distances

Most of these tendencies are in line with what could be expected from theoretical considerations and are also in line with the mechanisms and rationales identified in the qualitative interviews (see below). There are, however, some effects that may appear surprising, notably the tendencies to longer commuting distances and overall traveling distances on weekdays when living close to a third-order center. Better accessibility to job opportunities outside the local area when living close to the public transport connections usually available in a third-order center might be an explanation. In particular, such a tendency appears to exist among women. More research is still needed in order to uncover the reasons for the tendencies found towards a higher amount of travel on weekdays when living close to a third-order center.

Our material does not show any tendency to “compensatory travel” in the form of longer traveling distances in the weekend among respondents living at locations making it possible to manage on a low amount of travel on weekdays. In Europe, a hypothesis of compensatory travel (Vilhelmson, 1990; Kennedy, 1995; Tillberg, 2001) has gained much attention, and in our investigation in Copenhagen Metropolitan Area, certain indications of such travel could be found among residents of dense urban districts (Næss, 2006 a and c). In Hangzhou Metropolitan Area, there is even in the weekend a fairly strong and certain tendency to longer traveling distances the further away the respondents live from downtown Hangzhou.

Our interviewees' *rationales* for location of activities, choice of transport modes and route choice make up important links in the mechanisms by which urban structures influence travel behavior. The rationales are partially interwoven. Usually, the choice of an individual is not based on one single rationale, but on a combination of (and a trade-off between) several rationales. Most of the rationales identified either contribute actively to strengthen the relationships between residential location and travel, or are neutral as regards these

relationships. A few of the rationales form the base of "compensatory" mechanisms, which may contribute to weaken the relationships mentioned.

Our interviewees' choices of locations for daily activities are made as a compromise between two different concerns: a wish to limit travel distances and a wish for the best facility. For most travel purposes, our interviewees emphasize the possibility to choose among facilities rather than proximity. This means that the amount of travel is influenced to a higher extent by the location of the residence in relation to *concentrations* of facilities, rather than the distance to the *closest single facility* within a category. In particular, this is the case for workplaces and places of higher education, but also for cultural and entertainment facilities, specialized stores and, to some extent, also grocery stores. For leisure activities, the "atmosphere" and the esthetic qualities at the destination may also play a role, contributing to strengthen the attraction of Hangzhous central parts, in particular the areas bordering the West Lake.

The longer traveling distances among outer-area than among inner-area residents are mainly a result of longer commuting distances. The given configuration of residences and workplaces results in a shortage of suitable jobs within a moderate commuting distance when living in the outer parts of the metropolitan area. Outer-area residents therefore tend to make longer commutes, partly because local job opportunities often do not exist, and partly because jobs outside the local area are considered more attractive. Although the distances to shops are usually also longer when living in the suburbs, the outer-area interviewees often compensate for this by buying daily necessities along the route home from work. In this way, the rationale of distance limitation and the rationale of choosing the best facility can be combined for shopping trips and certain other errands.

Our interviewees' rationales for choosing modes of transportation usually contribute to a more extensive use of cars in the suburbs and a higher use of non-motorized modes in the inner city. The rationales for route choice imply that the interviewees are not apt to make long detours from the shortest route to daily-life destinations, and thus provide general support to the activity-based approach to transport analyses.

Activity participation

Our interviews indicate that people's activity patterns are to some extent adapted to the availability of facilities in the proximity of the dwelling. The interviewees still rarely give up activities completely as

a result of moving to a different urban structural situation. According to our survey data, “distance decay” in the form of reduced activity participation when living far away from relevant facilities is not very pronounced among our respondents. In general, the relationships between residential location and the frequencies of activity participation are relatively weak. Our material also shows some quite surprising tendencies of more frequent activity participation the further away the respondents live from the various types of centers where the activities in question can usually be performed. Notably, this is the case for shopping, where the frequency of visiting shops tends to increase the further away the respondents live from downtown Hangzhou as well as from the closest second- or third-order center. A plausible explanation might be that peripheral residents sometimes combine purchases of the most basic daily necessities in local stores (e.g. vegetable markets, fruit stands and small supermarkets) with shopping in larger and more well-assorted stores in Hangzhou in connection with commuting trips.

Our material shows that the propensity for using local facilities depends partly on which facilities *exist* in the proximity of the dwelling, and partly on the *competition* from non-local facilities. In the districts next to the downtown area, a relatively broad supply of local facilities often exists, but at the same time there is a strong competition from facilities in the city center. Conversely, the local supply of facilities is often more modest in the outer parts of the metropolitan area, but the long distance to the concentration of facilities found in central Hangzhou at the same time weakens the competition from the latter facilities. The two above-mentioned factors reflect the rationales for location of activities identified in the qualitative interviews. The wish to limit geographical distances and time consumption for travel motivates respondents to use local facilities, while the wish to choose the best facility pull them out of the local area and inward to the city of Hangzhou and in particular its inner districts. The mutual prioritization between the rationales, as well as the actual occurrence of local and competing external facilities, varies between different facility categories.

Differences between population groups

Analyses where the respondents have been divided into subgroups according to gender, age, household type or socioeconomic characteristics show that residential location influences travel behavior among all these groups. In particular, this applies to traveling distances and the proportion of travel accounted for by non-motorized modes. There are, however, some interesting differences across

population groups in the way that residential location affects travel behavior.

Traveling distances are influenced by residential location to a higher extent among men than among women, and to a lesser extent among childless households with two or more adults than among the remaining respondents. Men's traveling distances tend to increase considerably when living far away from the city center of Hangzhou, while women's amount of travel is also influenced by the location of the dwelling relative to the closest third-order center, where proximity to such a center tends to increase their traveling distances. This difference between men and women is to a high extent attributable to male suburbanites' choices of workplaces within a wider geographical area than among their female counterparts. There are also somewhat stronger influences of residential location on traveling distances among respondents with a low education level and income than among those with a high education or income.

The influences of residential location on traveling distances vary between different household types in a quite complex way. In general, respondents with two or more adult members and no children living at home tend to be more locally oriented than the remaining household groups. This group includes a relatively high proportion of pensioners, and this may explain why their travel behavior appears to be less influenced by the distance from the dwelling to the workplace concentrations in the central parts of the region.

There are certain differences in the likelihood of using car or taxi according to age, household type and education level, where the likelihood of being a car or taxi user does not appear to be influenced by residential location at all among the younger half of the respondents, single persons and respondents with education level above the median. Among respondents above the median age, respondents belonging to households with at least two adult members, and respondents with education level at the median or below, tendencies to lower likelihood of being a user of car or taxi are found among respondents living close to the city center of Hangzhou, and among the older half of the respondents also when living close to a third-order center.

There are only small differences between the investigated population groups in the influences of residential location on the shares of non-motorized travel.

The above-mentioned differences between population groups do not point in any clear and unambiguous direction in terms of the nature of

the relationships between residential location and travel in Hangzhou in the future. On the one hand, education levels as well as income could be expected to continue to rise. According to our material, this could be expected to contribute to a slight reduction of the influence of proximity to downtown Hangzhou on travel behavior. The same may be the case if the differences found between young and old respondents represent cohort effects (i.e. lifestyles that the young generation will continue to practice also when they get older) as distinct from mere life-phase effects. On the other hand, if the development towards an increasing proportion of one-person households continues (like it has done in Western countries for several decades), the influence of the location of the dwelling relative to the city center of Hangzhou on travel behavior may increase. The same applies if – as has been the case in Western countries – women increasingly adopt traditionally male types of travel behavior.

10.3 Comparison with the Copenhagen Metropolitan Area study

Table 10.1 shows the impacts of the location of the dwelling relative to different categories of urban centers in the metropolitan areas of Hangzhou and Copenhagen, respectively, on five main transport variables: total traveling distances on weekdays and in the weekend, commuting distances, and the proportions of non-motorized travel on weekdays and in the weekend. For Copenhagen Metropolitan Area, the influences of the location of the dwelling relative to the main city center and the local area density have been combined in order to make the Copenhagen results more comparable to those of Hangzhou. There is a considerable overlap between the local area density and the distance from the dwelling to downtown Copenhagen, as most of the high-density areas are located in the inner city or relatively close to it. It should still be kept in mind that the residential locational variables of the Copenhagen area study are differing somewhat those of the Hangzhou area study. For example, both the second- order and the third-order centers of the Copenhagen area study should probably be considered more local (i.e. belonging to a somewhat lower order in the hierarchy of centers) than the second- and third-order centers of Hangzhou Metropolitan Area, as nearly 20 second-order and almost 80 third-order centers were defined in the Copenhagen Metropolitan Area study, compared to only 2 second-order and 6 third-order centers in Hangzhou Metropolitan Area. We still think that the juxtaposition

of results from the two studies shown in Table 10.1 provides a useful background for comparison of the findings.

In general, there are considerable similarities between the findings of the two studies. Both in Hangzhou Metropolitan Area and in Copenhagen Metropolitan Area, living in the central parts of the region contributes to shorter overall traveling distances, shorter commuting distances and a higher share of non-motorized travel. In particular, the location of the dwelling relative to the main center of the region appears to influence traveling distances and modes in very similar ways. Moreover, both in Hangzhou Metropolitan Area and in Copenhagen Metropolitan Area, the influences of the location of the residence relative to lower-order centers are weaker and less unambiguous than the location of the dwelling relative to the main city centers of the two urban regions. In the metropolitan areas of both Hangzhou and Copenhagen, living close to a second-order area was found to contribute to a higher share of non-motorized travel in the weekend, but any similar effect on weekdays was only found in the Copenhagen area. In neither of the two case metropolitan areas, proximity of the dwelling to a second-order center appears to influence traveling distances much, except for a slight tendency to shorter traveling distances on weekdays in Copenhagen Metropolitan Area and a slight tendency to shorter commuting distances among workforce participants of Hangzhou Metropolitan Area.

Proximity to a third-order center shows a few somewhat surprising effects on traveling distances in Hangzhou Metropolitan Area, as respondents tend to travel somewhat longer on weekdays and make somewhat longer commutes the closer they live to a third-order center. It should be noted here that the influence of the peripheral location of all the third-order centers has already been accounted for by the variable measuring the location of the dwelling relative to the city center of Hangzhou. The travel-increasing effects of living close to a third-order center therefore do not simply reflect the long distances from these centers to the workplaces and service facilities found in the inner parts of the metropolitan area. Instead, living close to a third-order center implies a better access to public transport facilities than among the remaining outer-area residents, thus making it easier for those who live close to such a center to choose workplaces and service facilities outside the local district. The absence of any corresponding effects in Copenhagen Metropolitan Area is probably due to the much higher levels of car availability in the latter region. In the outer parts of Copenhagen Metropolitan Area, a large proportion of the residents are able to choose jobs and services outside the local district, even if they live in areas with poor public transport facilities.

Table 10.1 *Main effects on selected transport variables from residential location relative to the main metropolitan center, the closest second-order center and the closest third-order center among respondents in the metropolitan areas of Hangzhou and Copenhagen.*

	Proximity to the main center of the metropolitan area		Proximity to a second-order center		Proximity to a third-order center	
	Hangzhou Metropolitan Area	Copenhagen Metropolitan Area ¹	Hangzhou Metropolitan Area	Copenhagen Metropolitan Area	Hangzhou Metropolitan Area	Copenhagen Metropolitan Area ²
Total daily traveling distance on weekdays	Shorter	Considerably shorter	No clear effect	Somewhat shorter	Slightly longer	Somewhat shorter
Total daily traveling distance in the weekend	Shorter	Very slightly shorter	No clear effect	No clear effect	No clear effect	No clear effect
Commuting distance	Considerably shorter	Considerably shorter	Somewhat shorter	No clear effect	Longer	No clear effect
Non-motorized share of travel on weekdays	Considerably higher	Considerably higher	No clear effect	Considerably higher	No clear effect	No clear effect
Non-motorized share of travel in the weekend	Considerably higher	Considerably higher	Higher	Higher	Somewhat higher	No clear effect

There are also considerable similarities between the Hangzhou and Copenhagen study in the different ways that residential location influences travel among different population groups. In particular, this applies to gender differences. The difference between inner- and outer-area respondents in traveling distances is considerably larger among women than among men, suggesting that women's generally lower access to private motorized vehicles leads to a confinement of the geographical job markets of suburban women, compared to those of men.

The rationales on which the interviewees of the two studies base their travel behavior are also very similar across national contexts. In both Hangzhou Metropolitan Area and Copenhagen Metropolitan Area, the interviewees' choices of locations for their activities (work, shopping, leisure etc.) are based on a balancing between a wish to minimize traveling distances and/or travel time, and a wish for choosing the best and most suitable facility. And in both areas, the prioritization of the "best facility" rationale compared to the "distance minimizing"

rationale appears to be stronger the more specialized is the activity and the higher are the interviewees' mobility resources. As a result, this leads, for example, to the above-mentioned longer commuting distances among women than among men. The rationales for choices of modes of travel are also quite similar in the metropolitan areas of Hangzhou and Copenhagen. Notably, in both areas, the rationale to limit physical efforts leads to lower shares of non-motorized travel for long trips, and hence to lower shares of walk/bike travel in the parts of the urban region where distances to relevant facilities are long. The interviews in Hangzhou Metropolitan Area focused on rationales for activity participation, location of activities, travel modes and route choices somewhat more in-depth than the Copenhagen area study. Thus, some new or more detailed rationales were encountered in the qualitative interviews of the present study, thus giving an even more detailed account of the various mechanisms by which residential location influences travel behavior.

For example, a rationale for variety-seeking was found to influence the location of activities as well as the route choices of some of the respondents, contributing to increase traveling distances beyond what would have been the case if the closest facility or shortest route matching one's quality criteria were always chosen. The occurrence of this rationale does, however, not weaken the relationships between residential location and travel, as the possibility of choosing alternative routes or facilities without increasing trip lengths significantly is generally higher in inner-city dense environments than in the more thinly built-up outer areas.

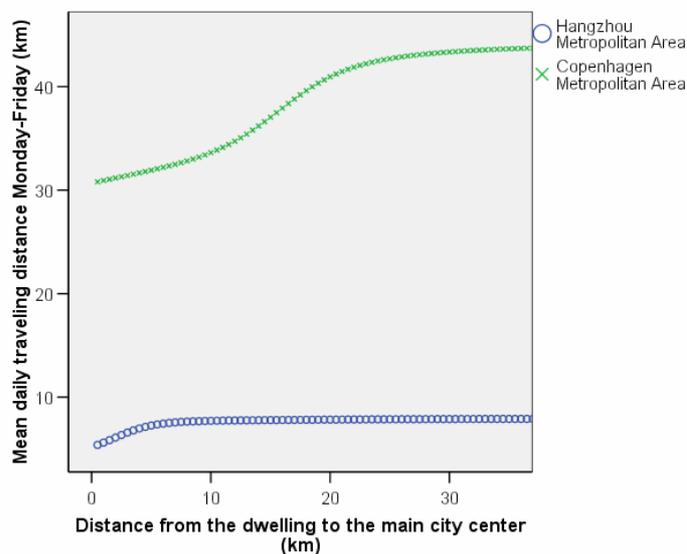
Another difference between the Hangzhou and Copenhagen studies is the strong emphasis placed by many Hangzhou interviewees on social contact as a rationale for activity participation as well as location of activities. Often, the interviewees of Hangzhou Metropolitan Area carry out various types of leisure activities (e.g. visits to cinemas, restaurants, cafes or parks) not so much for the activities themselves, but in order to use the activity as a facilitator of social contact. The locations for such activities were to a high extent based on what would be easiest accessible for the group of friends as a whole, rather than judged from an individual perspective or based on, e.g., the quality of a restaurant. In the Copenhagen Metropolitan Area study, no corresponding emphasis on social contact as a rationale for activity participation and location was found.

The above many similarities between the results of the studies in Hangzhou Metropolitan Area and Copenhagen Metropolitan Area might leave the impression that traveling patterns among inner- and

outer-area residents of Hangzhou Metropolitan Area are quite similar to those of residents living in the corresponding parts of Copenhagen Metropolitan Area. However, as can be seen in Figure 10.1, residents of Hangzhou Metropolitan Area travel in general only a small fraction of the distance traveled by Copenhagen Metropolitan Area residents. Although outer-area residents in both metropolitan areas travel longer than their inner-city counterparts do, the difference between the Chinese and Danish respondents is considerably larger than the average differences between respondents living in different parts of each metropolitan area. Thus, inner-city respondents of Copenhagen travel on average nearly four times as long on weekdays as the outer-area respondents of Hangzhou Metropolitan Area⁶⁹. Moreover, whereas traveling distances do not appear to increase to any extent worth mentioning when the distance from the dwelling to downtown Hangzhou increases beyond some 8 – 10 km, the curve of Copenhagen Metropolitan Area levels out at a distance from the city center of more than 40 km.

These differences across national contexts obviously reflect the far higher car ownership rates in Denmark than in China. Among the respondents of Copenhagen Metropolitan Area, 75% belong to a household having a private car at its disposal. Among the Hangzhou Metropolitan Area respondents, the corresponding figure is 6%. Although car ownership as well as the availability of company cars for private use is increasing rapidly in China, currently with a doubling of the car ownership rate each five years, there is still a considerable difference between China and Denmark in terms of car ownership and use. Since the rationales influencing travel behavior were found to be pretty much the same among the interviewees of the two studies, we might, however, expect that the curves showing the relationship between residential location and traveling distances in Hangzhou will be lifted upward as car ownership increases, and the distance from the city center of Hangzhou at which the curve begins to level out will be moved to the right in the figure.

Figure 10.1 *Expected daily traveling distances on weekdays among respondents living at different distances from the city centers of Hangzhou and Copenhagen, respectively, controlled for demographic, socioeconomic, attitudinal and other non-urban-structural variables.*



$N = 2305$ (Hangzhou Metropolitan Area) and 1414 (Copenhagen Metropolitan Area), $p = 0.000$ in both cases.

10.4 Comparison with other investigations

Apart from being highly consistent with the findings of the Copenhagen Metropolitan Area study, the results of our study are well in accordance with the conclusions from studies of residential location and travel in Aalborg (Nielsen, 2002) and Frederikshavn (Næss & Jensen, 2004). In both the latter studies, a methodology similar to the Copenhagen Metropolitan Area study was used. The results also fit well with two similar investigations in Greater Oslo (Næss, Røe & Sandberg, 1995; Røe, 1999). The results of investigations in the Århus area and some medium-sized Danish provincial towns follow the same pattern (Hartoft-Nielsen, 2001). As mentioned in chapter 2, a number of studies outside Scandinavia have also shown that residents of outer parts of the urban area travel considerably by motorized modes of transport than their inner-city counterparts. These studies include investigations in, among others, Paris (Mogridge 1985; Fouchier 1998), London (Mogridge, *ibid.*), New York and Melbourne (Newman

& Kenworthy 1989), San Francisco (Schipper et al. 1994), Dutch urban regions (Schwanen et al., 2001) and English cities (Stead & Marshall, 2001). Our results thus seem to be of a high generality, indicating that the dominating mechanisms by which residential location influences urban travel will be present across city sizes within a broad context of Scandinavian and European cities.

In cities and urban regions where the population has a low access to fast modes of transportation a more decentralized urban structure might still be transport efficient (Brotchie, 1984; Owens, 1986). The results of the Hangzhou Metropolitan Area suggest, however, that the mobility level of residents of cities on the affluent Chinese south-eastern coast is already above the level where a decentralized structure would be more transport-reducing, since traveling distances and the shares of motorized transport tend to be higher in the outer than in the inner parts of the metropolitan area, in spite of the occurrence of second-order and third-order centers in the peripheral parts. The influence of residential location relative to downtown is also likely to be weaker in high-mobility cities without any clear central business district, like Phoenix and Houston in the USA. Yet, even in such cities a central location is likely to generate less travel, as the point of gravity of the housing stock and the stock of workplaces in most cities is located relatively close to the city center. The average distance to all the other addresses of the city will even in a polycentric city tend to be shorter from a central than from a peripheral location.

Admittedly, some previous studies have concluded that only weak relationships or no relationship at all exist between urban structural characteristics and the inhabitants' travel behavior (see, e.g., Williams, Burton & Jenks (2000), where some of these studies are referred). However, such conclusions are often based on model simulations where the results simply reflect that the in-built assumptions of the model do not capture the actual influence of the spatial urban structure on travel behavior (cf., among others, Rickaby et al., 1992; Dasgupta, 1994, Simmonds & Coombe, 2000). In other cases, the apparent absence of any relationship between urban structure and travel transport is the outcome of studies not including the variables (urban structural as well as travel behavioral) that could from theoretical considerations be expected to exert the strongest influence on each other. Finally, the myth of weak or no relationship between urban structure and travel is sometimes reproduced in literature reviews (e.g. Gordon, 1997; Frey, 1999) where the results from one or both of the two above-mentioned types of studies are communicated uncritically, seemingly without being aware of the conclusions of other, more credible studies where relationships

between urban structural variables and travel behavior have been found.

In some empirical studies, for example, respondents have been asked to indicate travel *time* instead of travel distance. However, travel time is not very well suited as an indicator of the amount of transport, as travel speeds vary considerably between different modes of travel and in many cases also with the time and place of traveling (among others due to congestion)⁷⁰. For example, an analysis of traveling distances and travel times among inhabitants in the Paris region showed considerably longer traveling distances among inhabitants living in the outer parts of the region than among residents of the inner, dense districts. At the same time, travel times were slightly longer among the inner-city dwellers, mainly due to a higher proportion of travel being carried out by slow modes⁷¹ (Fouchier, 1998). As mentioned in Chapter 7, the Copenhagen Metropolitan Area study too illustrates the fact that residential location is much more closely related to travel distance than to travel time. Still, the literature on urban structure and travel includes several examples where conclusions of non-existence of any relationship between urban form and the amount of transport have been drawn on the basis of analyses where travel time has been used as the dependent variable instead of travel distance (see, e.g., Gordon & Richardson 1997; Snellen et al., 1998).

In some other studies addressing the same research question, the daily *number of trips* per person has been used as an indicator of the amount of transport (Kitamura et al., 1997; Boarnet & Sarmiento, 1998). However, distinct from travel distances, there is no theoretical reason to believe that the daily number of trips will be lower among inner-city dwellers than among residents of outer suburbs. On the contrary, one might perhaps expect the number of trips to be somewhat higher among residents of the inner city, where short distances from the dwelling to a broad range of facilities reduces the average inconvenience and cost per trip to these facilities (Crane, 1996). However, most studies of trip frequencies have concluded that the daily number of trips varies only modestly, if at all, between different types of neighborhoods (Cervero, 2000:3).

There also are several examples of studies focusing on urban structural factors that could hardly be expected to exert much influence on travel behavior, whereupon general conclusions are drawn about weak or absent relationships between urban structure and transport. For example, based on an analysis of correlation between transport and population density within functional urban regions in England, Gordon (1997) claims that there is poor evidence for the

assumption that urban structures influence travel behavior. However, the population density within a functional urban region is an imprecise indicator for the relationships that could be expected to exist between urban structure and travel, as the geographical areas within which population density is measured at this scale usually include both large, continuous non-built-up areas and urban land. Breheny (1995) draws a similar conclusion as Gordon based on a comparison of travel survey data in British cities of varying population sizes. However, the number of inhabitants is hardly any well suited indicator if the purpose is to test whether urban structure influences the amount of travel. For example, a study of 22 Nordic cities showed no relationship between energy use per capita for transport and the population size of the cities. Instead, energy use per capita was found to be influenced both by the population density within the urbanized area (measured as urban area per capita) and by the degree of centralized or decentralized location of residences within the urbanized area (Næss, Sandberg & Røe, 1996).

Whereas Breheny and Gordon draw general conclusions about the absence of any relationship between urban structure and transport based on aggregate-level data at a high geographical level, other studies (in particular in the U.S.A.) compare urban districts with different density and street layout. Typically, the latter studies compare districts developed before and after World War II, and sometimes also areas constructed in the 1980s and 1990s according to so-called neotraditional urban design principles, but without including the location of the areas relative to the center structure of the urban region in the analyses (cf. chapter 6). An example of studies belonging to this category is McNally & Kulkarni (1997).

Some of the debaters who claim that proximity or distance has lost its importance (e.g. Messelt & Kejser, 2001; Skjeggedal et al., 2003) seem to confuse the importance to people's choices of *activities*, the importance to their choices of the *locations* in which the activities take place, and the importance in term of the traveling carried out in order to reach the chosen destinations. While it may be true that most modern people are less tied to local places than previous generations (although this varies considerably among population groups), and hence engage in activities and utilize facilities more or less independently of what is available in the neighborhood of the residence, this does not mean that the location of urban functions has lost its importance to the amount of transport carried out in order to reach these destinations. On the contrary, the less people limit their choices of destinations (e.g. workplaces, schools, shops and leisure facilities) to what is available locally, the more will the amount of

transport carried out be influenced by the location of the residence in relation to the city-level pattern of such facilities.

Thus, the empirical studies concluding that urban structure has no influence worth mentioning on travel behavior have usually investigated other aspects of travel (e.g. trip frequencies or travel time) and/or focused on other urban structural conditions than those which, according to our investigations, exert the strongest influences on traveling distances and modal split. Moreover, a common feature of many of the publications from the above-mentioned studies is an absence of theoretical discussion of the reasons why urban structure could be expected to influence travel, what characteristics of the urban structure could be expected to exert the strongest influence on travel behavior, and what aspects of travel behavior could be expected to be influenced by urban structure. According to Chang (2006), some of the reason why certain studies of quite low scientific credibility are nevertheless extensively quoted could be ideological. In his analysis of the problematization of urban sprawl in the United States, Chang draws attention to the fact that several of the authors of the sprawl debate taking side against urban containment belong to “think-tanks” advocating free-market urban development with few regulations on land use.

Among theoretically informed, empirical, multivariate investigations into the influences on travel from the location of residences within the urban area, the converging conclusion is that living close to the city center does contribute to reduce traveling distances and the use of cars. Table 10.2 summarizes the results of some of the latter studies, viz. the studies conducted by myself and my colleagues in Hangzhou Metropolitan Area, Copenhagen Metropolitan Area, Frederikshavn (Næss & Jensen, 2004) and Aalborg (Nielsen, 2002) Greater Oslo (Næss, Røe & Sandberg, 1995).

Both in Hangzhou Metropolitan Area (population: 3.9 million), Copenhagen Metropolitan Area (population: 1.8 million), Aalborg (population: 160.000) and in Frederikshavn (population: 35.000), traveling distances increase the further away from the center of the urban region the residence is located. The table also shows that among the Danish cities, travel distances increase more quickly with increasing distance between the residence and downtown, the smaller is the city.

Table 10.2 *Comparison of results from studies in different urban areas of relationships between residential location and weekly distance traveled by motorized modes of transport.*

Distance from the residence to the city center	Increase in expected daily traveling distance over the week (km) from residential locations at different distances from the city center, compared to location in the downtown area (up to approx 1 km from the defined center)				
	4 km	8 km	12 km	20 km	40 km
Hangzhou Metropolitan Area (the present study)	1.7	2.35	2.47	2.55	2.63
Copenhagen Metropolitan Area (Næss, 2006a; Næss & Jensen, 2005)	3.4	6.1	8.4	13.7	18.6
Aalborg ⁷² (Nielsen, 2002)	3.2	6.4	9.5	---	---
Frederikshavn (Næss & Jensen, 2004)	11.1	12.9	12.9	---	---

Control for demographic socioeconomic and attitudinal variables. Car ownership is included as a control variable in all four urban areas. In all urban areas, urban structural variables other than the location of the residence relative to the main center of the city have been excluded from the analysis.

Controlling for non-urban-structural variables, the average daily travel distance over the week increases by about 11 km in Frederikshavn when the distance between the residence and the city center is increased by 4 km. In Aalborg, an increase in this order of magnitude does not occur until the distance between the residence and downtown reaches more than 12 km, and in Copenhagen Metropolitan area at some 17 km from the city center. Whereas weekly traveling distances in Copenhagen Metropolitan Area do not start leveling off until more than 30 km away from downtown, this point is reached already at a distance of 5 km from downtown in Frederikshavn. This reflects the fact that the continuous urban area in Frederikshavn reaches only some 3 – 4 km out from the city center. Beyond that range, there is open countryside where the supply of service facilities and workplaces apart from agriculture is limited to the relatively modest number existing in the villages surrounding the town. In comparison, Copenhagen Metropolitan Area covers a much larger area, and along some of the urban rail lines the continuous urban area reaches 25 – 30 km out from downtown Copenhagen. In Aalborg, the continuous urban area reaches some 5 – 7 km outward from the downtown area. Moreover, Copenhagen Metropolitan Area has a hierarchy of local centers in addition to the main center of the region. In Aalborg, a secondary relief center of considerable size exists (City South),

whereas the downtown area is the only location in Frederikshavn where any real concentration of center facilities exists. In Frederikshavn, the accessibility to facilities therefore first and foremost depends on the location of the residence relative to the downtown area. In larger cities, and in particular in metropolitan areas like Copenhagen Metropolitan Areas, the accessibility to facilities is normally determined both by the distance to the main city center and by the location of the dwelling relative to lower-order (sub-regional and local) centers.

At the level of individual cities or metropolitan areas there is thus strong evidence that residential location close to downtown contributes to reduce the amount of travel and energy use for transportation. However, it is more doubtful whether the advantages from centralization are also present when we turn from looking at single cities to larger regions (for instance a county or a province). Some professionals maintain that this will still be the case, from a line of argument that there will be a lot of crisscrossing transport between the different local communities in regions with a decentralized population pattern. However, several studies indicate that the amount of travel may be quite modest when people live sufficiently far away from large urban centers. The tendency of lower shorter traveling distances the further away the respondents live from a third-order center of Hangzhou Metropolitan Area illustrates this. A slight tendency of reduced travel distances could also be observed among the respondents living most peripheral parts of Copenhagen Metropolitan area. In a study of three Danish provinces, Næss & Johannsen (2003) found that the amount of motorized travel tended to increase at a steady pace with increasing distance from the dwelling to the town center of the closest one among the county's 4 – 6 largest towns, up to a distance of some 15 to 25 kilometers. Beyond that distance, traveling distances began to decline again, reaching levels in the most peripheral locations only slightly above the levels found among the residents living closest to the center of one of the county's main towns. A study of commuting distances in Finnish municipalities points in the same direction. Here, people living in rural and peripheral municipalities were found to usually have shorter commuting distances than those who live in the suburbs of the largest cities (Martamo, 1995). Similarly, an investigation of transport energy use in Swedish regions found that the energy use tended to increase the more the regional population was concentrated around the largest town of the region. Contrary to expectations, a high degree of urbanization, meaning that the proportion of the regional population living in rural areas and small settlements is small, tended to *increase*

the use of energy for transport. On the other hand, a high population density within the cities contributed (as might be expected) to reduced energy use. (Næss, 1993).

The studies of traveling distances at regional or provincial level clearly point at "distance decay" in the attractiveness of a large center. This also finds support in the Hangzhou Metropolitan Area study, cf. the leveling out of the curves showing relationships between the travel variables and residential location when the distance from the dwelling to downtown Hangzhou exceeds some 8 – 10 km, and the tendencies to shorter traveling distances among respondents living far away from the closest third-order center. Beyond the range of influence of the largest centers, most people are likely to orient themselves to smaller, more local centers, even if the job opportunities and selection of service facilities are narrower than in the big city. As mentioned in chapter 2, this might form a basis for the development of more local lifestyles and activity patterns among people living in the peripheral parts of a region. On the other hand, with an increasingly mobile population, the range of influence of large centers will probably expand. If a residential development in peripheral rural areas and villages is to be compatible with modest average amounts of travel, the distances to the closest cities (and in particular major metropolitan centers) must therefore be sufficiently long.

10.5 Concluding remarks

As mentioned in the introductory chapter, nearly one half of the World's current construction of buildings takes place in China, especially in the growing metropolitan areas along the eastern coast. In Hangzhou, 20 year old housing areas are considered old. This illustrates the rapid pace of change. Compared to cities in Europe and America, where it usually takes several decades to bring about a significant change in the urban form, the much higher pace of construction in Chinese cities implies that the increase in building stock during the next couple of decades may change the spatial structures of these cities dramatically. Thus, there is a high potential for influencing the urban form of Chinese cities in a medium-term perspective (15 – 20 years), depending on the urban planning and developmental strategies pursued. Whether the spatial development of Chinese cities takes place in a way contributing to a high amount of individual motorized transport or in a way more conducive to public and non-motorized travel modes, will have an important imprint on China's oil consumption, and hence also on China's degree of self-

supply with energy. Of even greater salience is the importance of urban planning in China in the context of global carbon dioxide emissions. In Europe and America, there has been a considerable debate about the impacts of different urban developmental strategies to energy use and CO₂ emissions, and in some countries (e.g. Norway and Sweden) this debate has contributed to a reversal of long-lasting trends of urban sprawl. While important both to the domestic greenhouse gas emissions and for other environmental reasons, the impact on the global climate from alternative urban developmental strategies in Europe is still by far not as large as in China. From a global climate perspective, energy-efficient urban developmental strategies for Chinese cities should therefore be among the top items of the agenda.

The results of the Hangzhou Metropolitan Area study show that it is crucial to avoid urban sprawl if China is to avoid an uncontrolled increase in motorized daily-life travel. In general, accommodating growth in the building stock by means of densification instead of outward expansion is preferable from a transport energy point of view. In particular, densification close to the main center of the urban region contributes to reduce the amount of travel and to increase the proportion of non-motorized travel. To some extent, densification close to the centers of second- or third-order towns may also be favorable, in particular if these towns are connected to the main city by means of high-standard public transport lines rather than new motorways.

It is, however, important to be aware that densification should not be pursued in isolation, but be accompanied by restrictions on urban motoring (e.g. road pricing), improved public transport services, better conditions for bicyclists and pedestrians, and provision of sufficient green areas and elements. In spite of the high proportion of bike travel in Hangzhou, the conditions for bicyclists are considerably poorer than in Copenhagen. Here, Hangzhou and other Chinese cities might preferentially gain a lot from implementing some of the schemes for bike paths and lanes existing in cities like Copenhagen and Amsterdam. Moreover, the recommendation of densification must not be interpreted as a recommendation of converting centrally located parks and hills (e.g. the areas adjacent to the West Lake) into developmental sites. Although highly important, goals of limiting energy use and motorized urban transport are not the only environmental concerns necessary to take into consideration in urban planning. (For a broader discussion of transport-reducing urban developmental strategies, seen in a wider sustainability and planning perspective, see Næss, 2006a, chapters 12 and 13).

Compared to the level of affluence among the inhabitants, the present urban form of Hangzhou Metropolitan Area may be considered largely favorable from a perspective of environmentally sustainable transport. Although the residential floor space per capita in Hangzhou Metropolitan Area is more than half that of their Danish counterparts, the inhabitants travel only about one seventh of the daily distance traveled by residents of Copenhagen Metropolitan Area (cf. Figure 10.1). Admittedly, some of the recent developmental areas (notably some economic and technological developmental zones) have a location and density that is not very favorable, seen from the perspective of transport energy minimizing. However, Hangzhou is still on average a dense city, and most of the outward urban expansion that has taken place in Hangzhou and in the second-order towns has been at fairly high densities, very different from the one-storey single-family home development so typical for urban expansion in many American cities.

The challenge for Hangzhou Metropolitan Area (and other similar Chinese urban areas) is maybe not to make the built-up areas even denser than they are already (although such density increases may also be relevant, in particular in the most central parts), but first and foremost to avoid adopting the low-density, sprawling form of development typical for American, and in a more moderate form also European, urban regions during the second half of the 20th century.

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Notes

¹ In order to avoid confusion with the structures of the agency-structure relationship discussed earlier, we have used the notion of “causal powers and conditions” in Figure 2.2 instead of Sayer’s term “structure”, since the latter also includes the powers, abilities and liabilities of individual persons.

² Pløger introduces the term of “Dionysian urban life” in order to conceptualize “the enjoyment, “intoxication”, the delight in the practice of flanerism, the expropriation of space by the eye, hedonism and above all individuality”.

³ Critics have claimed that central place theory is based on positivist principles assuming the existence of an identifiable order in the material world; that humans are rational, utility-maximizing decision-makers; and that economic activity takes place within a context of free competition and search for equilibrium (Brown, 1995). Actual locations of cities also deviate considerably from those predicted by central place theory (a fact emphasized by Christaller himself, who acknowledged the existence of a number of locational factors in addition to the ones included in his model: cities are seldom located on mountain tops, even if the distance to other centers, seen in isolation, might indicate such a location). However, the fact that humans are not *entirely* rational utility-maximizing decision-makers does not imply that they do *not at all* use instrumental rationality. According to Sayer (1992), central place theory makes up an important contribution to understand the mechanisms influencing the location of center functions. The strength of the theory thus lies in its contribution to explanation, while its ability to predict actual location patterns within a given area is limited.

⁴ The figure does not show conditions influencing the travel modes used, which make up another important aspect of the study. Travel modes could be expected to be influenced indirectly by the factors shown in Figure 2.4 through their influence on traveling distances, and directly by individual resources and motives, transport infrastructure and social environments.

⁵ This presupposes that the residents choose more or less the shortest routes. This is discussed further in chapter 5.5.

⁶ This touches on the so-called self selection problem addressed by several authors, in particular in the American debate on relationships between land use and travel. This will in particular be discussed in section 9.8.

⁷ Admittedly, some American studies include regional accessibility among the urban structural variables (e.g. Handy, 1993; Kitamura et al, 1997 and Krizek, 2003). However, in these studies regional accessibility is usually calculated by measuring travel times by auto to workplaces or retail employment within a given area, transformed by means of a gravity function. This measure fails to account for the higher accessibility to downtown facilities among residents living close to public transport stops or in the inner parts of the city. In Krizek’s analyses (*ibid.*), the accessibility measure was based only on the availability of retail employment within given travel times, and the effects of the urban form variables on travel were controlled for changes in commuting distances. Although this may be reasonable if the aim of the study is solely to trace the impact on non-work travel from changing residential location, it precludes estimating the influence of residential location on the

total daily or weekly travel. As will be shown later in this book, the length and travel mode of journeys to work among our respondents are more than any other travel purpose influenced by the location of the residence. Regrettably, Krizek's article does not address the influence of residential location on commuting distances.

⁸ As mentioned in the previous note, this information could not be used due to insufficient registration of previous residential addresses.

⁹ As will be discussed in section 3.4, the data from the travel diary investigation could be used only to a limited extent due to the low number of respondents and a high proportion of missing answers to many of the questions

¹⁰ In the Master Land Use and Infrastructure Plan 2001-2020 for Hangzhou Metropolitan Area (Municipality of Hangzhou, 2003), Xiasha is shown as a second-order center along with Xiaoshan and Yuhang (NE). However, by the time of the investigation (2005), only a small part of the planned broad range of center functions in Xiasha had been established. At this time, Xiasha is clearly a one-sided concentration of industrial workplaces along with a concentration of workplaces within higher education and research. (Yang, personal communication.)

¹¹ In the Hangzhou Metropolitan Area study, a trip was defined as a chained or non-chained journey from home to home, with chained trips subdivided into main and secondary purposes. The traditional way of defining trips in travel surveys, viz. as a travel episode linking two stays at a stationary location for activity engagement, with the purpose of the trip defined according to the activity taking place at its destination, tends to underestimate the length of commuting trips and overestimate the trip length for purposes tied to activities carried out on the way to and from work, such as shopping or bringing children to kindergarten. This traditional bias in the estimation of trip lengths and travel times for trips with different purposes was thus avoided in the Hangzhou Metropolitan Area study. (In the Copenhagen Metropolitan Area study, the analysis of commuting distances was not affected by this bias, as it was based on a measuring of distances along the road network between the home addresses and workplace addresses of the respondents.)

¹² Additive indices for environmental and transport attitudes were constructed, based on seven questions within each category. For each individual question, respondents were requested to express their attitude to a statement using a five-level Likert scale, ranging from totally agree to totally disagree.

¹³ We considered including the whole week in the travel diary. However, given the quite demanding travel activity registration asked of the respondents, we feared that an extension of the period would reduce the response rate too much. Including Friday but not Wednesday and Thursday might perhaps have been a compromise, allowing for more elaborate analyses of the Friday travel characterized by a combination of ordinary, commuting-dominated weekday travel, and the trips of some respondents to second homes at the coast etc. However, since our main purpose was not to investigate the variations in traffic flows in the transport system over the week, but instead to investigate the influence of residential location on the length and travel mode of trips with varying purposes, we considered the likely cost in terms of a reduced response rate to surmount the value of increased information about Friday travel patterns.

¹⁴ The travel diary respondents (as well as the Xiaoshan interviewees) were actually recruited from an area a few hundred meters to the west of location no. 38. This area also had some participants of the main survey, but because the number of respondents was only 8, this location is not shown on the map in Figure 3.3.

¹⁵ Distinct from the Copenhagen Metropolitan Area study, no GIS databases of addresses and road networks were available, so all distances had to be measured manually on maps.

¹⁶ Basically, social science studies aiming to throw light on relationships between outcomes and possible causes, as distinct from measuring the extension of a phenomenon at a given point of time, must be considered a kind of case studies. Judgments of the extent to which the relationships found in such studies can be generalized, must be based on the analytic generalization logic of case study research, not on the statistic generalizations of the 'context-independent' sciences. The fact that some time always passes between the collection of data and the publishing of the results of a study is in itself a reason for this: Even with perfect statistical representativeness during the phase of data collection, the world has already become different at the time of publishing.

¹⁷ A similar qualitative reasoning must be used when making generalization from our case city to other Danish or European cities. And the same of course also applies to the generalizations drawn from the qualitative interviews with individual households.

¹⁸ This has also been done in the above-mentioned studies of North European cities.

¹⁹ 72 respondents who report not to have traveled at all during the five weekdays have been excluded. Since even very short trips in the neighborhood were to be recorded, a travel distance of zero during the five weekdays would imply that the person in question had not been outside the dwelling at all during this period. There is reason to suspect that many of these respondents have made trips without reporting them. One might imagine that some very old people stayed at home during the whole week, but the average age among those with zero traveling distance on weekdays is only slightly above the average among all respondents. We therefore decided to exclude respondents with zero traveling distance from the sample. Moreover, 182 respondents with total traveling distances during the period Monday-Friday above 172 km have been excluded. The reported mean daily total traveling distances Monday-Friday and by different modes are based on the remaining 2900 respondents. (The actual numbers of respondents in the various figures and tables may be lower, due to missing information about traveling distances and/or other issues in the questionnaires of some respondents.)

²⁰ The median values indicate the typical traveling distances among the respondents living within each distance belt, whereas the arithmetic means also give an impression of any differences between the distance belts in the occurrence of respondents with considerably longer traveling distances than what is typical. (Extreme traveling distances have yet been excluded.)

²¹ 95 respondents who report not to have traveled at all during the weekend have been excluded. Moreover, 133 respondents with total traveling distances during the weekend above 80.6 km have been excluded. The reported mean daily total traveling distances Monday-Friday and by different modes are based on the remaining 2925

respondents. (The actual numbers of respondents in the various figures and tables may be lower, due to missing information about traveling distances and/or other issues in the questionnaires of some respondents.)

²² The median values indicate the typical traveling distances among the respondents living within each distance belt, whereas the arithmetic means also give an impression of any differences between the distance belts in the occurrence of respondents with considerably longer traveling distances than what is typical. (Extreme traveling distances have yet been excluded.)

²³ In addition to measuring commuting distances along the road network, the distances between home and workplaces or places of education were also measured as the crow flies (yet drawing the routes outside major obstacles like the West Lake and large continuous hills and forest areas not crossed by roads). The results based on these alternative measures are very similar in terms of relationships between residential location and commuting distances.

²⁴ In these figures too, commuting distances above 50 km were excluded.

²⁵ The exact position of the interview area from which the Xiaoshan interviewees were chosen is not shown in Figure 3, as the number of survey respondents from this area is lower than ten. In the town of Xiaoshan, survey respondents were recruited from six different locations, with the majority living in an area approximately 800 m to the east of the area from which the participants of the qualitative interviews were chosen.

²⁶ There are no indications of any attitudinal or ideological influences that are likely to lead to biased inferences about the influence of residential location on the travel modes among the interviewees. A few of the interviewees express more pronounced attitudes to transport and environmental issues than what is common among the interviewees in general, but these attitudes do not seem to influence their travel behavior much, if at all. One interviewee in Cuiyuan shows a higher environmental awareness than the remaining interviewees, whereas three interviewees of Zhuangtang and Xiaoshan seem to be more car-oriented or less concerned about environmental issues than the remaining interviewees. These attitudes may partly themselves to some extent be influenced by their experiences from the urban environmental situation in their residential locations and, in the case of the Zhuangtang interviewees, habits developed through car driving for occupational trips. A fourth interviewee (in Banshan) is much concerned about physical exercise and this may have made him choose bike instead of bike for his trips to the downtown area in connection with his weekend job.

²⁷ Admittedly, one of the Xixi Road interviewees is not able to pursue his old hobby of fishing, but very few of the residential areas in the metropolitan area have fishing opportunities in their proximity.

²⁸ It is, however, uncertain how much this topic has at all been addressed in the interviews.

²⁹ This is the case also when excluding respondents with extreme travelling distances.

³⁰ Based on theoretical considerations as well as a number of preliminary, iterative analyses of the empirical data, the location of the residence relative to the city center of Hangzhou was measured by means of a variable constructed by transforming the linear distance by means of a non-linear function. This function was composed of a hyperbolic tangential function and a quadratic function, calculated from the following equation:

$$\text{mainhypnew} = ((\text{EXP}(\text{kmtomain} * 0.3 - 0.3)) - \text{EXP}(-(\text{kmtomain} * 0.3 - 0.3))) / (\text{EXP}(\text{kmtomain} * 0.3 - 0.3) + \text{EXP}(-(\text{kmtomain} * 0.3 - 0.3))) - (0.00007 * (\text{kmtomain} - 40) * (\text{kmtomain} - 40)),$$

where Mainhypnew = the transformed distance from the dwelling to the city center of Hangzhou and kmtomain = the linear distance, measured in kilometer. The linear distance was normally measured as the crow flies, yet avoiding to cross lakes (notably the West Lake) or continuous natural areas with no roads (notably the hills to the west and south-west of the West Lake). In cases where the direct, linear distance was crossing such obstacles, the distance from the dwelling to the city center of Hangzhou was instead measured along the shortest broken line avoiding these obstacles. Given a positive relationship between the transformed function and the traveling distance, this function describes a situation where traveling distances increase quite rapidly as the distance from the dwelling to the city center increases from zero up to some 6 km, then less steeply until a level where traveling distances increase only very slightly as the distance from the residence to the city center increases beyond some 10 km.

³¹ Similar to the location of the dwelling relative to the city center of Hangzhou, the linear distance from the dwelling to the closest second-order center was transformed by means of a non-linear function; in this case a hyperbolic tangential function calculated from the following equation: $\text{Sechypnew} = ((\text{EXP}(\text{kmtosec} - 2)) - \text{EXP}(-(\text{kmtosec} - 2))) / (\text{EXP}(\text{kmtosec} - 2) + \text{EXP}(-(\text{kmtosec} - 2)))$, where Sechypnew = the transformed distance from the dwelling to the closest second-order center and kmtosec = the linear distance, measured in kilometer. Given a positive relationship between the transformed function and the commuting distance, this function describes a situation where commuting distances are relatively constant as long as the distance from the closest local center does not exceed 1 km, then changes relatively sharply with increasing distances from the closest local center, until it stabilizes at a distance of approx. 3 km from the closest second-order center.

³² Similar to the location of the dwelling relative to the city center of Hangzhou, the linear distance from the dwelling to the closest third-order center was transformed by means of a non-linear function; in this case a hyperbolic tangential function calculated from the following equation: $\text{Thirhypnew} = ((\text{EXP}(\text{kmtothir} - 2)) - \text{EXP}(-(\text{kmtothir} - 2))) / (\text{EXP}(\text{kmtothir} - 2) + \text{EXP}(-(\text{kmtothir} - 2)))$, where Thirhypnew = the transformed distance from the dwelling to the closest second-order center and kmtothir = the linear distance, measured in kilometer. Given a positive relationship between the transformed function and the commuting distance, this function describes a situation where commuting distances are relatively constant as long as the distance from the closest local center does not exceed 1 km, then changes relatively sharply with increasing distances from the closest local center, until it stabilizes at a distance of approx. 3 km from the closest third-order center.

³³ Each of the two attitudinal variables was an index based on seven separate questions. The respondents were asked to indicate the extent to which they agreed or

disagreed to the statements about transport or environmental issues presented in each question, ticking for the relevant alternative on a 5-level Likert scale.

³⁴ With all 20 independent variables included in the regression model, the four urban structural variables have the following Tolerance levels: Location of the residence relative to downtown Hangzhou 0.76; Location of the residence relative to the closest second-order center 0.89; and Location of the residence relative to the closest third-order center 0.91. None of the 20 independent variables have Tolerance levels below 0.60. In the models on which Tables 6.1 - 6.26 have been based, where variables not fulfilling a required significance level below 0.25 have been removed, the Tolerance levels are generally even higher than in the regression models with all the independent variables included. According to Lewis-Beck (1980:60) problems of high multicollinearity exist if any of the variables of the regression model has a Tolerance level "close to zero". Given the fact that the theoretical range of Tolerance levels is from 0 to 1, the Tolerance levels of the urban structural variables as well as the non-urban structural variables must be considered clearly satisfactory.

³⁵ The values on the vertical axis have been calibrated in such a way that the mean value of the expected daily travelling distance on weekdays fits with the observed mean daily travelling distance on weekdays.

³⁶ The following non-urban-structural variables have been controlled for: Sex; age; number of children younger than 7 years of age in the household; number of children aged 7 – 17 in the household; number of adult persons in the household; education level; personal income; car ownership; driver's license for car; whether or not the respondent is a workforce participant; whether or not the respondent is a student; attitudes to transport issues; attitudes to environmental issues; whether or not the respondent had moved to her/his present dwelling less than 5 years ago; regular transport of children to/from kindergarten or school; whether or not the respondent has been outside Hangzhou Metropolitan Area during the week of investigation, and whether or not the respondent has stayed overnight away from home four or more nights during the week of investigation.

³⁷ The same non-urban-structural variables as in Table 6.2 have been controlled for.

³⁸ The same non-urban-structural variables as in Table 6.2 have been controlled for.

³⁹ The same non-urban-structural variables as in Table 6.2 have been controlled for.

⁴⁰ The same non-urban-structural variables as in Table 6.2 have been controlled for.

⁴¹ The same non-urban-structural variables as in Table 6.2 have been controlled for.

⁴² The same non-urban-structural variables as in Table 6.2 have been controlled for.

⁴³ The same non-urban-structural variables as in Table 6.2 have been controlled for.

⁴⁴ The values on the vertical axis have been calibrated in such a way that the mean value of the expected daily travelling distance in the weekend fits with the observed mean daily travelling distance in the weekend.

⁴⁵ The same non-urban-structural variables as in Table 6.2 have been controlled for.

⁴⁶ The same non-urban-structural variables as in Table 6.2 have been controlled for.

⁴⁷ The same non-urban-structural variables as in Table 6.2 have been controlled for.

⁴⁸ The same non-urban-structural variables as in Table 6.2 have been controlled for.

⁴⁹ The same non-urban-structural variables as in Table 6.2 have been controlled for.

⁵⁰ The same non-urban-structural variables as in Table 6.2 have been controlled for.

⁵¹ The same non-urban-structural variables as in Table 6.2 have been controlled for.

⁵² The same non-urban-structural variables as in Table 6.2 have been controlled for.

⁵³ The values on the vertical axis have been calibrated in such a way that the mean value of the expected daily travelling distance in the weekend fits with the observed mean daily travelling distance in the weekend.

⁵⁴ The same non-urban-structural variables as in Table 6.2 have been controlled for.

⁵⁵ The same non-urban-structural variables as in Table 6.2 have been controlled for.

⁵⁶ The control variables are the same as in the analyses presented in sections 6.3 to 6.5, except the following two, which are considered less relevant as the analysis of commuting distances does not refer to travel during a limited investigation period: whether or not the respondent has been outside Hangzhou Metropolitan Area during the week of investigation, and whether or not the respondent has stayed overnight away from home four or more nights during the week of investigation.

⁵⁷ The same control variables as mentioned earlier, except variables indicating particular activities likely to influence travel behavior during the period of detailed travel registration

⁵⁸ The same control variables as mentioned earlier, except variables indicating particular activities likely to influence travel behavior during the period of detailed travel registration

⁵⁹ The values on the vertical axis have been calibrated in such a way that the mean value of the expected daily travelling distance on weekdays fits with the observed mean daily travelling distance on weekdays. Among the variables of Table 1, only those variables meeting a required significance level of 0.25 have been included in the calculations on which the two curves are based.

⁶⁰ If the three mentioned variables had been excluded as control variables, the gap between the two curves would have been larger. However, such an exclusion would probably lead to an exaggeration of the influence of residential location on traveling distances. In particular, the income level may influence the choice of residential type and location. For car availability and possession of driver's license, the relationships with traveling distances are likely to involve influences in both directions, i.e. that these characteristics of the respondents may influence as well as be influenced by residential location. Arguably, controlling for these variables may be a kind of 'over-control'. This will be discussed further in chapter 9.

⁶¹ The same non-urban-structural variables as in Table 8.1 have been controlled for.

⁶² The same non-urban-structural variables as in Table 8.1 have been controlled for.

⁶³ The same non-urban-structural variables as in Table 8.1 have been controlled for.

⁶⁴ The same non-urban-structural variables as in Table 8.1 have been controlled for.

⁶⁵ The same non-urban-structural variables as in Table 8.1 have been controlled for.

⁶⁶ The same non-urban-structural variables as in Table 8.1 have been controlled for.

⁶⁷ The same non-urban-structural variables as in Table 8.1 have been controlled for.

⁶⁸ Because car availability and possession of driver's licence are both dichotomous variables, the influences of residential location on these variables has been analyzed by means of binary logistic regressions. However, this makes it difficult to calculate indirect effects, as the effects of the other variables have been assessed by means of ordinary least square regressions. Instead, the magnitude of the indirect effects will be indicated by comparing the effects of the urban structural variables found in the ordinary analyses (where the "gray zone" variables have been included among the control variables) with the corresponding effects found in analyses where the "gray zone" variables have been omitted as control variables.

⁶⁹ It should be noted that the curves in Figure 10.1 only show the influences of the distances from the dwelling to the city centers of Hangzhou and Copenhagen, respectively. The other urban structural variables have been kept constant at mean values. Since inner-area residents of Copenhagen Metropolitan generally live closer to second-order centers than their outer-area counterparts do, this implies that the traveling distances of inner-city residents of Copenhagen tend to be somewhat exaggerated in Figure 10.1.

⁷⁰ Travel time may of course be a relevant variable if the purpose of the analysis is to investigate welfare or economic consequences of transport, e.g. how simple or time-consuming it is to reach the locations where daily or weekly activities take place.

⁷¹ Røe (1999) has found a similar pattern among respondents in Oslo, cf. chapter 7.8.

⁷² Based on information in Nielsen (2002).