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STILL GOING ... AND GOING: THE EMERGING TRAVEL PATTERNS OF OLDER ADULTS

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This document summarises the results of a study on the mobility behavior of older adults aged 65 years and older. The research was sponsored by the Institute for Mobility Research (ifmo) and conducted under the lead of Texas A&M Transportation Institute as well as strong support by the German Aerospace Center (DLR) and Imperial College London.

Study partners:

Texas A&M Transportation Institute (Consortium Leader)

German Aerospace Center (DLR) / Institute of Transport Research, Berlin

Imperial College London / Department of Civil and Environmental Engineering

Design: Bernhard Moosbauer, www.exsample.org

Photography: Bernhard Moosbauer, 123rf.com

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Foreword

An increasing number of countries around the world are currently undergoing a period of demographic change that is leading to a rise in the proportion of older people. The transport sector will strongly be influenced by these developments, as a result of the distinct differences that exist between the mobility patterns of older people and those of the younger generations. While we see growing evidence that those aged 65 and over in the USA will not increase their car usage any further, the rate of car use by older people in countries such as Germany and China has not yet peaked.

People older than 65 years are increasingly mobile. This is not only because of their better health and higher life expectancies; factors including pensions and participation in the workforce, changing living arrangements, and social connections - in combination with more varied and better transport options - have an impact on the amount of travel and the mode choices of older people.

The objective of ifmo in initiating this study was to analyse the travel behaviour of the senior generation in countries that are at various stages of mass motorisation. Five countries provide its geographic scope: Germany, the USA, the UK, Japan and China. Investigating the differences between these countries helps to tease out important cross-national similarities and distinctions in the ageing process in relation to driving.

The essential value of this study is to enable a deeper understanding of how the senior generation travels today, and what factors may lie behind possible future changes in the travel behaviour of this age group. Also of interest is the discussion about how digital technologies might affect their travel behaviour, and whether or not car ownership will continue to play a dominant role in their travel. This will support different stakeholders in the transport industry in modifying existing products and services, and developing new ones, to enable the mobile life of the senior generation.

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Executive Summary

This report provides an understanding of how the senior generation travels at present, based on historical trends; what changes might be expected among the seniors of tomorrow; and the factors that will influence those changes. For this study, 'tomorrow' is defined as the year 2025. Analyses are conducted in a cross-national context, with information presented on Germany, the United States (USA), the United Kingdom (UK), China and Japan. The primary travel behaviour variables of interest are kilometres of travel and car availability.

Senior Mobility

The amount of travel increases sharply when one enters adulthood, and is relatively stable throughout the active mid-life period. A visible decline can be seen with age, though that decline has, since the 1970s, tended to push later into life. While the growth in total travel has slowed for younger age groups since the 1990s, it has continued for seniors (and for those in their forties and fifties). Today, Germans in their fifties are nearly as mobile as those in their twenties, whereas in the 1970s, twenty-something Germans travelled 36% more than fifty-somethings. By and large, the shape of the travel demand across the age groups, and its development over time, is similar in the other study countries.

In recent decades, the distance travelled per day has increased among seniors. Trips have become longer and seniors travel at higher speeds - due mainly to higher levels of car ownership in recent decades. Thus, seniors have a much larger activity radius today than only a few decades ago. The USA is the exception. Levels of car ownership among seniors in the USA rose sharply in the mid-twentieth century and have maintained that high level through subsequent generations.

Car Availability

Car availability is defined as the coincidence of having a driving license on the personal level and car ownership on the household level. In terms of trends in car availability, the USA and Japan represent two extremes, leading to either saturation or continued car market development. Germany and the UK, and other European countries, fall between the two extremes of the USA and Japan.

- Because there was rapid growth in car ownership early in the twentieth century in the USA, all generations born in 1950 or later have maintained a level of car availability that is well above 90%. Moreover, these levels of car availability are almost as high as those for persons who were born 20-30 years later. Consequently, very little growth in the percentage of seniors with cars can be expected in coming years.
- In Japan, those born around 1950 and after have attained car availability levels of only 60%-70%. Preceding generations had very low levels of car availability - or even none at all - to maintain as they aged. Growth in car ownership is thus likely to continue for another 20 to 30 years.

In general today, there are still more vehicles per driver for working-age people than for seniors. This means older drivers share cars with other people in their households more than younger drivers do. The cars-per-driver ratio remains relatively stable with increasing age. So the cars-per-driver ratio that is present in a working-age household will be maintained as the household members age.

One reason for this is that women are catching up with men's levels of car ownership and levels of mobility. In this respect, the USA is ahead of the other countries studied. This factor, combined with the early advent of overall motorisation, explains why car ownership saturation was attained faster in the USA, and why senior mobility levels are greater than in other countries. In Europe, and especially in Japan, the growth in mobility among senior women (and hence among seniors overall) will probably continue into the coming decades, while in the USA it will not.

Prototypical Model of Ageing

This study introduces a prototypical model of mobility while ageing (see Figure O.1) that depicts both *intergenerational* and *intragenerational* effects on mobility. The model begins at around age 60+. When "economic activity ends", which indicates retirement from the workforce, a drop occurs in mobility because trips that relate to work are no longer made. Following this, the subsequent decline in mobility is relatively gradual until such time as a senior experiences a major mobility impairment. After such an impairment occurs, mobility will generally not come to a complete halt, but will continue to gradually decline with age, the rate of decline varying for each individual (i.e. intragenerational changes).

The two lines shown in Figure O.1 illustrate intergenerational differences. While both generational cohorts (i.e. those born in year n and those born in year $n+10$) experience drops in mobility associated with intragenerational effects, younger-age cohorts (i.e. those born in year $n+10$) typically experience higher levels of mobility to begin with. Thus, the end result is generally higher mobility at any given age for cohorts born more recently.

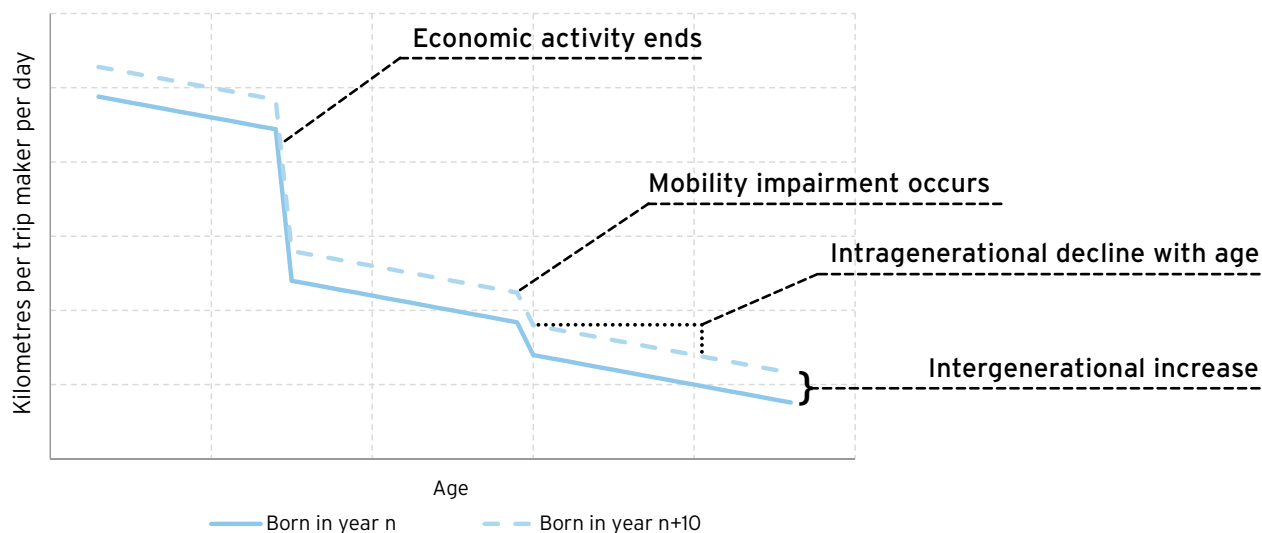


Figure O.1 Prototypical model of mobility while ageing

When quantified for Germany, the model components comprising changes in mobility were:

- **Retirement (-10 km):** on average, seniors who are not employed travel 10 km less per day than those of the same age who are still employed.
- **Mobility Impairment (-2 km):** on average, travellers with mobility impairments report 2 km of daily travel less than those without mobility impairments.
- **Steady Intragenerational Decline (-100 m for each additional year of age):** on average, this steady decline accounts for about 100 m less travelled per day for each additional year of age.
- **Car Availability (+13 km):** seniors with a car available to them are significantly more mobile than those without a car - reporting 13 km more of daily travel.
- **Urban Seniors (-4 km):** after controlling for the above factors, urban seniors report about 4 km less of daily mobility than seniors residing in rural areas.
- **Men (+6 km):** after controlling for all of the above factors, senior men still report about 6 km more of daily mobility than senior women.
- **Intergenerational Increase (+200 m per year):** finally, the intergenerational increase of 200 m of mobility per year's difference in date of birth, under ceteris paribus conditions (i.e. other things being equal), can be established (i.e. the difference in mobility between two travellers of the same age in two consecutive years).

Critical Factors in Senior Mobility Trends

There has been significant growth in kilometres travelled per day by seniors in the study countries:

- (1) a **70%** increase in **England** from 1982 to 2012
- (2) a **40%** increase in **Germany** from 1982 to 2012
- (3) a **40%** increase in the **USA** from 1983 to 2008
- (4) a **30%** increase in **Japan** from 1987 to 2010.

Some of this increase was intragenerational (i.e. individual) change, and some of it was intergenerational. The individual changes in mobility while ageing depend on whether or not seniors are employed, when mobility impairments start to have an effect, the severity of these impairments, and the individual's level of wealth or income. When the prototypical model of ageing was quantified for Germany, it was found that seniors who are not employed travel less per day than those of the same age who are employed. In the USA and the UK, senior workforce participation is on the rise. Both countries have non-compulsory retirement policies and also less substantive pension plans than in Germany, where workforce participation after the age of 65 decreases sharply.

Mobility impairments also are associated with declines in mobility. While our study countries have an increasing life expectancy, extended life does not necessarily equate to extended quality of life. The prevalence of health inhibitors - such as smoking, diabetes, obesity and low levels of exercise - are all continuing or even on the increase. Rising healthcare costs, especially in the USA - which does not have universal health insurance - could make up a greater share of household spending among seniors, contributing to a reduction in discretionary household income and dwindling wealth accumulation.

Much of the intergenerational mobility effects can be explained by car availability. Seniors with a car available to them are significantly more mobile than those without a car. Car availability is high among seniors in all study countries except China.

Projected Travel Behaviour Changes for Seniors in 2015 in Germany and the USA

Three scenarios related to the travel of seniors in 2015 and 2025 were developed for Germany and the USA: a base case scenario, a low-automobility scenario and a high-automobility scenario. Factors such as income, health, economic activity and car ownership were considered in the formation of the high-automobility scenarios, and the low-automobility scenario relied on assumptions about income only. Implementation of the scenarios was performed by developing new weights for each nation's national household travel data.

Population change

Among the notable findings from the comparative scenario analysis that was carried out are that in both Germany and the USA, the senior population is projected to grow between 2015 and 2025, though more so for the USA. However, the 70-79 age group will actually decrease in number between 2015 and 2025 in Germany, which is a result of low birth rates during and soon after the Second World War. In both countries, the growth in senior male population is expected to be slightly higher than for female seniors.

Car ownership

In both countries, an increase in the car stock in use by seniors is projected to occur over the next decade. In the USA, the growth in car ownership on the per capita level is negligible or even negative in the low-automobility scenario. The reason for this is simply that the level of car ownership among American seniors is so high already that saturation has been almost achieved - continued growth appears unlikely. For Germany we can still expect to see substantial growth in car ownership on the per capita level in the coming decade, particularly among senior women.

Kilometres of travel

For both countries, future growth in kilometres of travel is affected by intergenerational increases in mobility. For Germany, the growth in total kilometres travelled is projected to be between 20% and 33%. The proportional growth in car travel is higher than the proportional growth in total travel. This indicates that there will be a mode shift from other modes to the car due to higher car availability among German seniors. For the USA, this growth is projected to be between 27% and 40%. This demand is linked very closely to car travel.

In both study countries and for both scenarios, the growth in senior women's kilometres of travel is higher than for senior men. This is true of both total growth and per capita growth, but the contrast between men and women is stronger when it comes to per capita growth. This may be due to longevity trends among women. Senior German women are projected to experience the strongest growth in mobility on the per capita level among the total senior population in both countries. This is also in line with the projected changes in car ownership by gender.

Chapter One Introduction



1.1 Background

The ageing of the world's population is a megatrend that will shape the global economy and global society for decades to come. Declining fertility together with improved health and longevity have driven a rise in both the numbers and the proportions of the older population in most of the world, encompassing developed and developing countries. Soon people aged 65 and over will outnumber children under the age of five for the first time in history (He, Goodkind et al. 2016). A look at a few major economies provides a brief illustration of the dynamics at play. In 2010, the percentage of people aged 65 and older was 23% in Japan, 21% in Germany, 17% in the United Kingdom (UK), 13% in the United States (USA) and 8% in China. By 2050, the percentages are expected to rise to 37% (+14% on the 2010 figure) in Japan, 33% (+12%) in Germany, 25% (+8%) in the UK, 21% (+8%) in the USA and 24% (+16%) in China. By this same year, older adults are expected to outnumber all children under the age of 14. While the percentages of the senior generation in developing countries may be smaller than in developed ones, the numbers are often large. In terms of absolute size of the 65+ population, China and India are ranked first and second respectively, followed by the USA, Japan, Russia and Germany.

As the percentage of people aged 65 and older continues to grow and the relative proportion of 15- to 64-year-olds shrinks, the effects on the transport sector - in both the supply and the demand sides - will be substantial. In the past, the mobility patterns of persons aged 65 and older were often ignored because this segment travelled less than other age groups, or did not travel at all owing to travel-restrictive impairments. They were truly 'the elderly'. But the senior generation of today is redefining the notion of what it means to be 'old'.

Today, many people in their sixties and seventies may be perceived (and may indeed perceive themselves) as still in their prime years, maintaining an overall activity level not previously associated with those age brackets. Such perceptions may vary by financial resources, overall health, and mobility. Even more important to the objectives of this research is realising that the senior generation of tomorrow will be different even from the seniors of today. For example, today's seniors are generally less active than tomorrow's will probably be. Life spans will continue to lengthen. The seniors of tomorrow will have continued employment, second careers, or volunteer work, which will alter both their economic situations and overall psychological outlook. At the same time, ageing is a physiological process that typically brings increased physical limitations which can be slowed but not stopped. So there are certain inevitabilities that seniors will face as they age.

While there are many factors that act to sustain an ageing individual's mobility patterns, there are also other challenging factors which may hinder mobility. Not all seniors will react in the same way. The senior generation today is a multisegmented group. There is no one homogenous group which we can label 'old'. As society changes, so will travel and mobility patterns, but the type and extent of these changes are uncertain.

1.2 Research Objectives

Given these anticipated - though uncertain - social changes, the objectives of this research are to provide an understanding of how the senior generation travels at present, based on historical trends; what changes might be expected among the seniors of tomorrow; and the factors that will influence those changes. For this study, 'tomorrow' is defined as the year 2025. Analyses are conducted in a cross-national context, with information presented on Germany, the USA, the UK, China and Japan. The primary travel behaviour variables of interest are kilometres of travel and car availability.

The study is organised around three research questions.

How do/did seniors travel today and in the past?

This research describes travel behaviour changes among seniors (defined as persons aged 65+) in Germany, the USA, the UK and Japan over five decades, through analyses of national travel survey data. The analyses examine both intragenerational and intergenerational changes, thus disentangling age-related and cohort-related influences. In addition, behavioural changes under *ceteris paribus* conditions are described. *Ceteris paribus* (Latin for “other things equal”) analysis refers in the context of this study to the situation in which a subgroup of the population (e.g. 80- to 90-year-olds with low income from the rural population) exhibits behavioural change over time that is different from changes induced by an altered socio-economic context, such as a financial crisis. Car ownership and trip-making among seniors in China using recent data from the China Household Finance Survey (CHFS) are also described.

What changes in travel behaviour are projected for seniors in 2025?

It is a challenge to model the impact of changes to mobility behaviour that are induced by external factors which are not yet relevant or do not even exist as yet. Therefore, in order to explore these changes, three scenarios for senior mobility were developed for Germany and the USA: base cases, plus two plausible extreme scenarios with regard to the mobility of seniors. The base case is a 2025 forecast based on 2008 national travel survey data that were calibrated to 2025 demographic information through iterative proportional fitting. Extreme Scenario 1 assumes a widening income gap (so this is the low-automobility scenario). Extreme Scenario 2 assumes growing wealth and sustained health leading to an active, car-oriented lifestyle (making this the high-automobility scenario).

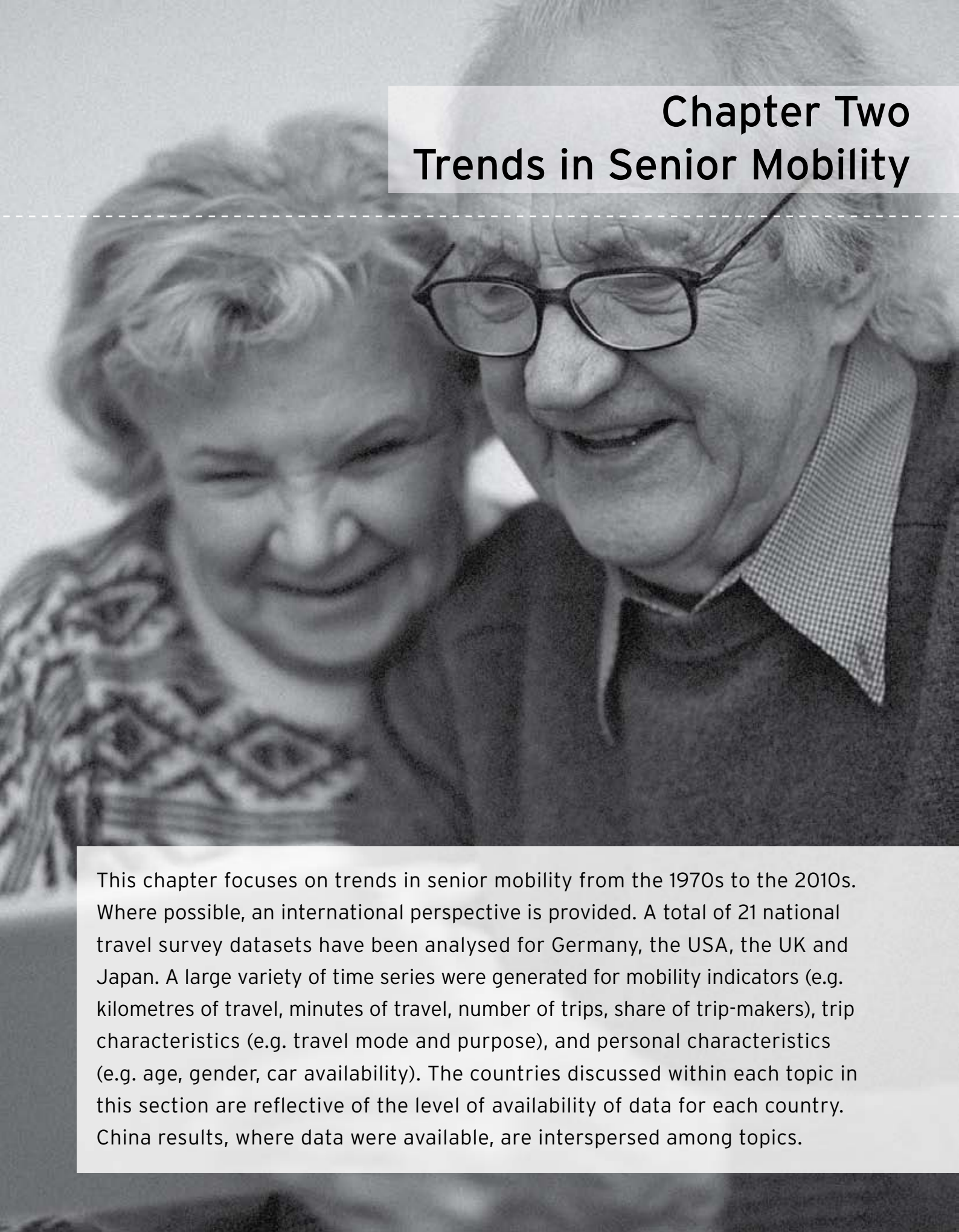
What are the drivers of change in travel behaviour for the future senior generation?

Four countries provide the geographic scope for this analysis: Germany, the USA, the UK and China. Investigating the differences between these countries helps to tease out important cross-national similarities and distinctions in the ageing process in relation to driving. A review of relevant literature identifies key points of influence and describes factors that may be critical in the changing mobility patterns of people aged 65 and over. Issues investigated included:

- population change;
- pensions, wealth and workforce participation;
- life expectancy and health;
- living arrangements and social connections; and
- transport options and use of technology.

1.3 Organisation of the Report

In addition to this introduction, this report contains four chapters. Chapter Two presents trends in senior mobility for Germany, the USA, the UK and Japan. Some recent information is provided for China. Chapter Three reviews factors influencing the ageing process in Germany, the USA, the UK and China, and discusses the impact on mobility. Chapter Four introduces the scenarios and presents the 2025 forecasts for Germany and the USA. Chapter Five provides our conclusions.



Chapter Two Trends in Senior Mobility

This chapter focuses on trends in senior mobility from the 1970s to the 2010s. Where possible, an international perspective is provided. A total of 21 national travel survey datasets have been analysed for Germany, the USA, the UK and Japan. A large variety of time series were generated for mobility indicators (e.g. kilometres of travel, minutes of travel, number of trips, share of trip-makers), trip characteristics (e.g. travel mode and purpose), and personal characteristics (e.g. age, gender, car availability). The countries discussed within each topic in this section are reflective of the level of availability of data for each country. China results, where data were available, are interspersed among topics.

2.1 National Mobility Trends

Figure 2.1 shows the kilometres travelled per trip-maker per day by age in Germany at four points in time since the 1970s. Note that the amount of travel increases sharply when entering adulthood, and remains relatively high throughout the active mid-life period. A visible decline can be seen with age, though that decline has, since the 1970s, tended to push later into life. While the growth in total travel has slowed for younger age groups since the 1990s, it has continued until the most recent datapoint for seniors (and for those in their forties and fifties). Today, Germans in their fifties are nearly as mobile as those in their twenties, whereas in the 1970s, twenty-something Germans travelled 40% more than fifty-somethings. By and large, the shape of the travel demand across the age groups, and its development over time, is similar in the other study countries.

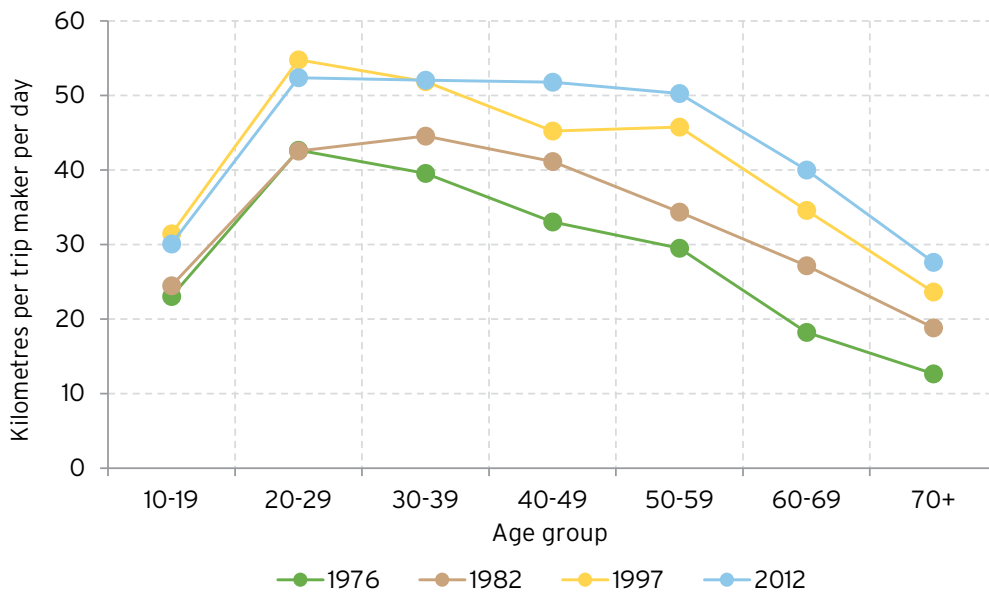


Figure 2.1 Kilometres travelled per trip maker per day by age in Germany based on national travel survey data for 1976, 1982, 1997 and 2012

Using data from Germany, the USA, the UK (or more precisely, England) and Japan, Figure 2.2 shows the national trends over recent decades for number of trips made per day by seniors, Figure 2.3 illustrates trends in minutes of travel per day for seniors, and Figure 2.4 provides trends for kilometres travelled per day by seniors.

While the number of trips made and the minutes of travel per day for seniors have not grown much in recent decades (with the exception of the USA), the distance travelled per day has increased more strongly. This shows that trips have become longer and that seniors travel at higher speeds today than only a few decades ago. While not investing that much more time in travel, seniors have a much larger activity radius today than only a few decades ago. Again, the USA is the exception, with senior travel speeds having actually decreased slightly.

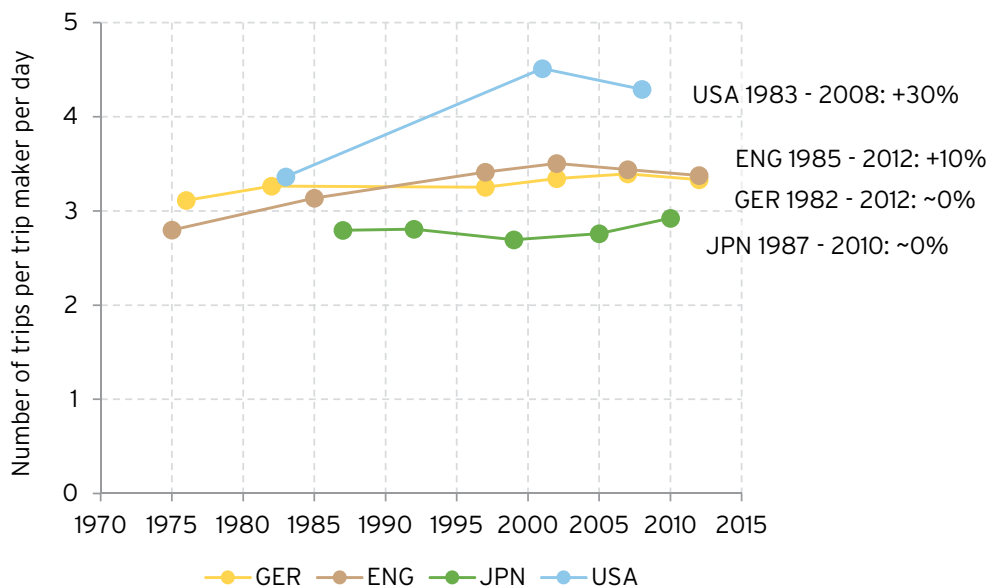


Figure 2.2 National trends in number of trips made per day by seniors (60+) based on national travel survey data (see legend in graph for years)

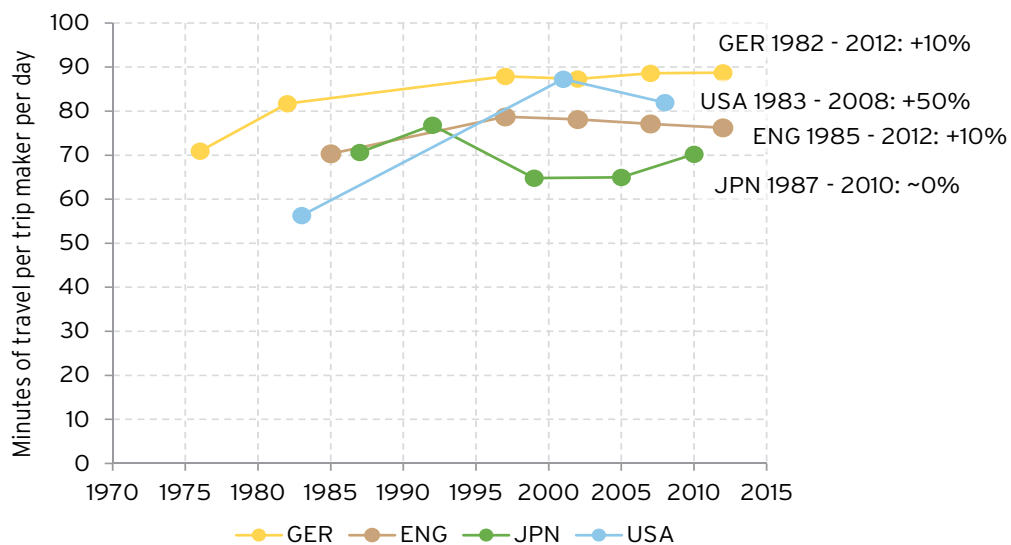


Figure 2.3 National trends in minutes of travel per day for seniors (60+) based on national travel survey data (see legend in graph for years)

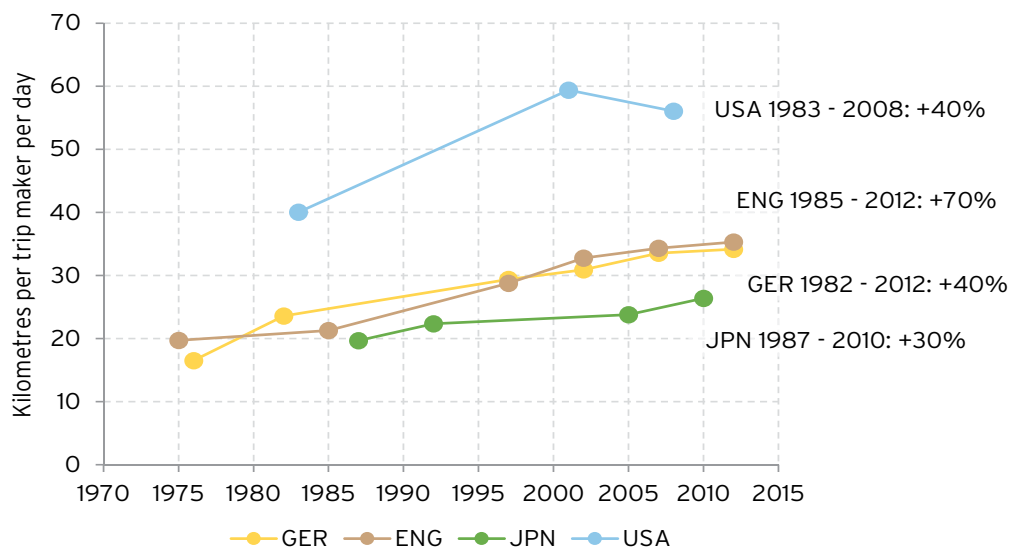


Figure 2.4 National trends in kilometres travelled per day by seniors (60+) based on national travel survey data (see legend in graph for years)

2.2 Dimensions of Mobility and Ageing

The results presented in the previous section indicate that the mobility of seniors is changing. However, this change in senior mobility has two dimensions:

- **Intragenerational (or individual) change:** as each person gets older there will be changes in their individual behaviour. On average, mobility declines as age advances for seniors.
- **Intergenerational change:** the seniors of today are different from the seniors of the past. On average, seniors are more mobile today than they were in the past.

This section is dedicated to decomposing the observed changes in senior mobility into intragenerational and intergenerational components. Moreover, this section takes a closer look at the relevant stages of the intragenerational changes and identifies factors driving the intergenerational change.

Prototypical model of mobility while ageing

To conceptually illustrate the stages of change in senior mobility, we introduce a prototypical model of mobility while ageing (see Figure 2.5). The model begins at around age 60+. The first dramatic drop is labelled “economic activity ends”, which indicates retirement from the workforce. This drop may be sudden or gradual, depending on whether seniors completely leave the workforce or first transition into a period of part-time employment. The drop is due to the notable number of trips that relate to work that are no longer made (i.e. travelling to/from work, travelling for business, travelling to buy lunch in the middle of the working day, etc.).

Following the steep drop associated with retirement, the subsequent decline in mobility is relatively gradual until such time as a senior experiences a major mobility impairment. Examples include breaking a hip, deterioration in eyesight and becoming unsteady on one’s feet. After such an impairment occurs, mobility will generally not come to a complete halt, but will continue to gradually decline with age, the rate of decline varying for each individual. Intragenerational decline is specific to individuals.

The two lines shown in Figure 2.5 illustrate intergenerational differences. While both generational cohorts (i.e. those born in year n and those born in year $n+10$) experience drops in mobility associated with the end of economic activity and mobility impairments, younger-age cohorts (i.e. those born in year $n+10$) typically experience higher levels of mobility to begin with. Thus, the end result is general higher mobility at any given age for cohorts born more recently.

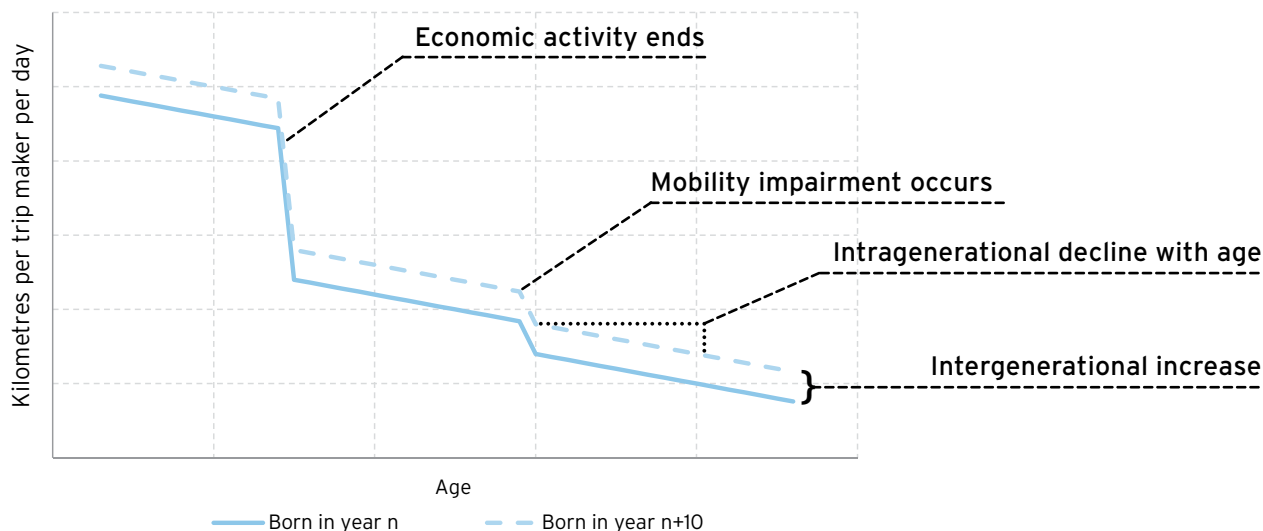


Figure 2.5 Prototypical model of mobility while ageing

Prototypical model of mobility while ageing quantified for Germany

The previous discussion is qualitative in nature, to help illustrate the logic of the conceptual model. In this section, the prototypical model has been quantified for Germany. In principle, the findings presented are qualitatively generalisable to other countries.

Figure 2.1 indicated a sharp linear age-related decline in mobility for German seniors. Mobility declines at a rate of about one kilometre per person per day for each additional year of age. In other words, those who are ten years older have approximately 10 km less of daily mobility. This statistic has been deduced from cross-sectional data from different years of observation (1976, 1982, 1997 and 2012). Hence in Figure 2.1, the intergenerational increase in kilometres travelled that can be observed during recent decades is superimposed on the intragenerational decline of mobility with increasing age. As an example, consider the 2012 results: people 75 years old in 2012 were not only ten years older than people aged 65 in 2012, they were also born ten years earlier. Thus, 2012's 75-year-olds belong to an older generation cohort that, on average, was less mobile throughout their lifespan. Approximately half of any individual senior's mobility decline can be attributed to intragenerational effects (i.e. a decline of about 500 m per person per day for each additional year of age). A large part of this decline is associated with retirement and mobility impairments. The other half is intergenerational decline - this is due to the fact that, being older, they were born longer ago and thus belong to an earlier cohort whose mobility, at any and every age, is less than that of more recent generations.

Looking at the intra- and intergenerational changes in senior mobility in Germany, the following summary presents, and quantifies, the most important socioeconomic factors, different stages of ageing, and relevant drivers that shape them:

- **Retirement (–10 km):** on average, seniors who are not employed travel 10 km less per day than those of the same age who are still employed. It can thus be seen that the average age of retirement has an impact on the aggregate mobility of seniors. In Germany, the average age of retirement had decreased slightly until the mid-2000s (see Chapter Three).
- **Mobility Impairment (–2 km):** with advancing age, the proportion of travellers who report mobility impairments increases. On average, travellers with mobility impairments report 2 km of daily travel less than those without mobility impairments. The average age at which mobility impairments occur differs by individual, with some experiencing health improvements in recent decades and others not.
- **Steady Intragenerational Decline (–100 m for each additional year of age):** after accounting for retirement and reported mobility impairments, there is still a steady decline of mobility that seniors experience as they age. On average, this steady decline accounts for about 100 m less travelled per day for each additional year of age. This decline stems from gradual small changes in lifestyle or incremental increases in health issues associated with ageing.
- **Urban Seniors (–4 km):** after controlling for the above factors, urban seniors report about 4 km less of daily mobility than seniors residing in rural areas. However, the shift from urban to rural population among seniors was not large enough in recent decades to significantly influence aggregate travel indicators, meaning that this change cannot be counted as part of the intergenerational increase in mobility.
- **Men (+6 km):** after controlling for all of the above factors, senior men still report about 6 km more of daily mobility than senior women. This difference in mobility trends for senior men and senior women will be described in more detail, and from a cross-national perspective, immediately below.
- **Car Availability (+13 km):** seniors with a car available to them are significantly more mobile than those without a car – reporting 13 km more of daily travel. Here, car availability is defined as a person who has a driving licence and lives in a car-owning¹ household. Car ownership among seniors has increased substantially in Germany in recent decades and continues to do so. This increasing car ownership accounts for about half of the intergenerational increase in mobility among seniors. The growth in senior car ownership is depicted in more detail, and with a cross-national perspective, in the next section of this chapter.

¹ Within this section, “car ownership” refers to the number of cars per 1,000 population or the fact that a household has a car. On the other hand, “car availability” refers to the combination of both licence-holding and car ownership within the household.

- **Intergenerational Increase (+200 m per year):** finally, the intergenerational increase in mobility per year's difference in date of birth, under *ceteris paribus* conditions, can be established (i.e. the difference in mobility between two travellers of the same age in two consecutive years). For example, a 70-year-old in 2001 (born in 1931) with all the factors listed above being equal travels, on average, 200 m less per day than a person born one year later. For the present study's timeframe - the 1970s to the 2010s - no indication of saturation of this intergenerational growth for Germany was found. Therefore, it is likely that this growth in senior travel is still continuing.

2.3 National Car Ownership Trends

In all of the countries considered in this study except China, car ownership among seniors has in recent decades increased more rapidly than among younger and middle-aged adults, and continues to do so. In China, car ownership is highest among those in their thirties and forties. For China, age is a predictor of car ownership in models used in CHFS data for 2011 and 2013. Car ownership was highest among those in their thirties, forties and twenties, in that order. This pattern is also represented in regional travel survey data. The 2014 Nanjing dataset indicates that car ownership is higher for men than for females, and quite low among seniors. These data indicate that 16% of males aged 60+ and only 1% of females of that age reported owning a car. On the one hand, 77% of men aged 40-49 and 36% of women aged 40-49 reported owning a car. On the other hand, trip rates among seniors are higher than those for persons in their forties, indicating quite a few non-car trips. The trends in Germany are noticeably different. Figure 2.6. shows the number of cars on register per population by age group in Germany. Car ownership among those above the age of 65 has tripled since the mid-1980s - a stronger increase than that seen in any other age group.

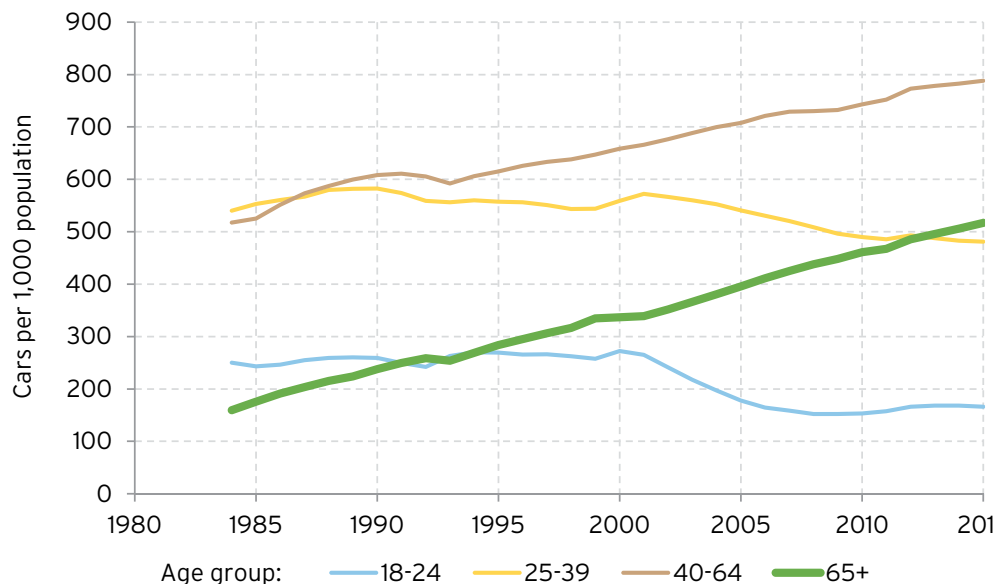


Figure 2.6 Car ownership (private registrations) per population by age in Germany since 1982.

SOURCE: Kraftfahrt-Bundesamt 2016.

Car availability trends across generations

Car availability is defined as the coincidence of having a driving licence on the personal level and car ownership on the household level. Figure 2.7 and Figure 2.8 illustrate intergenerational changes with regard to car availability in the USA and Japan, which represent extremes among large industrialised countries in the development of car ownership. Germany and England (and other European countries, and other industrialised countries) lie somewhat in between these two extremes (Ecola, Rohr et al. 2014).

In the USA, the rapid growth in car ownership began earlier in the twentieth century than in any other country, and has now risen to a very high level (see Figure 2.7). All generations born in 1950 or later attained a level of car availability well above 90% once they had passed through their twenties. After this, they maintained this very high level of car ownership. Even generations born 20-30 years earlier than 1950 attained a level of car availability of 80% and higher by the end of their working life, and maintained this level until they reached the age of around 75. Because levels of car availability for seniors in the USA are almost as high as those for people 20-30 years younger, not much future growth in the percentage of seniors with cars can be expected.

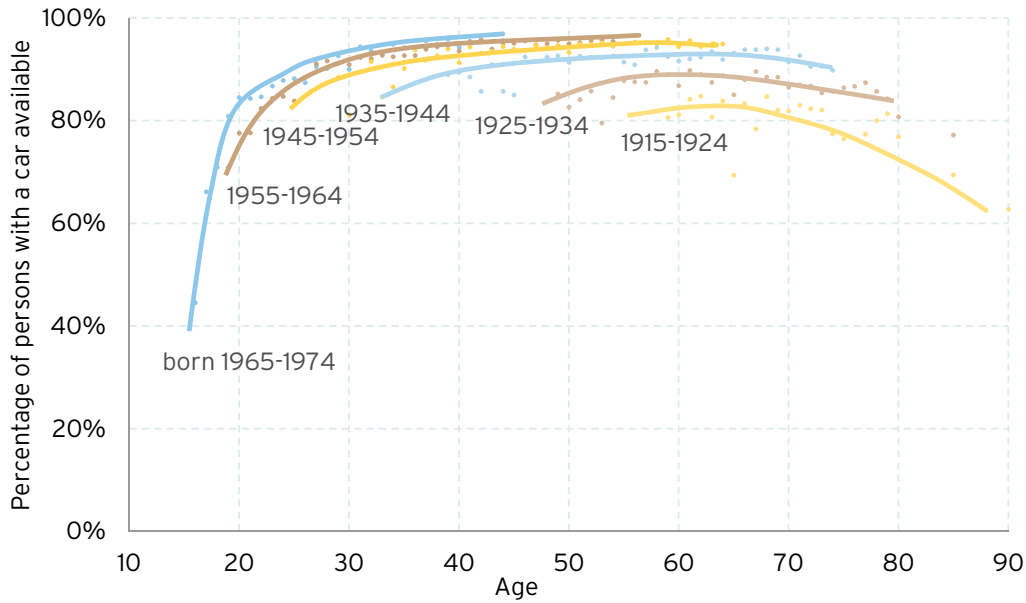


Figure 2.7 Percentage of persons with car availability by age and year of birth - USA
(based on national travel survey data)

In Japan, those born around the year 1950 reached a saturation level of car availability, and later generations have not substantially exceeded this level (see Figure 2.8). This level (about 60%-70%) is much lower than the 90% attained in the USA. Moreover, the difference in Japan between those born around 1950 and preceding generations is much greater. Consequently, growth in car ownership among seniors in Japan is likely to continue for another 20 to 30 years, even though Japan is not expected to come close to reaching the level of car ownership of American seniors.

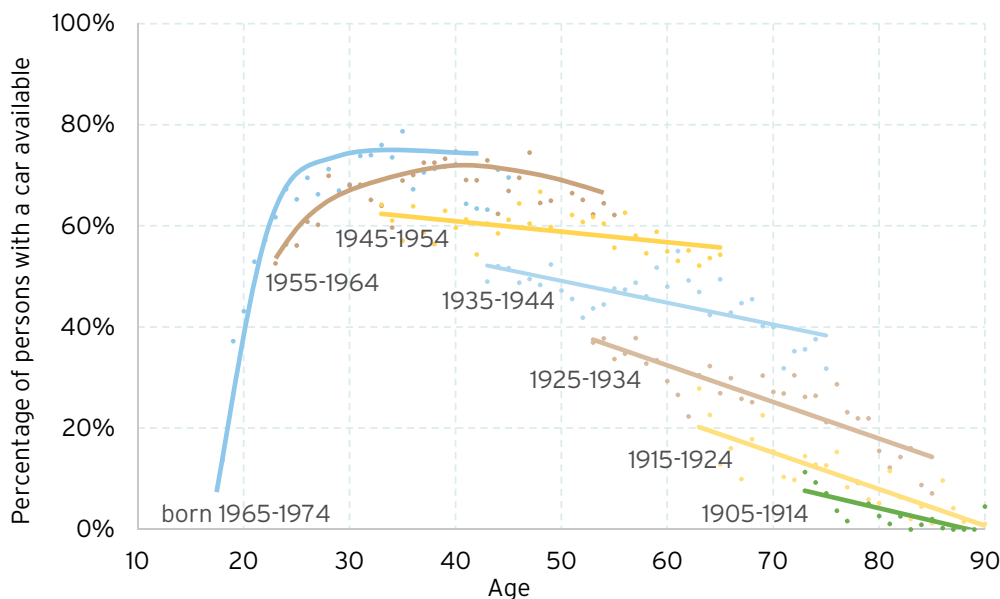


Figure 2.8 Percentage of persons with car availability by age and year of birth - Japan
(based on national travel survey data)

Stability of car ownership habits when ageing

Figure 2.9 shows the level of car availability for the cohort born from 1930-1939 for three study countries (Germany, England, and the USA) at two different stages of ageing, disaggregated by gender. For every country and each gender, the left bar shows the level of car availability roughly towards the end of a typical working life (in their late fifties / early sixties), while the right bar shows car availability at a later state of ageing (in their seventies) - about 15 years later. Seniors in the USA have the highest proportions of car availability, with women in the USA being almost on a par with men in Germany. Own-car (as opposed to shared-car) availability is extremely high in the USA. In Germany, while car availability is also high, a substantial proportion of it is by means of vehicles shared with other drivers in the household. In Germany and the USA, a small proportion of this generation gave up car availability, and presumably driving also, during the later stage of ageing. In England, car availability for those in later life was lower, but proved to be more stable as those with access to cars age.

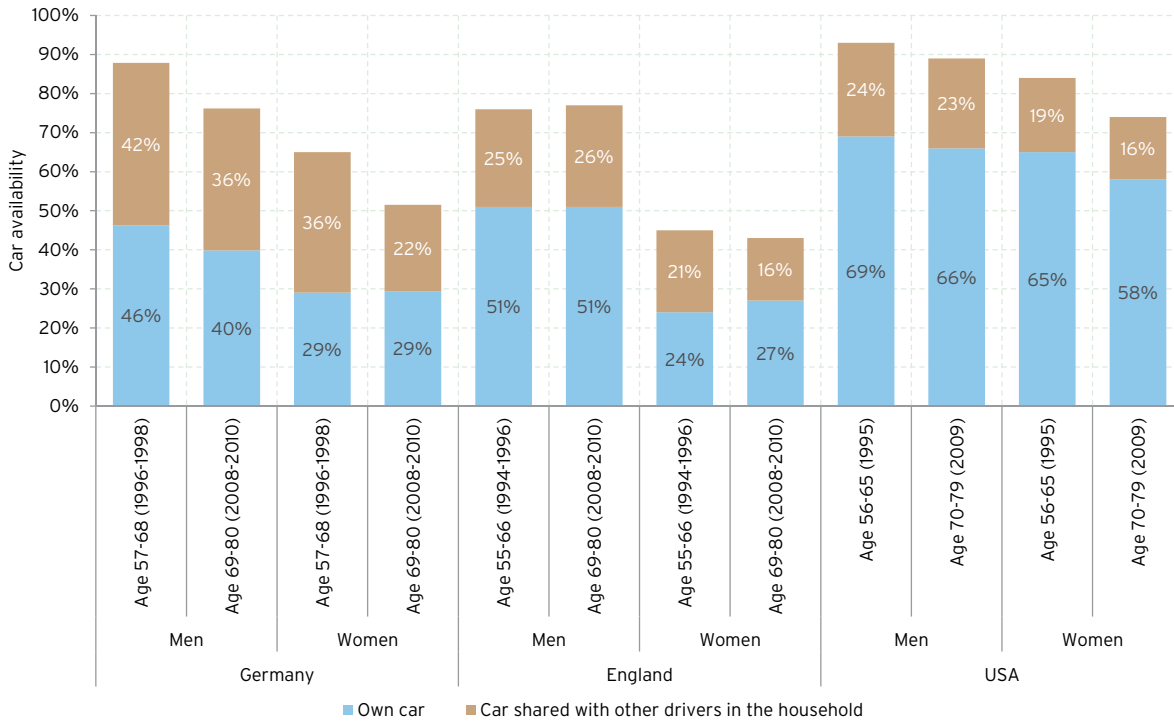


Figure 2.9 Car availability of the cohort born from 1930-1939 at different stages of ageing (based on national travel survey data)

Being able to use a car as a driver has substantial positive impacts on individual levels of mobility, not to mention psychological benefits, even if household members share the same vehicle. However, when it comes to trip-making, it makes a difference whether or not drivers share household vehicles. This also matters with respect to the total number of vehicles on the road for the vehicle market. For this reason, Figure 2.9 distinguishes between the two types of car availability (drivers having their own vehicle, drivers sharing a vehicle(s) with other drivers in the household) and gives the levels separately.

Today, there are still more vehicles per driver for working-age people than for seniors. This means that older drivers share cars with other people in their households more than younger drivers do. Moreover, German households with drivers between the ages of 40 and 60 show a trend towards owning second and third cars. This means that a growing proportion of drivers in these middle-aged households have their own car, and have no need to share it with other drivers in the household.

Against this backdrop, it is important to question whether drivers will maintain their car ownership habits as they age. Will multiple-car, working-age households maintain a car for each driver as they get older? Or will they reduce total car ownership by sharing cars among household members, once the need for multiple cars has decreased?

Figure 2.9 shows that among Germans with car availability, the share of those with their own (i.e. not shared) vehicle remained relatively stable for the generation studied here, and for German women the proportion actually increased substantially. At the ages of 57-68 (shown in the left bars), three quarters of German women born from 1930-1939 lived in a multi-person household. Fifteen years later, a majority of them (55%) lived in a single-person household. It is likely that in the majority of these cases the husband died. If a couple shared a car before, it has now become the sole car of the only driver in the household - the wife. Therefore, while it is likely that some households reduce the number of cars they own as they age, is also likely that increasing levels of singleness due to the death of a spouse counterbalances this phenomenon. Consequently, the cars-per-driver ratio is relatively stable with increasing age.

Overall, women are catching up with men's levels of car ownership and with their levels of mobility. In this respect, the USA is ahead of the other countries studied. This factor, when combined with the early advent of overall motorisation, explains much of why car ownership saturation was attained faster, and why senior mobility levels are greater in the USA than in other countries. In Europe, and especially in Japan, the growth in mobility among senior women (and hence among seniors overall) will probably continue into the coming decades, while in the USA it will not. In Chapter Four, we present results of models to test this prediction.

2.4 Summary

This chapter contains an overview of trends in senior mobility. The findings from the USA appear to be the most unique, with differences in historical mobility trends closely linked with intense motorisation that characterises the country. Japan is at the other extreme, with European countries in the middle. Both intra- and intergenerational effects influence mobility and the broader ageing process. A prototypical model of mobility and ageing illustrates both of these effects (intra- and intergenerational), but also the impact of economic activity ending and mobility impairment occurring. This model was quantified for Germany - demonstrating the relative contribution of these various factors on declining mobility. Levels of car ownership and the role of gender were reviewed at a cross-national level. The next chapter will move from discussing historical trends, to focusing on present trends in senior mobility in the countries of interest.



Chapter Three Critical Issues in Ageing and Mobility

This chapter provides findings from a review of literature on key issues for seniors in Germany, the USA, the UK and China and their implications for mobility. Some of the literature revealed striking similarities among the different countries, but notable contrasts stemming from differences in policy and culture were also seen. Portions of the review are cited here to provide a high-level overview of critical information. The subheadings contained within this chapter consist of key takeaway statements with potential links to senior mobility. They are followed by discussion of potential implications for future travel behaviour among seniors, along with supporting details for each country.



Population change

Pensions, wealth and
workforce participation



Life expectancy
and health



Living arrangements and
social connections



Transportation options
and technology use



3.1 Population Change

Germany, the USA, the UK and China will experience an increase in the total number and proportion of seniors between now and 2025.

All four countries (Germany, the USA, the UK and China) anticipate growth in the proportion of the population who are seniors in the coming decade. This trend supports the need to understand the travel patterns and mobility needs of this segment of the population.

- Within the European Union, Germany can be considered an 'old people's home' (FAZ.NET 2012). In 2011, 21% of the German population consisted of seniors and by 2025 the percentage is forecast to be 25% (BBRS n.d.-a, BBRS n.d.-b). This forecast is based on the assumptions of a constant low birth rate, a slightly increasing life expectancy, and ongoing positive net migration (BBRS n.d.-c).
- The USA expects a rise in the proportion of seniors, with 15% of the population consisting of seniors in 2016, and 19% by 2025 (United Nations 2016). Immigration is expected to play an important role in how the age structure changes over the next four decades. The ageing of the baby boomers increases the proportion in the older age groups, but projected immigration into the working-age groups tends to mitigate the impact of this. In other words, US ageing is slowed somewhat by immigration of younger people.
- Lengthening life expectancy and sub-replacement fertility have combined to yield a rapidly ageing British population, though this effect has been mitigated since the 1990s by high rates of immigration (primarily of working-age individuals) from abroad. In 2016, seniors comprised 18% of the UK population. This percentage is expected to rise to 20% by 2025 (The World Bank 2016).
- In China, only 10% of the population consisted of seniors in 2016. However, this is expected to increase to 14% by 2025 (The World Bank 2016).

In the coming decades, a higher proportion of seniors are expected to be immigrants/foreign-born in Germany, the USA and the UK than is seen in current senior populations. China is more nationally homogenous, with a much lower proportion of foreign-born persons than the Western countries.

Particularly in Germany, the USA and the UK, in the coming years, the population of seniors will be heavier in minorities/immigrants. Differences in the transport experiences that these newcomers bring with them may have an impact on travel patterns (e.g. by introducing more reliance on family members, a change in levels of reliance on public transport, and aspirations for car ownership).

- The current senior population of immigrants in Germany is characterised by several waves of immigration (Munz and Ulrich 2000): forced migration following the Second World War until the 1950s (mainly ethnic Germans), immigration of migrant workers starting in the 1960s and early 1970s (mainly from Turkey, Yugoslavia, Italy and Greece), immigration of refugees and asylum seekers in the late 1980s and early 1990s, late repatriates (ethnic Germans chiefly from the former Soviet Union during the 1990s) and the current wave of Syrian and other refugees from the Middle East. In 2015, 21% of the German residential population had a migration background, while only 10% of seniors over 65 were immigrants (DESTATIS n.d.-a).
- According to the American Community Survey (ACS), as of 2014, 13% of Americans aged 65+ are foreign-born (kidsdata.org). By 2060, this is expected to increase to 32% (Colby and Ortman March 2015). The proportion of the population aged 65 and older is expected to increase within both the native and foreign-born populations; however, the percentage increase is projected to be much larger for the latter.
- Britain has an increasingly diverse population, particularly amongst younger cohorts. Among older generations, 7% of people aged 55-64 are from ethnic minorities, compared to just 2% of people aged 85 and older.² There is greater ethnic diversity of the senior generation within London, a diversity which is also reflected amongst younger-age cohorts (Office for National Statistics n.d.-a).
- China has proportionally fewer immigrants relative to Western societies, with approximately 0.05% of the population born abroad as of 2010 (National Bureau of Statistics of China 2011). There is some evidence of distinctive patterns of immigration of marriage-aged females to Chinese provinces which have particularly skewed male/female ratios. Though the number of immigrants is small, specific neighbourhoods in Chinese cities are known for their concentration of foreigners of various backgrounds (Lu, Jia et al. 12 May 2012). Some knowledgeable observers (e.g. the Brookings Institution) expect an increase in immigration to China in the coming years (Lu, Jia et al. 12 May 2012).

² These statistics are for England and Wales only, rather than the UK as a whole.

3.2 Pensions, Wealth and Workforce Participation

Pension plans and workforce participation have direct ties to retirement planning, which in turn has an impact on travel patterns in the form of number and type of trips made, and levels of discretionary income available for travel. Germany, the USA, the UK and China all have some form of a state pension plan available to at least a portion of the senior population; however, pension requirements vary by country.

The state pension plans in each country are subject to policy changes. As seniors become a growing proportion of the population, pensions may be subject to reduced payments and/or to older minimum-age requirements for receiving the benefits, to ensure the long-term viability of the pension plans. This may in turn have an impact on retirement practices.

- In Germany in 2009, 96% of men aged 65+ and 84% of women aged 65+ cited a pension/annuity as their main source of livelihood (DESTATIS n.d.-a). Of senior German women, 13% cite income from relatives (mainly that of their spouse or partner) as their main source of livelihood, while this is the case for only 0.2 % of their male counterparts (DESTATIS n.d.-a).
- Depending on birth year, Americans can begin receiving full social security payments between the ages of 65 and 67. Reduced payments can be received from the age of 62. Personal savings and employer pensions are other common forms of retirement income (Broadridge Investor Communication Solutions 1 January 2014).
- In the UK, the central government's state pension pays a maximum of £6,200 per annum as of 2016 (BBC News 20 November 2015), with the age at which this can be claimed being slowly raised (gov.uk n.d.). For people born before 1950, this 'state pension age' is 65 for men and 60 for women, though retirement at this age is not compulsory. In addition to the state pension, three quarters of British households (of all ages) have some form of current or expected private pension provision (either through current employment, retained, or being paid out) (Crawford, Innes et al. 2015). There has also been a trend in the UK away from defined-benefit pension plans in favour of defined-contribution plans, with individuals bearing greater financial risks in the latter case (and employers bearing greater risks in the former case).
- In China, the urban and rural resident pension system (or national social security system) was started in 2014. The pension system has two components: a basic pension component financed by local and central governments, and a personal account component based on contributions from enrolled individuals (Social Security Office of Retirement and Disability Policy 2014).

The USA and the UK are seeing increased workforce participation by those aged 65+, while Germany and China have relatively low senior workforce participation levels, which is associated with their retirement policies.

Senior workforce participation levels vary among the countries of interest. This is relevant to the present study, because workforce participation levels may be closely related to mobility patterns. A rising retirement age may mean a longer period of time during which more home-based work trips are made. Seniors in all four countries will continue to have mobility needs even after retirement. However, seniors' mobility needs and options will change as they age. Retirement, and mobility impairments, may contribute to changes in both the need and the capability for mobility, which in turn lead to dips in levels of travel (see previous discussion in Chapter Two).

- In Germany, workforce participation after the age of 65 decreases sharply, and of those who do work, most do not work full-time (DESTATIS n.d.-a). This is a reflection of policies that do not make it very financially worthwhile to work once receiving a pension.
- Senior workforce participation is on the rise in the USA and the UK. Both of these countries have non-compulsory retirement policies which allow for continued workforce participation as people age. The reason for continued workforce participation of seniors in these countries may be a mix of financial, personal and social factors. Increasing life expectancies may make some people feel more financial pressure because of the potential need to fund more retirement years. Others may enjoy their work and want to continue this aspect of their lives while they are able to. Some may choose to transition to part-time work prior to retiring altogether (Broadridge Investor Communication Solutions 1 January 2014). The most common type of occupation for seniors in the USA is 'Management, professional, and related occupations' (Bureau of Labor Statistics-United States Department of Labor). While 14% of senior British jobs fall into the category of 'Managers / directors / senior officials' (compared to just 11% of jobs held by all workers aged 16+), 'Professional occupations' represent the highest proportion (15%) of jobs held by seniors³ (Office of National Statistics n.d.-b).
- In China, retirement age is more strictly enforced, and is younger than in Western countries. Women in management positions are required to retire at the age of 55, and women in non-management positions are required to retire at the age of 50. Men are required to retire at 60. Persons working in high-risk jobs and those who are disabled can retire earlier (The Central People's Government of China 1979).

³ These reported statistics for British jobs are only reflective of seniors from England and Wales only.

3.3 Life Expectancy and Health

All four countries of interest have an increasing life expectancy - with women living longer than men.

As noted earlier, increasing life expectancy is a contributory factor to anticipated growth in the proportion of the population who are seniors. In all four countries of interest, women have a higher life expectancy than men; however, life expectancy is increasing for both genders, and the gender gap in this statistic is decreasing. Increasing life expectancy may point to better health for a longer period of time and subsequent prolonged mobility; or it could simply mean more senior years, but with limited mobility. The desire for prolonged mobility into the reaches of older age may point to the need for innovation in providing options that allow for seniors' transport needs to be safely met.

- The average life expectancy in Germany is projected to increase at least until 2060 (DESTATIS 2015a). The differences in life expectancy between men and women are expected to continue. In 2010 the actual life expectancy in Germany was 82.8 years for women and 77.7 years for men, and by 2060 these numbers are forecasted to increase to 88.8 years and 84.8 years respectively (DESTATIS 2015a).
- In the USA, life expectancy in 2016 was 82.3 years for women and 76.3 years for men. By 2025, life expectancy was expected to increase to 83.7 years for women and 77.6 years for men, and by 2035 to 84.8 years for women and 79.1 years for men (Data 360 n.d.).
- As of 2012 a 65-year-old British woman could expect to live an average of 20.9 additional years (until the age of 86), while a man of the same age had an expected additional lifespan of 18.4 years (until the age of 83). The UK gender gap in life expectancy at the age of 65 has been decreasing over time (Office for National Statistics 24 September 2015).
- In 2015, Chinese life expectancy at birth was 77.5 years for women and 74.5 years for men, and by 2025 is expected to increase to 79.6 years for women and 76.7 years for men. By 2035, life expectancy is expected to be 81.3 years for women and 78.8 years for men (The World Bank 2016).

Smoking, diabetes, obesity and low levels of exercise among seniors (and probably also in the years leading up to senior years) are related to many of the health issues related to the leading causes of death in the four countries of interest.

Many of the health issues prevalent in all four countries of interest - such as heart disease, lung cancer and stroke -are linked to smoking, diabetes, obesity and low levels of exercise. Continuing, and in several cases increasing, prevalence of these health inhibitors among seniors may contribute to their poorer health, and a subsequent decrease in senior mobility in the future. Living longer is almost certain to lead to making more trips and/or travelling more, given increased lifespans. However, extended life does not necessarily equate to extended quality of life. Therefore, although people will live longer, their mobility is likely to be affected by poor health and/or disabilities associated with mobility impairments (see previous discussion in Chapter One).

- **Smoking:** as of 2008, 17% of Germans aged 55-69 were smokers while only 7% of Germans aged 70-85 were smokers. The proportion of persons who have never smoked was higher for the older age category, with 49% of those aged 55-69 having never smoked and 65% of those aged 70-85 having never smoked (Mokl_Klingebl, Wurm et al. 2010). As of 2014, 9% of Americans aged 65+ smoked (Jamal, Homa et al. 13 November 2015). As of 2014, 11% of British people aged 60+ smoked, with similar rates for men and women (Office of National Statistics 18 February 2016). In China, smoking is much more prevalent among males than females. Smokers accounted for only 7% of women aged 65+ compared to 40% of men in the same age group (and 23% of all over-65s) in 2014 (World Health Organization 2014-a).
- **Diabetes:** in Germany, the prevalence of diabetes increases with age. As of 2008, approximately 11% of persons aged 55-69 and 19% of persons aged 70+ were diabetic (Mokl_Klingebl, Wurm et al. 2010). The diabetes rate among Americans aged 65-74 was 22% in 2014 - up from 10% in 1994. Similar trends were seen in Americans aged 75+, among whom 19% had diabetes in 2014 and 10% had diabetes in 1994 (Center for Disease Control and Prevention (CDC) n.d.-a). As of 2012, 10% of UK residents aged 55-64 had diabetes, with corresponding rates of 13% for persons ages 65-74 and 15% for those aged 75+ (National Health Service (NHS) 2014). As of 2010, 22.5% of Chinese aged 60-69 had diabetes, and 24% of those aged 70+ (Xu, Wang et al. 2013).
- **Obesity:** for people aged 65+, a body mass index (the individual's weight in kilograms divided by the square of their height in metres) of 24 to 29 is recommended. In Germany, in 2009, about one out of five men and a similar proportion of women aged 65-75 exceeded this recommendation, while for seniors ages 75+, only about one out of six did so. Gender differences hardly exist, but there are differences dependent on level of education. Among less-educated persons aged 65+, 26% are obese, compared to only 14% of their more highly educated contemporaries (BZgA 2013). The obesity rate among Americans aged 65+ varied by state in 2014, ranging from a low of 21% in Colorado to a high of 33% in Ohio (Trust for America's Health and the Robert Wood Johnson Foundation n.d.). In the UK, as of 2014, 34% of those aged 55-64 were obese, while only 20% of those aged 85+ were obese⁴ (Scantlebury and Moody 16 December 2015). Information on obesity rates of Chinese seniors was not obtained, though the overall rate of obesity for all adults aged 18+ is 7% (World Health Organization 2014-b), which seems to be much lower than obesity rates in the Western countries of interest.

⁴ This statistic is only for England only, not the UK as a whole.

- Low levels of exercise: seniors are among the least likely to meet physical activity recommendations. While in 2008, 33% of Germans aged 55-69 reported undertaking physical activity several times a week, only 21% of Germans aged 70-85 reported the same statistic. Additionally, 47% of Germans aged 55-69 reported physical activity 'less frequent than once a week / never' and 63% of Germans aged 70-85 reported this low level of physical activity (Mokl_Klingebiel, Wurm et al. 2010). Most senior Americans are not meeting recommended physical activity guidelines set by CDC (CDC n.d.-b). In 2012, only 17% of American males aged 65-74 met the guidelines, while only 13% of American females in the same age group did so. The percentages are even lower for those aged 75+, with 10% and 6% of males and females respectively meeting the guidelines (vocativ n.d.). In 2012, only 18% of British males and 19% of British females aged 55-64 met physical activity recommendations. This statistic drops to 10% of British males and 2% of British females aged 75-84⁵ (Scholes and Mindell 16 December 2015). For China, in 2014, 18% of people aged 60-69 and 11% of people aged 70+ reported regularly exercising (3+ times a week, 30+ minutes each time, at medium or higher intensity) (Li 2016).

Health insurance of the senior population varies by type and source across the countries of interest.

The level of access to and cost of health insurance will have a direct connection to levels of health and the duration of better health, which in turn will have an impact on senior mobility patterns. The level of access to health insurance may contribute towards better maintenance of overall health among seniors, and affect when a drop in mobility (as discussed in Chapter One) due to poor health or illness occurs. Each of the four countries have their own form of health insurance options available to seniors, with varying levels of public or private options.

- In Germany nearly everyone (as of 2007, all but 0.2% of the total population and all but 0.1% of those aged 65+) has health insurance (DESTATIS 2011). As of 2007, 92% of German seniors had statutory health insurance and 9% had private health insurance (DESTATIS 2011).
- In the USA, Medicare is a reduced-cost federal health insurance programme available to those aged 65+ (The Henry J. Kaiser Family Foundation n.d.). In 2013, 93% of Americans aged 65+ had Medicare (Administration on Aging). Seniors often supplement Medicare with additional private coverage (The Henry J. Kaiser Family Foundation n.d.).
- The UK has the National Health Service (NHS), which is free at the point of use except for prescriptions, and optical and dental services. The NHS accounts for 83% of health spending in the UK, with private healthcare accounting for the rest (Nuffield Trust n.d.). Only 11% of the population has private health insurance (Nuffield Trust n.d.).

⁵ This statistic is only for England only, not the UK as a whole.

- China has a hybrid publicly/privately financed health insurance system. Three forms of public-sector medical insurance exist. China allocates only 6% of its GDP to health spending, which is a much lower proportion than the Western countries considered in this report (The World Bank 2016).

3.4 Living Arrangements and Social Connections

As seniors age, they become much more likely to live alone. Moreover, compared to men, women have higher life expectancies, so living alone may be a more common occurrence for them as they age.

On a personal level, senior living arrangements and levels of car ownership have a direct connection with the level and type of seniors' mobility (i.e. whether a household member can assist with making trips, and whether car travel is an option): the mobility patterns of seniors who live alone will probably be different from those who do not. Seniors who live alone may find that a mobility impairment has a greater impact on them, as they are not able to rely on other household members to chauffeur them around or run errands for them. Given the higher life expectancy of women in all four countries of interest, it follows that many older senior females are likely to be affected by the mobility impacts of living alone as they age.

- In Germany in 2010, females aged 65+ were much more likely to be living alone than their male contemporaries (45%, compared to 19% of men). Correspondingly, German males of this age cohort are more likely to live in a couple household (78%, compared to 49% of women) (DESTATIS 2015-b).
- As of 2010 in the USA, only 28% of those aged 65+ lived alone, compared with 48% of those aged 85+. For those aged 65+, 56% lived either just with their spouse or with their spouse and others, while only 33% of those aged 85+ were in the same category (U.S. Census Bureau 2010).
- In the UK in 2011, 59% of persons aged 65+ were living in a couple, while only 27% of those aged 85+ were living in a couple⁶ (Office for National Statistics n.d.-c).
- In China, based on 2011 data, 9% of Chinese seniors aged 65+ live alone, while 73% live either just with their spouse or with relatives and their spouse. For those aged 85+, 12% live alone and 41% live either just with their spouse or with relatives and their spouse.

⁶ These statistics are for England and Wales only, rather than the UK as a whole.

Reliance on some form of assisted living becomes more prevalent with age in Germany, the USA and the UK. In China, seniors tend to rely heavily on family members for housing support as they age.

Senior living arrangements will probably have an impact on seniors' demand for transport, as some institutional care settings may bring services directly to their residents which previously required travel in order to access them. Additionally, reliance on the assisted living centre in the first place may be an indication of decreased independence, which will be reflected partially in decreased travel.

Senior home ownership is not as prevalent in Germany as in the USA and the UK (in other words, the proportion of seniors renting is higher in Germany). While home ownership rates in the USA and the UK are higher among seniors than for the population as a whole, the rate of household ownership decreases as one ages from old to very old. Seniors living in households with family members may be reliant on them to travel to doctors' appointments and for meeting other basic needs. Senior home ownership rates may to some extent be a reflection of economic well-being, with a byproduct of home ownership being an increase in discretionary income available for travel. Living arrangements may also be a reflection of culture, with seniors in China relying on family members for housing support as they age. The decline in home ownership rates in the USA and the UK of seniors as they age (which is evident from respective national data) is largely a reflection of turning to assisted living facilities with increasing age - all three Western countries see an increase in assisted living rates with age. The renting or owning of one's home implies that the seniors in question are not dependent on assisted living centres, which may be an indication of better health than that of seniors living in assisted living facilities, and allow for more travel.

- In Germany, only a small proportion (4%) of the population aged 60+ lives in institutional care. More than two thirds of this group are women. This proportion increases with age. In 2009, about 17% of German men and women aged 85+ lived in institutional care. The majority of the German senior population lives in private households - about 55% as owner and 41% as a renter. About 80% of the owners live in detached or semi-detached houses (Deutscher Bundestag 2013).
- In the USA, older adults become more likely to live in nursing facilities as they age. Less than 1% of US adults aged 65-74, 3% of adults aged 75-84 and 11% of adults aged 85+ reside in skilled nursing facilities. In the USA, the number of seniors aged 65+ living in nursing homes declined almost 20% between 2000 and 2010. Meanwhile, the share of older adults living in other care settings has been increasing (U.S. Census Bureau 2014). Seniors aged 65+ are more likely to own their home (77% do) than the population in general: the average ownership rate for households in the USA stands at 65%. However, the data reveal that home ownership rates for older seniors, aged 85+, are lower, at 66%, making them more similar to the rate for the total population (65%) (U.S. Census Bureau n.d.-a).

- In the UK in 2011, only 2% of persons aged 65+ lived in communal establishments compared to 16% of those aged 85+⁷ (Office for National Statistics). More British seniors own their home (75% do) than the proportion for all households (64%)⁸ (Office for National Statistics n.d.-d).
- The CHFS data indicate that approximately 90% of seniors in China live in houses owned either by themselves or by immediate family members (Survey and Research Center for China Household Finance).

The proportion of the population in rural areas who are seniors is higher than is the case for urban areas.

Rural and urban seniors may each have different types, and levels, of mobility options available to them. Moving forward, seniors in each setting will require a unique set of solutions to allow for continued mobility as they age.

- In Germany, following the process of suburbanisation which began in the 1960s, urbanised areas around cities in particular will be characterised by larger proportions of ageing baby boomers. Rural areas, in turn, will experience age-selective out-migration of younger cohorts to urban areas. As a consequence, in 2035 about one third of the rural population will be 65 or older, while the respective share in urban areas will be slightly lower (at 29%) (BBSR n.d.-c).
- Seniors constitute a larger proportion of the rural population than of the urban population in the USA as well. As of 2014, in the USA persons aged 65+ comprised 16% of the rural population and 13% of the urban population (U.S. Census Bureau n.d.-b).
- In the UK in 2011 persons aged 65+ represent a larger proportion of the rural population (25%) than the urban population (19%) (Office of National Statistics n.d.-e).
- The proportion of the Chinese senior generation living in urban and rural areas shows seniors concentrated in rural areas, whereas younger age groups are correspondingly over-represented in towns and cities. In 2010, 10% of the rural population was aged 65+ compared to only 8% of the urban population being aged 65+ (National Bureau of Statistics of China 2010).

⁷ These statistics are for England and Wales only, rather than the UK as a whole.

⁸ These statistics are for England and Wales only, rather than the UK as a whole.

3.5 Transport Options

Car ownership/availability levels vary across the different countries, with the USA having the highest rates and China having the lowest rates. In the Western countries, levels of car ownership decrease with age.

Levels of car ownership/availability among seniors may be closely linked to their mobility. Depending on the country, the setting (i.e. rural or urban) and other features unique to an area, the extent of availability of modes other than car may vary drastically - as also will the need to rely on a car. As seniors age and lose dexterity and visual acuity, they may need to rely on other modes of transport more frequently. Other reasons for decreasing levels of car ownership in older households may be shrinking household sizes, inability to drive and/or limited finances.

- In Germany, as of 2008, 76% of households with the main income earner aged 65-69, 72% of households with the main income earner aged 70-79, and only 52% of households with the main income earner aged 80+ owned a car (DESTATIS 2011).
- In the USA, according to the 2011-2015 ACS 5-Year Estimate, 13% of householders aged 65+ have no vehicle available, while 87% had one or more vehicles available. In comparison, when considering all householders aged 15+, 9% had no vehicle available, while 91% had one or more vehicles available (U.S. Census Bureau n.d.-c).
- In the UK, as of 2011, 18% of those aged 65-74 and 42% of those aged 75+ lived in a carless household. While 42% of individuals of all ages had 2+ vehicles, only 30% of those aged 65-74 had 2+ vehicles and only 12% of those aged 75+ had 2+ vehicles⁹ (Office for National Statistics n.d.-f).
- Overall, levels of car ownership are much lower in China than in the Western countries of interest. The CHFS data indicate that in 2011 about 16% of all households owned a car, and that by 2013 this percentage had increased to 17%. Car ownership is quite low among seniors - about 5% for those aged 60+.

All four countries offer some form of free and/or discounted public transport use for seniors.

⁹ These statistics are for England and Wales only, rather than the UK as a whole.

On a more regional level, the geographic location of senior households has a direct connection to the transport modes available (essentially, whether or not public transport is available) and the length of trips. Differences in mobility options exist between urban and rural areas, particularly in the USA, with urban seniors often having better access to public transport. Seniors receive public transport discounts to varying degrees in the four countries of interest.

- In Germany, seniors generally have better access to the bus than to rail, with the distance to the nearest rail station varying based on spatial context. Senior Germans in peripheral areas with no private car could be at risk of limited access to local infrastructure.
- In the USA, access to public transport varies by region as well as by urban/rural context. Overall, 55% of US households have access to public transport (69% of urban households and 14% of rural households) (American Society of Civil Engineers (ASCE) 2013). The situation is expected to deteriorate, with smaller US metropolitan areas being expected to see a larger increase in the percentage of seniors with poor access to public transport (AARP n.d.). US public transport providers with Federal Transit Administration (FTA) funding are required to provide a reduction of at least half the ticket price for persons aged 65 and over (see the website of the Regional Transportation Authority of Northeastern Illinois as an example) (Regional Transportation Authority 2016). US paratransit services are available from fixed-route public transport providers and non-profit organisations (American Public Transportation Association November 2015). Paratransit is recognized in North America as special transportation services for people with mobility disabilities, often provided as a supplement to fixed-route bus and rail systems by public transit agencies.
- In the UK, seniors of state pension age receive free bus travel, administered by the national governments. In London the Underground (Tube) network is included, and many local authorities offer additional discretionary concessions over and above the statutory minimum (Butcher 15 July 2015). UK seniors are also eligible for a 'Senior Railcard', which offers up to a third off the cost of travel on National Rail Services (National Rail 2017). Despite these offerings, many UK seniors do not use public transport regularly and those in rural areas have worse access to public transport. The UK also has paratransit options available and features to help those with impairments.
- In many Chinese cities, public transport is free or heavily discounted for elderly residents (China National Radio 21 June 2016). For example, in Shanghai, bus travel was free for people aged 70 and over until 2016, when this benefit was replaced with a cash payment (China National Radio 21 June 2016), and in Beijing people from the age of 65 can take a bus on any route for free (General Office of the Municipal People's Government of Beijing 7 October 2008).

In all four countries, seniors are less likely to own and/or use technology than their younger counterparts, which may make it more challenging for them to take up new transport products or services.

There are several different types of technologies which seniors in all four countries are less likely than younger cohorts to use. This may have an impact on seniors' ability to use (and/or their level of comfort when using) mobility options that are increasingly automated - they may not be able to use the Internet in ways that may eliminate the need for a trip altogether, or to look up information about mobility options online. However, the other side of the coin is that as technology continues to advance, it may provide seniors with additional opportunities for travel well beyond the cessation of their ability to drive safely. Advanced driver assistance systems (ADAS) are becoming increasingly prevalent in all four countries, and this may enable greater mobility for seniors as they age. Future generations of seniors will have been increasingly exposed to technology throughout their life, and so will feel more comfortable using it.

- In Germany, younger households are more likely to own mobile devices, and a large proportion of senior households stick to home (as opposed to portable or mobile) computers. However, 86% of senior German households do own a mobile telephone in parallel with having a landline (DESTATIS 2015-b).
- In the USA, adults aged 65+ are less likely to own a computer, mobile phone, smartphone or tablet than all adults aged 18 or over. More than half (59%) of American adults aged 65+ go online (74% of those aged 65-69, but only 37% of those aged 80+) (Smith 3 April 2014).
- In the UK, seniors are less likely to own a smartphone, less likely to own a tablet and less likely to use the Internet (Ofcom 6 August 2015) than the population as a whole.
- In China, as of 2012, only 2% of those aged 55+ owned a smartphone (compared to 31% of those aged 18-24, 41% of those aged 25-34, 15% of those aged 35-44 and 6% of those aged 45-54) (Statista 2012). However, there are 94 mobile telephones per 100 population (Central Intelligence Agency 2016). It is estimated that 46% of the Chinese population use the Internet (Central Intelligence Agency 2016), while only 13% of those aged 60+ use it (Statista 2014).

3.6 Summary

The proportion of seniors in Germany, the USA, the UK and China is expected to increase in the coming decade. As is evident from this chapter's overview, a myriad of topics relate to present trends in senior mobility. The three overarching themes of retirement, health and social connections surfaced as important factors associated with present trends in senior mobility in the four countries. Trends associated with pension plans and workforce participation relate to retirement, which in turn affects mobility patterns. Closely related to senior health are, first, increasing life expectancies; second, prevalence of diseases linked to smoking, diabetes, obesity and low exercise levels; and, third, health insurance. As people live longer, their prolonged lifespan may create additional mobility needs. However, increased life expectancy does not necessarily equate to prolonged quality of life. Healthcare systems, which are liable to change, will be tasked with the burden of serving an increasing proportion of seniors in coming decades. The theme of social connections is seen at personal, regional and transnational levels - ranging from living arrangements and levels of car ownership (the personal level), to the location of senior households (the regional level), to the level of foreign-born seniors, and seniors' access to technology / comfort in using it (the broad-scale level).

An assessment of trends that have an impact on senior mobility has highlighted common characteristics across Germany, the USA, the UK and China, as well as ones that are and unique to each country. The following chapter provides more detailed insights into the range of future scenarios for senior mobility that are possible by the year 2025.



Chapter Four Scenarios for Senior Mobility in 2025 in Germany and the USA

This chapter focuses on changes in senior mobility up to and including the year 2025 in Germany and the USA. To explore possible changes, scenarios were developed, and the mobility market (i.e. the number of kilometres travelled) for each was then analysed. For these analyses, seniors are defined as those aged 60 and over.

4.1 Scenario Modelling Approach

The scenarios for senior mobility were generated on the basis of different projections for two influential dimensions: socioeconomics and mobility (i.e. kilometres travelled). To cover the first dimension, we developed two scenarios (low- and high-automobility) for the socioeconomic situation of seniors in 2025; for the second, we identified a lower (minimum) and upper (maximum) boundary for mobility on a per capita level in 2025 (under socioeconomic *ceteris paribus* conditions). By combining these projections, we obtained four possible mobility markets for seniors in 2025, as illustrated in Figure 4.1. The rationale behind generating the socioeconomic scenarios and choosing the minimum and maximum boundaries for per capita mobility is explained in the following subsections.

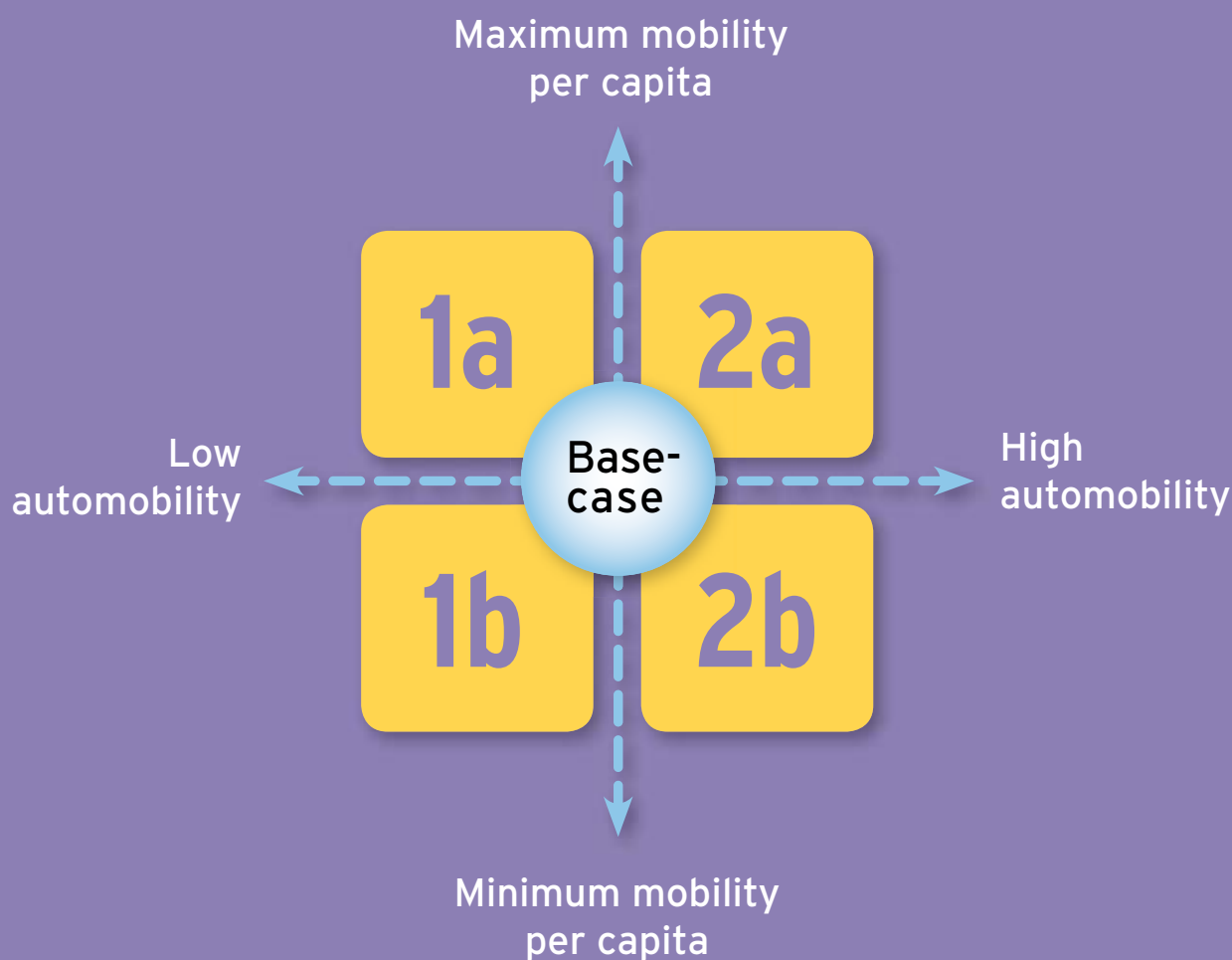


Figure 4.1 Illustration of the scenario dimensions

Base case scenario

A base case scenario provided the statistical foundation on which to build the two socioeconomic scenarios. The base case scenario assumes that changes between 2015 and 2025 are exclusively due to changes in the age-gender composition of the senior population, and in licence-holding. We assumed *ceteris paribus* conditions for the base case with regard to other socioeconomic factors for each age, gender and licensing group. Changes in aggregate distributions for other factors are only those induced by sociodemographic changes or changes in licence-holding. The socioeconomic scenarios were built relative to the base case to form plausible extremes with regard to the automobility of seniors.

Socioeconomic scenarios

The low-automobility and high-automobility scenarios were based on assumptions about distributions of four factors influencing automobility: income, health, workforce participation and car availability. The assumptions are presented in Table 4.1 The low-automobility scenario was built solely on assumptions about income distribution, while assumptions about all four factors were used to generate the high-automobility scenario. The underlying assumptions, shown as cell values in Table 4.1, are extreme but plausible.

- **Low-automobility scenario:** this scenario imagines prevailing socioeconomic conditions such that private car ownership of seniors is on the very low side. For both study countries, there is a shift of the income distribution of seniors towards lower-income classes relative to the base case (as shown in the yellow cells in Table 4.1). However, there is an increasing income gap among seniors, such that the proportion of seniors in the highest-income class is the same as in the base case scenario. Hence, the second-highest-income class (i.e. an upper middle class) has decreased substantially and the lowest-income class has grown.
- **High-automobility scenario:** under this scenario, socioeconomic conditions are such that seniors are able to maintain the high levels of car ownership attained during working-age years as they age; furthermore, they are physically able to be mobile and drive. Seniors in both Germany and the USA in 2025 have higher rates of economic activity, have higher incomes, and are healthier (i.e. have fewer mobility impairments) than in the base case scenario (blue cells in Table 4.1). As a result of these beneficial circumstances, the seniors were able to maintain the high levels of car ownership. For example, we assumed that in 2025 the proportion of 80-year-old German men with their own car was 46%, which is the same proportion observed for 63-year-old men in 2008 (i.e. 17 years earlier). The implication of this assumption is higher personal car ownership among seniors, in particular in Germany, where car ownership rates in 2015 are not as high as in the USA.

Table 4.1 Factors and assumptions comprising socioeconomic scenarios

Germany	Low automobility	Base case	High automobility
Seniors by workforce participation			
No	91%	91%	86%
Yes	9%	9%	14%
Total	100%	100%	100%
Seniors by income group (equivalent income per person)			
Under €900	37%	31%	28%
€900 to under €1,200	24%	24%	22%
€1,200 to under €1,700	20%	27%	28%
€1,700 and over	19%	19%	22%
Total	100%	100%	100%
Seniors by level of car availability			
No licence	10%	10%	10%
Licence, no car	10%	10%	5%
Car shared within household	39%	38%	39%
Own car	42%	42%	47%
Total	100%	100%	100%
Seniors by mobility impairment			
No	84%	84%	88%
Yes	16%	16%	12%
Total	100%	100%	100%

USA	Low automobility	Base case	High automobility
Seniors by workforce participation			
No	69%	68%	63%
Yes	31%	32%	37%
Total	100%	100%	100%
Seniors by income group (equivalent income per person)			
Under US\$1,200	40%	34%	32%
US\$1,200 to under US\$2,000	25%	25%	22%
US\$2,000 to under US\$3,200	15%	20%	22%
US\$3,200 and over	20%	20%	24%
Total	100%	100%	100%
Seniors by level of car availability			
No licence	4%	4%	4%
Licence, no car	8%	7%	4%
Car shared within household	12%	11%	13%
Own car	77%	78%	79%
Total	100%	100%	100%
Seniors by mobility impairment			
No	77%	78%	81%
Yes	23%	22%	19%
Total	100%	100%	100%

NOTE: Percentages may not appear to sum to 100%, owing to rounding.

All three scenarios (i.e. the base case, low-automobility and high-automobility) share common projections about the age-gender composition of the senior population in 2025, which were drawn from external forecasts. Moreover, we used similar assumptions about cohort effects on the ability to drive (i.e. driving licence ownership) for each of the scenarios. These cohort effects follow the assumption that the proportion of licensed drivers for each senior age-gender group in 2025 is the same as for the individuals who were 17 years younger in 2008 (i.e. the year in which national travel survey (NTS) data underlying the scenarios were collected). The increase in licence-holding associated with cohort effects is particularly relevant for Germany.

To implement the socioeconomic scenarios, new weights were developed for the 2008 NTS person datasets for Germany and the USA. These new weights were generated using an iterative proportional approach. The person datasets were weighted consecutively to conform to (a) the required age-sex-licensing distributions and (b) the assumed distributions for the factors defining the scenarios. This procedure was repeated until the weights converged and all desired marginal distributions were satisfied.

Definition of minimum and maximum boundaries for per capita mobility

Two projections were developed for the trend in per capita mobility under ceteris paribus conditions, based on the findings discussed in Chapter Two:

- minimum boundary: no growth in mobility under ceteris paribus conditions (i.e. no intergenerational growth between 2015 and 2025); and
- maximum boundary: continued intergenerational growth of 100 m per mobile person per day.

From today's perspective, both projections appear possible. In both study countries, we observed intergenerational growth for the decades until around 2010. For Germany, we observed 200 m per person per day without signs of saturation. In the USA, this situation was more complex. The observed intergenerational growth for earlier decades was substantially higher than in Germany; however, there were clear signs of saturation. Thus, it is unlikely that after 2015 per capita travel demand will continue to grow at the historical rates observed until the 2010s. An intergenerational growth rate of 100 m per mobile person and day appears to be a plausible projection for a maximum boundary.

These minimum and maximum boundaries are only relevant for the travel demand (i.e. for the kilometres travelled). They do not have an impact on the demographics or socioeconomics of the scenarios, nor the car stock. As a consequence, these boundaries are only relevant for the last part of our analysis, the mobility market analysis for each scenario. To implement the minimum and maximum boundary we used a factor that was applied to all trips for each scenario.

4.2 Comparative Scenario Analysis

The following subsections present and discuss changes between 2015 and 2025 as projected in the scenarios. First, we present basic demographic changes which apply to all scenarios (including the base case scenario). These developments are not an output of our scenario simulation, but rather an input sourced from external population projections.

Second, we show the changes in the car stock of seniors. Third, we present changes in the mobility market (i.e. travel demand in kilometres). Finally, we point out the distinct developments for men and women in our study countries. These last three dimensions of changes are results of the scenario simulations.

Changes in senior population by age and gender from 2015 to 2025

Figure 4.2 depicts the changes in age and gender which are to be expected in the populations of Germany and the USA. In both countries, the senior population is projected to grow, though more strongly in the USA than in Germany. Also, in both cases, growth in the male population is predicted to be slightly higher than the growth in the female population.

The most striking difference between Germany and the USA can be observed in the growth in the senior population by ten-year age brackets. While in the USA the strongest growth is in the 70-79 year age class, the population of this age class is actually decreasing in Germany between 2015 and 2025. This finding for Germany is in striking contrast to the general trend of an increasing senior population which we observe in the country on either side of this ten-year bracket: among those under 70 years of age and those over 80 years of age. The demographic reason for this exceptional development in this particular age class is the low birth rate in Germany at the end of, and right after, the Second World War. It is these birth year cohorts that will reach the age class of 70-79 within the next decade. These far-reaching consequences of the war are the reason why the overall growth in the senior population ages 60+ is lower in Germany than in the USA. The growth for the other ten-year age brackets in Germany is comparable to or higher than that seen in the USA.

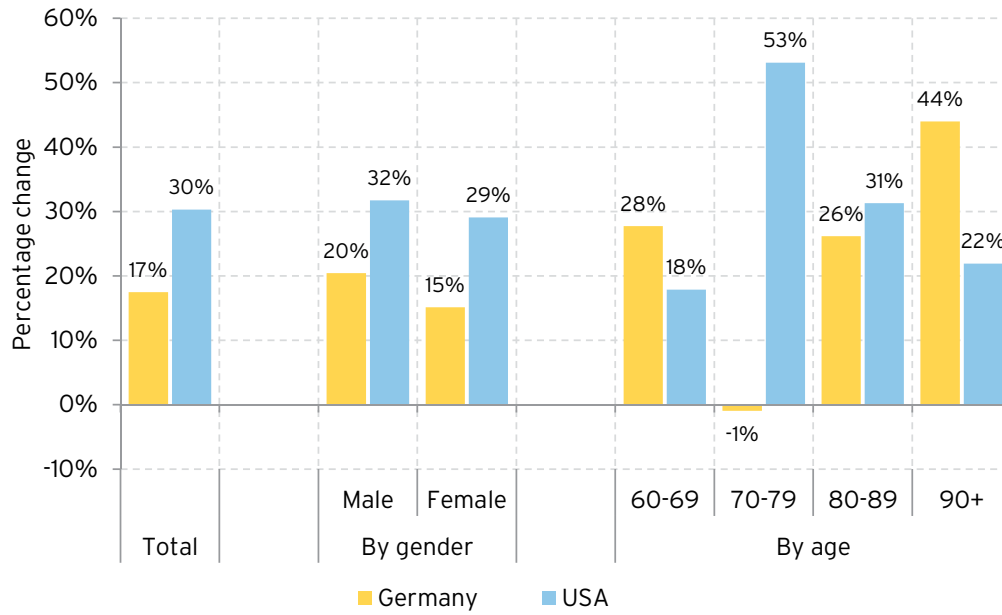


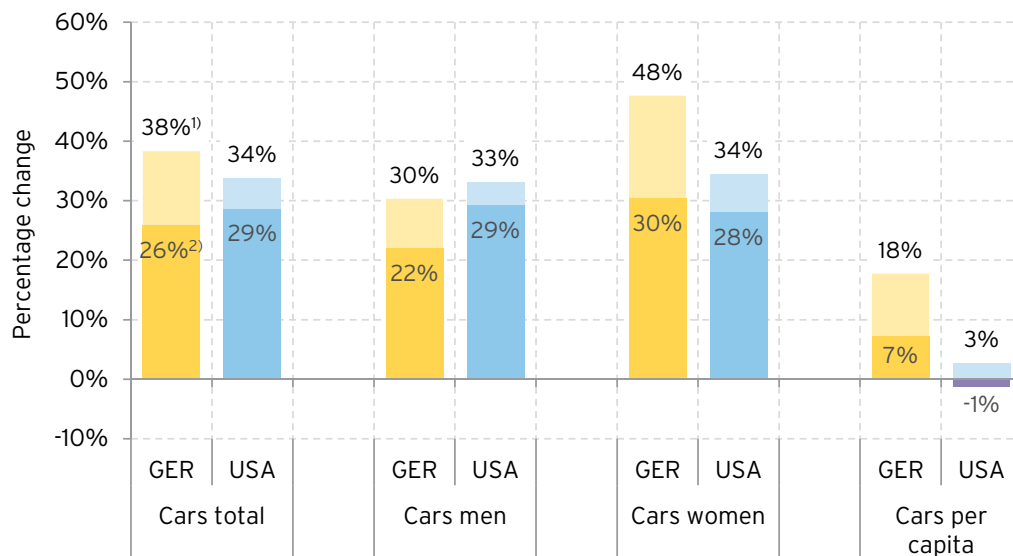
Figure 4.2 Changes in senior population (60+) by age and gender for Germany and the USA from 2015 to 2025

Changes in the car stock among the senior population from 2015 to 2025

Figure 4.3 shows the projected changes in the car stock among seniors for the low- and high-automobility scenarios for each country. In both countries, a strong increase in the car stock in use by seniors is projected to occur over the next decade. Obviously, this growth is smaller - but nevertheless still substantial - for the low-automobility scenario in both countries. However, Germany and the USA differ in the drivers of this growth.

In the USA, the growth in car ownership on the per capita level is negligible - in fact negative - in the low-automobility scenario. The reason for this is simply that the level of car ownership among American seniors is so high already that saturation has nearly been achieved - continued per capita growth thus appears unlikely. Any increases in car stock are due to increases in the total population, arising mainly from foreign-born individuals. In addition to the total senior car stock being smaller in the low-automobility scenario, it is also older. In the US low-automobility scenario, 53% of the cars of seniors are older than eight years as opposed to 51% in the high-automobility scenario.

In Germany we can still expect to see substantial car ownership growth on the per capita level in the coming decade. In the German low-automobility scenario, 50% of the cars of seniors are older than eight years as opposed to 49% in the high-automobility scenario.



1) Maximum mobility scenario 2) Minimum mobility scenario

Figure 4.3 Changes in the car stock of the senior population (60+) for Germany and the USA from 2015 to 2025

Changes in travel demand by the senior population from 2015 to 2025

Figure 4.4 shows the changes in kilometres travelled by the senior population between 2015 and 2025 for each scenario and country. Every scenario produces a minimum and a maximum projected value: these are represented by the two heights making up each bar. For Germany, the growth in total kilometres travelled will be at least 20% but is unlikely to be higher than 33%. For the USA, this growth is projected to be between 27% and 40%.

In both countries, the projected growth in vehicle-kilometres (i.e. kilometres travelled in the car as driver or passenger) is slightly higher than the growth in total kilometres. This difference is more pronounced in Germany than in the USA. In the USA, the growth in total travel demand is linked very closely to the growth in car travel. In Germany, the proportional growth in car travel is higher than the proportional growth in total travel. This indicates that there is a shift from other modes to the car due to higher car availability among German seniors.

In both countries, the difference between the minimum and the maximum for each scenario is smaller than the difference between scenarios. This indicates that the uncertainties associated with the socioeconomic situation of seniors (which basically will control how many cars are available to them) will have a greater influence on senior travel demand trends in the next ten years than the uncertainties associated with continued intergenerational growth on the per capita level.

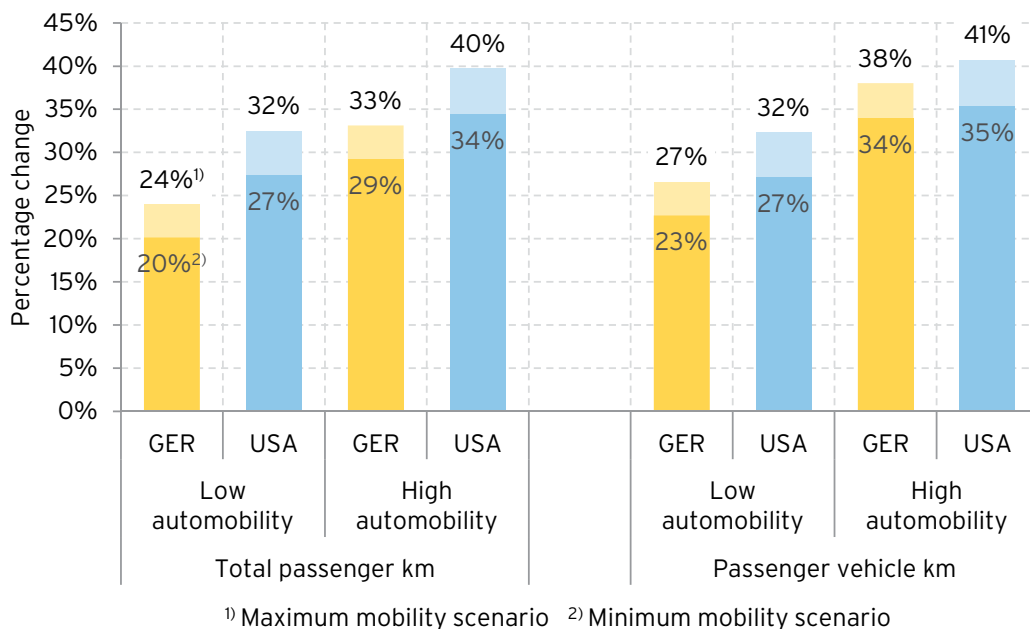
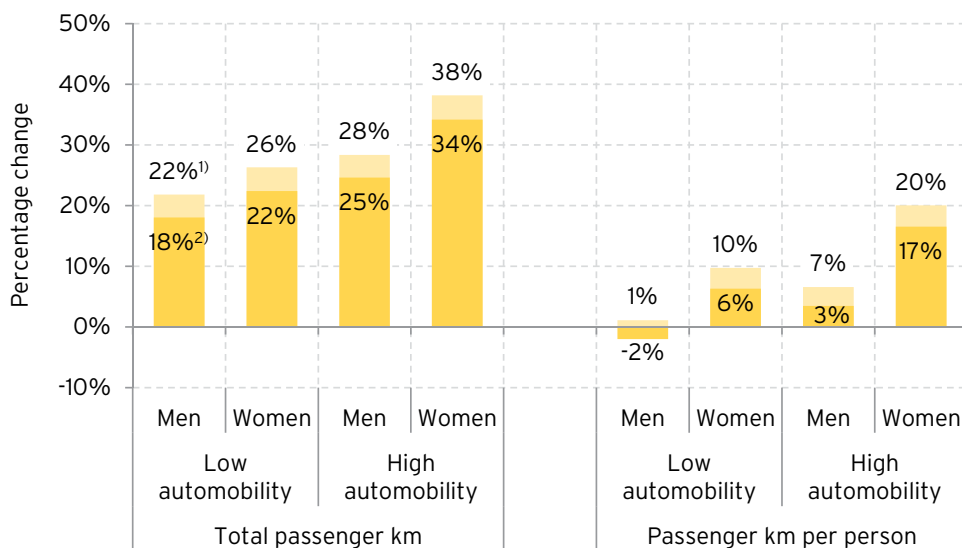


Figure 4.4 Changes in kilometres travelled by the senior population (60+) for Germany and the USA from 2015 to 2025

Changes in the senior mobility market by gender from 2015 to 2025

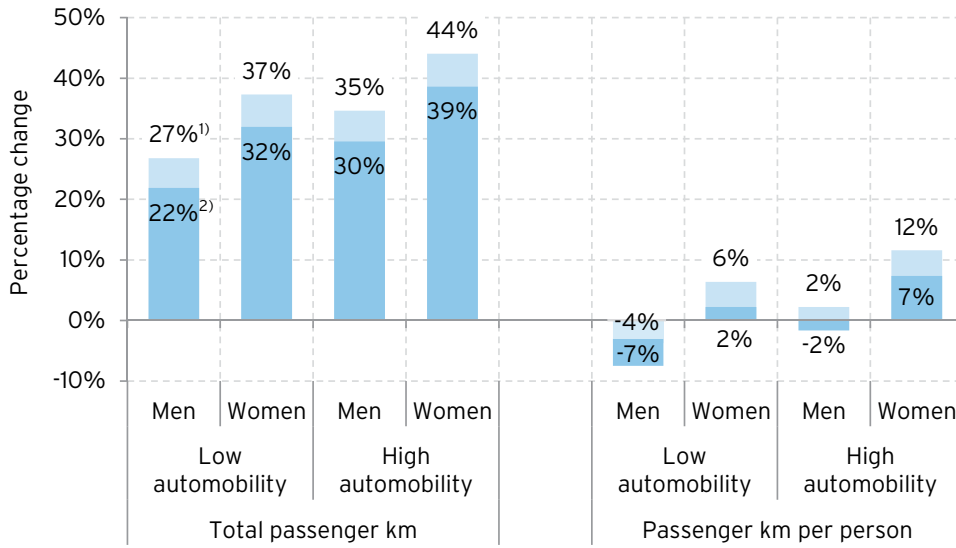
Figure 4.5 and Figure 4.6 depict the changes in travel demand by gender for the senior population in the study countries Germany and the USA respectively. In both study countries and for both scenarios, the growth for women is higher than for men. This is true of both total growth and per capita growth, but the contrast between men and women is stronger when it comes to per capita growth, and is partly mitigated by the stronger growth in total senior male population in both countries (Figure 4.2).

Also, when comparing Germany and the USA, we observe different drivers of the total growth. While in the USA, growth in senior travel demand is more driven by population growth, per capita growth for both men and women is lower than in Germany. Overall, as a continuation of trends seen in the recent past (see Chapter One), senior German women will experience the strongest growth in mobility on the per capita level among the total senior population in both countries. This is also in line with the projected changes in car ownership by gender (Figure 4.3). In the high-automobility scenario, the car stock of senior German women could increase by almost 50% in the next ten years, which is substantially higher than that for any other group studied in this report.



¹⁾ Maximum mobility scenario ²⁾ Minimum mobility scenario

Figure 4.5 Changes in kilometres travelled by the senior population (60+) by gender for Germany from 2015 to 2025



¹⁾ Maximum mobility scenario ²⁾ Minimum mobility scenario

Figure 4.6 Changes in kilometres travelled by the senior population (60+) by gender for the USA from 2015 to 2025

4.3 Summary

This chapter has described the assumptions associated with three scenarios related to the travel of seniors in 2015 and 2025: a base case scenario, a low-automobility scenario and a high-automobility scenario. The results are largely displayed as the percentage change in values anticipated to occur between 2015 and 2025. Factors such as income, health, economic activity and car ownership were considered in the formation of the high-automobility scenarios, and the low-automobility scenario relied on assumptions about income only. Implementation of the scenarios was performed by developing new weights for each nation's national household travel data. Scenarios were created for both Germany and the USA.

Among the notable findings from the comparative scenario analysis, are that in both Germany and the USA, the senior population is projected to grow between 2015 and 2025, though more so for the USA. However, the 70-79 age group will actually decrease in number between 2015 and 2025 in Germany, which is a result of low birth rates during and soon after the Second World War. In both countries, the growth in senior male population is expected to be slightly higher than for female seniors. There is expected to be a strong increase in senior car stock in both countries in the coming decade, though on a per capita level, saturation has nearly been achieved in the USA and therefore continued growth in car stock on a per capita level seems unlikely there.

In terms of an increase in total kilometres travelled, both countries are expected to see growth. In the USA, growth in total travel demand is closely linked to growth in car travel. However, in Germany, there is expected to be a mode shift from other modes to the car because of greater car availability among German seniors. In terms of gender, the growth in travel demand is expected to be higher for women than for men. Notably, in the high-automobility scenario, the car stock of senior German women would increase by almost 50% in the next decade.



Chapter Five Conclusions

Conclusions

The mobility habits of today's seniors differed from their predecessors and will also differ from that of tomorrow's seniors. Analyses of NTS data from Germany, the USA, the UK and Japan revealed a marked decline in mobility (i.e. kilometres travelled) as individuals age, but also indicated that the decline is being pushed later into life. Instead of occurring in one's fifties, the decline is now occurring in these seniors' sixties or later.

5.1 How Do / Did Seniors Travel Today and In the Past?

Today's Germans who are in their fifties are nearly as mobile as those in their twenties. For this reason, there has been significant growth in kilometres travelled per day by seniors for which NTS data were analysed. Increases were:

- (1) a **70%** increase in **England** from 1982 to 2012;
- (2) a **40%** increase in **Germany** from 1982 to 2012;
- (3) a **40%** increase in the **USA** from 1983 to 2008; and
- (4) a **30%** increase in **Japan** from 1987 to 2010.

Some of this increase was intragenerational (i.e. individual) change, and some of it was intergenerational. We found that senior mobility declines at a rate of about one kilometre per person per day for each additional year of age. This means that individuals have approximately 10 km more of daily mobility than those who are ten years older than they are. This can be forestalled by delaying retirement and by a healthier lifestyle. At the same time, succeeding generations travel more than prior ones. So while mobility is indeed declining with age, succeeding generations are starting their declines at higher levels of mobility. The main contributor to higher levels of mobility has been steady growth in car ownership. In Germany, for instance, car ownership among those above the age of 65 has tripled since the mid-1980s - a stronger increase than for any other age group.

Car availability refers to the situation of both having driving licence and owning a car. In terms of car availability trends, the USA and Japan represent two extremes, leading to either saturation or continued car market development. Germany and the UK, and other European countries, fall between the two extremes of the USA and Japan.

- Because there was rapid growth in car ownership early in the twentieth century in the USA, all generations born in 1950 or later have maintained a level of car availability that is well above 90%. Moreover, these levels of car availability are almost as high as those for persons who were born 20-30 years later. Consequently, very little growth in the percentage of seniors with cars can be expected in coming years.
- In Japan, those born around 1950 and after have attained car availability levels of only 60%-70%. Preceding generations had very low levels of car availability- or even none at all - to maintain as they aged. Growth in car ownership is thus likely to continue for another 20 to 30 years.

5.2 What Changes in Travel Behaviour are Projected for Seniors in 2025?

Scenario-based simulation models were developed and analysed for Germany and the USA.

Car ownership

In both countries, a strong increase in the car stock in use by seniors is projected to occur over the next decade. Obviously, this growth is smaller - but nevertheless still substantial - for the low-automobility scenario in both countries. However, Germany and the USA differ in the drivers of this growth. In the USA, the growth in car ownership on the per capita level is negligible - in fact negative - in the low-automobility scenario. The reason for this is simply that the level of car ownership among American seniors is so high already that saturation has nearly been achieved - continued per capita growth thus appears unlikely. In addition to the total senior car stock being smaller in the low-automobility scenario, it is also older. In Germany we can still expect to see substantial growth in car ownership on the per capita level in the coming decade, particularly among senior women.

Kilometres of travel

For both countries, future growth in kilometres of travel is affected by intragenerational declines in mobility. For Germany, the growth in total kilometres travelled is projected to be between 20% and 33%. The proportional growth in car travel is higher than the proportional growth in total travel. This indicates that there will be a mode shift from other modes to the car owing to higher car availability among German seniors. For the USA, this growth is projected to be between 27% and 40%. This demand is linked very closely to growth in car travel.

In both study countries and for both scenarios, the growth in senior women's kilometres of travel is higher than for senior men. This is true of both total growth and per capita growth, but the contrast between men and women is stronger when it comes to per capita growth. This may be due to longevity trends among women. Senior German women will experience the strongest growth in mobility on the per capita level among the total senior population in both countries. This is also in line with the projected changes in car ownership by gender.

5.3 What are the Drivers of Travel Behaviour Change for the Future Senior Generation?

The individual changes in mobility while ageing depend on whether or not seniors are employed, when mobility impairments start to have an effect, the severity of these impairments, and the individual's level of wealth or income. How the socioeconomic circumstances of seniors unfold over the next decade will determine whether or not there is growth in their mobility.

When the prototypical model of ageing was quantified for Germany, it was found that seniors who are not employed travel about 10 km less per day than those of the same age who are employed. In the USA and the UK, senior workforce participation is on the rise. Both countries have non-compulsory retirement policies and also less substantive pension plans than in Germany, where workforce participation after the age of 65 decreases sharply.

Mobility impairments also are associated with declines in mobility. On average, travellers with mobility impairments report 2 km of daily travel less than those without mobility impairments. While our study countries have an increasing life expectancy, extended life does not necessarily equate to extended quality of life. Increasing life expectancy may point to better health for a longer period of time and subsequent prolonged mobility - or it could simply mean more senior years, but with limited mobility. The prevalence of health inhibitors - such as smoking, diabetes, obesity and low levels of exercise - are all continuing or even on the increase in our study countries. Rising healthcare costs, especially in the USA - which does not have universal health insurance - could make up a greater share of household spending among seniors, contributing to a reduction in discretionary household income and dwindling wealth accumulation.

Seniors with a car available to them are significantly more mobile than those without a car, with 13 km more of daily travel. Car availability is high among seniors in all study countries except China; however, as noted in the preceding paragraph, the onset of health impairments (e.g. breaking a hip, deterioration in eyesight, cognitive impairments) will cause a significant drop in mobility, regardless of one's car availability situation.

5.4 Senior Mobility After 2025

This study on senior mobility has looked at the coming decade. However, after 2025 senior mobility, and its importance for the entire mobility market, is likely to take yet another important turn.

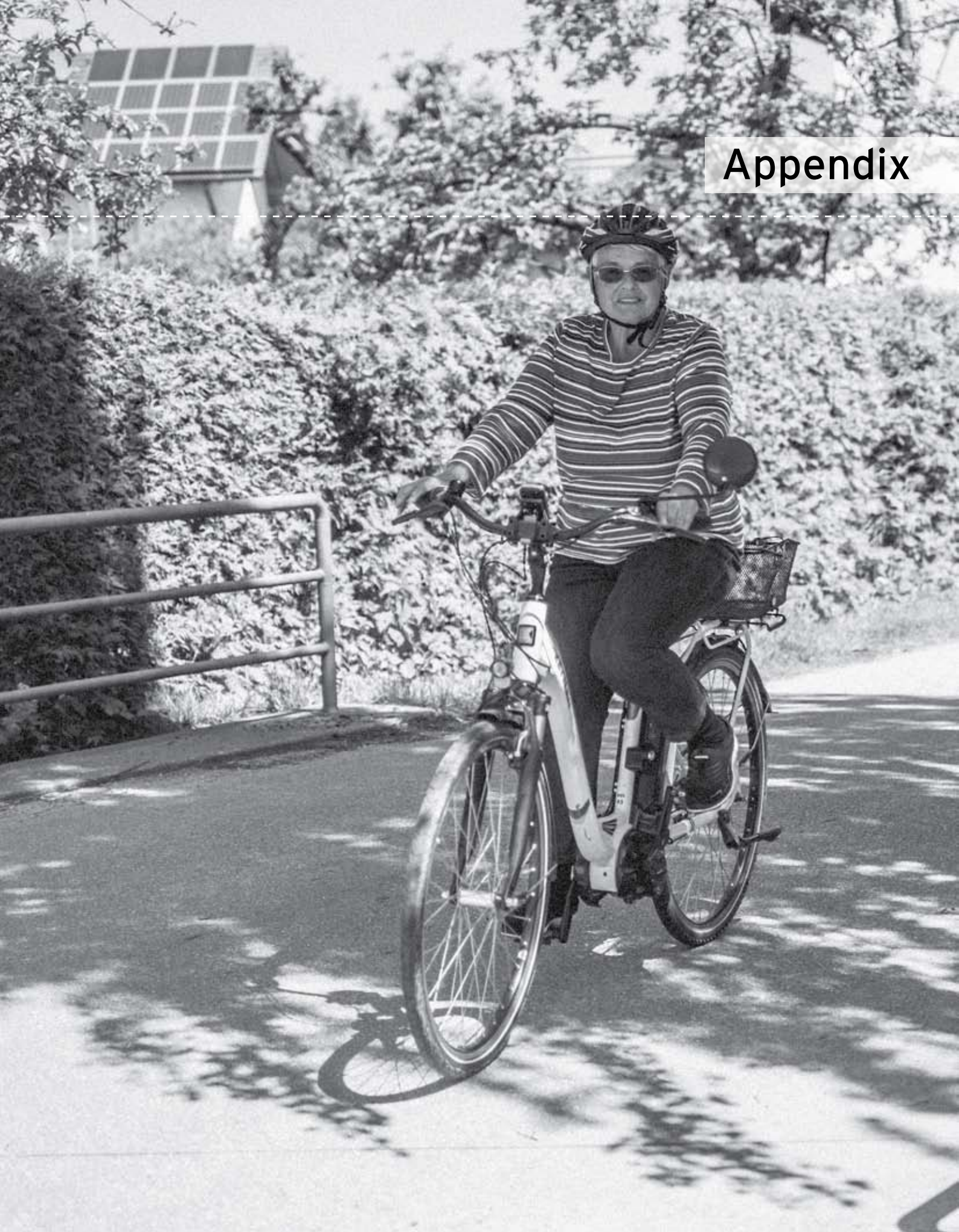
This will be due first to demographic developments: from 2025 onwards the proportion of seniors in the population will grow even faster in many industrialised countries than it does up to the year 2025. The reason for this is that the baby boomer generation will reach retirement age in many countries up through 2025.

Second, changes will occur because of probable technological developments: this research has indicated that senior generations in the study countries have experienced a growth in mobility. While a decline in mobility can be seen as people age, that decline has, since the 1970s, tended to push later into life. Such an age-induced decline may be less evident in the future, as the ageing of the population converges with the advent of autonomous vehicles (AVs). That future might be realised soon after 2025.

The automobile marketplace is rapidly reaching a significant inflection point in the availability of vehicle automation. Within the next four years, BMW hopes to have cars on the street with medium-level automation. BMW and other companies are also working on driverless prototypes that have no steering wheel, or brake or acceleration pedals. Honda, Volvo, Nissan and Toyota are anticipating substantial self-driving capability from 2020. Ford and Baidu are suggesting a rollout year of 2021. Whether these exact dates will be met, or rollout will prove to be many years off, the spectrum of vehicles eventually coming to market will allow older drivers to consider what type will best suit their mobility needs.

The demand for mobility is clearly there among senior generations. Tens of thousands of people are turning 65 every day. The challenge of meeting the mobility needs of older people is compounded by differences in the way in which the various generations address mobility. Driving has become the most common form of transport among older adults, but when it comes to the senior population, there really has been very little research aimed at understanding the impact of AV availability on senior mobility.

Appendix



Bibliography

- AARP.** (n.d.) "Waiting for a Ride: Transit Access and America's Aging Population." Retrieved 22 March 2016, from <http://www.aarp.org/content/dam/aarp/livable-communities/learn/transportation/waiting-for-a-ride-transit-access-and-americas-aging-population-aarp.pdf>.
- Administration on Aging, Administration for Community Living., U.S. Department of Health and Human Services.** (n.d.) *A Profile of Older Americans: 2014*.
- American Public Transportation Association.** (November 2015). "2015 Public Transportation Factbook." Retrieved 22 March 2016, from <http://www.apta.com/resources/statistics/Documents/FactBook/2015-APTA-Fact-Book.pdf>.
- ASCE- American Society of Civil Engineers** (2013) *Report Card for America's Infrastructure Findings Transit*.
- Bank, T. W.** (2016). "Health Nutrition and Population Statistics: Population estimates and projections."
- BBC News** (November 20, 2015) "Basic state pension set to rise to 119.30 [pounds] a week."
- BBSR.** (n.d-a) "Die Raumordnungsprognose 2035 nach dem Zensus." Retrieved 27 January 2017, from <http://www.bbsr.bund.de/BBSR/DE/Veroeffentlichungen/AnalysenKompakt/2015/AK052015.html?nn=395966>.
- BBSR.** (n.d-b) "Raumordnungsprognose 2030." Retrieved 27 January 2017, from http://www.bbsr.bund.de/BBSR/DE/Raumbeobachtung/UeberRaumbeobachtung/Komponenten/Raumordnungsprognose/Download_ROP2030/DL_uebersicht.html.
- BBSR.** (n.d c). "Die Raumordnungsprognose 2035 nach dem Zensus. Bevölkerung, private Haushalte und Erwerbspersonen." BBSR-Analysen KOMPAKT 05/2015 Retrieved 12 April 2016, from http://www.bbsr.bund.de/BBSR/DE/Veroeffentlichungen/AnalysenKompakt/2015/DL_05_2015.pdf?blob=publicationFile&v=4.
- Broadridge Investor Communication Solutions, I.** (1 January 2014). *Retirement Income: The Transition Into Retirement*.
- Bureau of Labor Statistics-United States Department of Labor.** (n.d.) "Employed persons by detailed occupation and age, 2013 annual averages." Labor Force Statistics from the Current Population Survey Retrieved 14 March 2016, from http://www.bls.gov/cps/occupation_age.htm.
- Butcher, L.** (15 July 2015). *Concessionary bus fares*. Briefi Paper, House of Commons Library. SN01499.
- BZgA** (2013). *Alte Menschen. Expertise zur Lebenslage von Menschen im Alter zwischen 65 und 80 Jahren*.
- Center for Disease Control and Prevention.** (n.d-a.) "Rates of Diagnosed Diabetes per 100 Civilian, Non-Institutionalized Population, by Age, United States, 1980-2014." Diabetes Public Health Resource Retrieved 11 March 2016, from <http://www.cdc.gov/diabetes/statistics/prev/national/figbyage.htm>.
- Center for Disease Control and Prevention.** (n.d-b). "How much physical activity do older adults need?" Division of Nutrition, Physical Activity, and Obesity Retrieved March 10, 2016, from http://www.cdc.gov/physicalactivity/basics/older_adults/index.htm.
- Central Intelligence Agency** (2016). *The World FactBook*.
- China National Radio.** (June 21, 2016). Retrieved 24 January 2017, from http://china.cnr.cn/qqhygbw/20160621/t20160621_522456972.shtml.
- Colby, S. L. and J. M. Ortman.** (March 2015). "Projections of the Size and Composition of the U.S. Population: 2014 to 2060." Population Estimates and Projections Retrieved 30 March 2016, from <https://www.census.gov/content/dam/Census/library/publications/2015/demo/p25-1143.pdf>.
- Crawford, R., D. Innes and C. O'Dea** (2015). *The Evolution of Wealth in Great Britain: 2006-08 to 2010-12*, Institute for Fiscal Studies: Figure 3.4.
- Data 360.** (n.d) "Life Expectancy-United States." Retrieved 9 March 2016, from http://www.data360.org/dsg.aspx?Data_Set_Group_Id=195.
- DESTATIS.** (n.d-a). "Bevölkerung nach Migrationshintergrund und Altersgruppen." Retrieved 29 March 2017, from <https://www.destatis.de/DE/ZahlenFakten/GesellschaftStaat/Bevoelkerung/MigrationIntegration/Migrationshintergrund/Tabellen/MigrationshintergrundAlter.html>.
- DESTATIS** (2011). *In the Spotlight: Older People in Germany and the EU*. Statistisches Bundesamt (Federal Statistical Office), Wiesbaden: p. 25.
- DESTATIS** (2015a). "Bevölkerung Deutschlands bis 2060." 13. koordinierte Bevölkerungsvorausberechnung.

- DESTATIS** (2015b) *Die Generation 65+ in Deutschland*. Retrieved on 8 September 2017 from https://www.destatis.de/DE/PresseService/Presse/Pressekonferenzen/2015/generation65/Pressebrochure_generation65.pdf?__blob=publicationFile
- Deutscher Bundestag** (2013). *Wohnsituation von Seniorinnen und Senioren in Deutschland. Antwort der Bundesregierung auf die Kleine Anfrage der Abgeordneten Heidrun Dittrich, Heidrun Bluhm, Diana Golze, weiterer Abgeordneter und der Fraktion DIE LINKE*. Drucksache 17/11965, 17. Wahlperiode. .
- Ecola, L., C. Rohr, J. Zmud, T. Kuhnimhof and P. Phleps** (2014). *The Future of Driving in Developing Countries*, Rand Corporation.
- FAZ.NET** (2012) "Lebenserwartung in Deutschland steigt weiter." *Altenheim Europas*.
- General Office of the Municipal People's Government of Beijing**. (October 7, 2008). Retrieved 24 January 2017, from <http://zhengwu.beijing.gov.cn/gzdt/gggs/t995341.htm>.
- gov.uk** (n.d.) *State Pension age timetables*. Retrieved 1 May 2016 from <https://www.gov.uk/government/publications/state-pension-age-timetable>.
- He, W., D. Goodkind and P. Kowal** (2016). *An Aging World: 2015*. International Population Reports, United States Census Bureau.
- Health Care & Social Care Information Centre** (June 2014). *The Health and Care of Older People*. Retrieved 8 September 2017 from <http://content.digital.nhs.uk/catalogue/PUB14369/focu-on-hac-op-main-pub-doc%2011.pdf>
- Jamal, A., D. M. Homa, E. O'Connor, S. D. Babb, R. S. Caraballo, T. Singh, S. S. Hu and B. A. King**. (November 13, 2015). "Current Cigarette Smoking Among Adults -- United States, 2005-2014." Retrieved 11 March 2016, from http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6444a2.htm?s_cid=mm6444a2_w.
- Kraftfahrt-Bundesamt, Fahrzeugstatistik**. *Bestand am 1. Januar 2016 nach Haltern* [Statistics on the number of vehicles registered on January 1, 2016], Flensburg, Germany, 2016.
- kidsdata.org**. "Foreign-Born Population, by Age Group (regions of 65,000 Residents or More)." A Program of Lucile Packard Foundation for Children's Health Retrieved 15 March 2016, from <http://www.kidsdata.org/topic/346/immigration250/table#fmt=464&loc=2,127,331,171,345,357,324,369,362,360,337,364,356,217,328,354,320,339,334,365,343,367,344,366,368,265,349,361,4,273,59,370,326,341,338,350,342,359,363,340,335,1&tf=79&ch=938,789,936,935,937&sort=ColumnId=0&sortType=asc>
- Li, F.** (2016). "Physical activity and health in the presence of China's economic growth: Meeting the public health challenges of the aging population." *Journal of Sport and Health Science* 5(3): 258-269.
- Lu, N., Z. Jia and The Central People's Government of China** (May 12, 2012). Minister of the National Health and Family Planning Commission.
- Mokl_Klingebiel, A., S. Wurm, O. Huxhold, and C. Tesch-Romer**. (Hrsg.) (2010). *Altern im Wandel. Befunde des Deutschen Alterssurveys (DEAS)*. Stuttgart.
- Munz, R. and R. Ulrich** (2000). *Die ethnische und demographische Struktur von Ausländern und Zuwanderern in Deutschland. Blickpunkt Gesellschaft 5. Deutsche und Ausländer: Freunde, Fremde oder Feinde? Empirische Befunde und theoretische Erklärungen*. Westdeutscher Verlag: Wiesbaden. R. Alba, P. Schmidt and M. W. (Hrsg.).
- National Bureau of Statistics of China**. (2010). "2010 Population Census of The People's Republic of China." Retrieved April 2016, from <http://www.stats.gov.cn/english/Statisticaldata/CensusData/rkpc2010/indexch.htm>.
- National Bureau of Statistics of China**. (2011). "Major Figures on Residents from Hong Kong, Macao and Taiwan and Foreigners Covered by 2010 Population Census." Retrieved April 2016, from http://www.stats.gov.cn/english/NewsEvents/201104/t20110429_26451.html.
- National Rail**. (2017). "SeniorRailcard." Retrieved 25 January 2017, from <http://www.senior-railcard.co.uk/>.
- Nuffield Trust**. (n.d.) "UK spending on public and private health care." Retrieved 11 January 2016, from <http://www.nuffieldtrust.org.uk/data-and-charts/uk-spending-public-and-private-health-care>.

Ofcom (August 6, 2015). *The Communications Market Report*.

Office for National Statistics. (n.d.-a) "CT0570_2011 Census - Sex by age by IMD2004 by ethnic group: 27 March 2011."

Retrieved 1 May 2016, from

<https://www.ons.gov.uk/peoplepopulationandcommunity/culturalidentity/ethnicity/adhocs/005378ct05702011census-sexbyagebyimd2004byethnicgroup>.

Office for National Statistics. (n.d.-b) "DC6112EW - Occupation by sex by age: 29 November 2011." Retrieved 2 May 2016, from

<https://www.nomisweb.co.uk/query/construct/summary.asp?reset=yes&mode=construct&dataset=794&version=0&anal=1&initset=>

Office for National Statistics (n.d.-c). "DC1108EW - Living arrangements by sex by age: 27 March 2011." Retrieved 2 May 2016, from

<https://www.nomisweb.co.uk/query/construct/summary.asp?mode=construct&version=0&dataset=747>

Office for National Statistics (n.d.-d) "DC4201EW - Tenure by ethnic group by age - Household Reference Persons: 27 March 27 2011." Retrieved 2 May 2016, from

<https://www.nomisweb.co.uk/query/construct/summary.asp?mode=construct&version=0&dataset=710>

Office of National Statistics. (n.d.-e) "QS110EW - Adult life stage (alter- native adult definition): 27 March 2011." Retrieved 2 May 2016, from

<https://www.nomisweb.co.uk/query/construct/summary.asp?mode=construct&version=0&dataset=510>

Office for National Statistics. (n.d.-f) "DC4109EWla - Car or van availability by sex by age: 27 March 2011." Retrieved 2 May 2016, from

<https://www.nomisweb.co.uk/query/construct/summary.asp?mode=construct&version=0&dataset=1135>.

Office for National Statistics (24 September 2015) *National Life Tables*, United Kingdom: 2012-2014: 1-16.

Office of National Statistics. (18 February 2016) "Adult Smoking Habits in Great Britain, 18 February 2016." Retrieved 11 January 2017, from

<https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/drugusealcoholandsmoking/datasets/adultsmokinghabitsingreatbritain>.

Regional Transportation Authority. (2016). "Rider Resources." Retrieved 28 March 2016, from <http://www.rtachicago.com/rider-resources>.

Scantlebury, R. and A. Moody (16 December 2015). *Health Survey for England, 2014: Chapter 9: Adult obesity and overweight*. H. S. C. I. Centre.

Scholes, S. and J. Mindell (16 December 2015). *Chapter 2: Physical activity in adults*, Health & Social Care Information Centre.

Smith, A. (3 April 2014). "Older Adults and Technology Use-Usage and Adoption." Retrieved 23 March 2016, from <http://www.pewinternet.org/2014/04/03/usage-and-adoption/>.

Social Security Office of Retirement and Disability Policy. (2014). "Social Security Programs Throughout the World: Asia and the Pacific, 2014." Retrieved 24 January 2017, from <https://www.ssa.gov/policy/docs/prodesc/ssptw/2014-2015/asia/china.html>.

Statista. (2012). "Smartphone users in China in 2012, by age group." Retrieved April 2016, from <http://www.statista.com/statistics/279361/smartphone-users-in-china-by-age-group/>.

Statista (2014). "Distribution of internet users in China as of May 2014, by age group."

The Central People's Government of China (1979). State Council Circular on Issuing "State Council Temporary Measures on Providing for Old, Weak, Sick, and Handicapped Cadres" and "State Council Temporary Measures on Workers' Retirement, Resignation".

The Henry J. Kaiser Family Foundation. n.d. "Medicare at a Glance." Retrieved 14 March 2016, from <http://kff.org/medicare/fact-sheet/medicare-at-a-glance-fact-sheet/>.

The World Bank. (2016). "Health Nutrition and Population Statistics: Population estimates and projections" Retrieved April 2016, from <http://databank.worldbank.org/data/reports.aspx?source=health-nutrition-and-population-statistics:population-estimates-and-projections>.

Trust for America's Health and the Robert Wood Johnson Foundation. n.d. "The State of Obesity-Better Policies for a Healthier America." Retrieved 11 March 2016, from <http://stateofobesity.org/obesity-by-age/>.

U.S. Census Bureau. (n.d.-a) "QT-HW-Geography-United States: Tenure, Household Size, and Age of Householder: 2010." 2010 Census Summary File 1, from http://factfi.census.gov/bkmk/table/1.0/en/DEC/10_SF1/QTH2.

U.S. Census Bureau. (n.d.-b) *Table QCT0103, PERCENT OF THE TOTAL POPULATION WHO ARE 65 YEARS AND OVER.* United States--Urban/Rural and Inside/Outside Metropolitan and Micro-politan Area, from http://factfi.census.gov/bkmk/table/1.0/en/ACS/14_5YR/GCT0103.US26.

U.S. Census Bureau. (n.d.-c) *Table B25045, TENURE BY VEHICLES AVAILABLE BY AGE OF HOUSEHOLDER.* 2011-2015 American Community Survey 5-Year Estimate.

U.S. Census Bureau. (2010). "Table 5-3: Living Arrangements of the Household Population Aged 65 and Over: 2010 from 65+ in the United States." from <https://www.census.gov/content/dam/Census/library/publications/2014/demo/p23-212.pdf>.

U.S. Census Bureau (2014). *65+ in the United States: 2010.* U.S. Government Printing Office, Washington, DC: 23-212.

United Nations, DESA., Population Division (2016). "World Population Prospects: The 2015 Revision. (Medium variant)." Population Pyramids of the World from 1950 to 2100 Retrieved March 7, 2016, from <http://populationpyramid.net/united-states-of-america/2016/>.

Vocativ. (n..d.) "At Least Three Quarters of Americans Don't Exercise Regularly." Retrieved 21 March 2016, from <http://www.vocativ.com/culture/science/at-least-three-quarters-of-americans-dont-exercise-regularly/>.

World Health Organization (2014-a). "Obesity (body mass index ≥ 30) (age-standardized estimate) Data by country."

World Health Organization (2014-b). *WHO Framework Convention on Tobacco. Reporting Instrument of the WHO Framework Convention on Tobacco Control.*

Xu, Y., L. Wang, J. He, Y. Bi, M. Li, T. Wang, L. Wang, Y. Jiang, M. Dai, J. Lu, M. Xu, Y. Li, N. Hu, J. Li, S. Mi, C.-S. Chen, G. Li, Y. Mu, J. Zhao, L. Kong, J. Chen, S. Lai, MPH; Weiqing-Wang, W. Zhao and G. Ning (2013). "Prevalence and Control of Diabetes in Chinese Adults."

National Travel Survey Data

This annex lists National Travel Surveys (NTS) which were used in the analysis of micro data in this study.

Germany

- BMV (Bundesministerium für Verkehr) (1976). Kontinuierliche Verkehrserhebung (Kontiv) 1976.
 - BMV (1982). Kontinuierliche Verkehrserhebung (Kontiv) 1982.
 - BMV (1989). Kontinuierliche Verkehrserhebung (Kontiv) 1989.
 - BMVBS (Bundesministerium für Verkehr, Bau und Stadtentwicklung) (2010). Deutsches Mobilitätspanel (MOP) 1995-2014.
-

England

- DfT (Department for Transport) (2010a). British National Travel Survey 1975-1976: Version 2003. UK Data Archive Study Number 2853.
 - DfT (2010b). British National Travel Survey 1985-1986: Version 2003. UK Data Archive Study Number 2855.
 - DfT & National Centre for Social Research (2010). British National Travel Survey 1995-2014.
-

Japan

- MLIT (Ministry of Land, Infrastructure, Transport and Tourism) (2010). Nationwide Person Trip Survey 1987, 1992, 1999, 2005, 2010.
-

USA

- USDOT (U.S. Department of Transportation) & FHWA (Federal Highway Administration) (2006). Nationwide Personal Transportation Survey 1983. Washington, DC.
- USDOT & FHWA (2005). National Household Travel Survey 2001: Version 2004. Washington, DC.
- USDOT & FHWA (2010). National Household Travel Survey 2009: Version 1/2010. Washington, DC.

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