Demography matters: effects on daily mobility due to demographic changes in the Netherlands

Demografie doet er toe: effecten op dagelijkse mobiliteit door demografische veranderingen in Nederland

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Samenvatting

Stagnatie van de bevolkingsgroei, vergrijzing, een grotere arbeidsparticipatie van vrouwen, bevolkingskrimp in de periferie. Het zijn slechts enkele voorbeelden van factoren die van invloed zijn op de bevolkingsomvang en de bevolkingssamenstelling. Zowel de bevolkingsomvang en bevolkingssamenstelling in diverse Nederlandse regio's verandert. De vraag is dan: wat is het effect op de mobiliteit die in Nederland wordt gegenereerd?

Voor het afstudeerverslag (Huisman 2014), dat aan de basis ligt van dit paper, is met behulp van mobiliteitsdatabases en bevolkingsprognoses van het Centraal Bureau voor de Statistiek (CBS) en het Planbureau voor de Leefomgeving (PBL) is de relatie 'ontrafeld' tussen demografie en mobiliteit. Vervolgens is een mobiliteitsprognose gedaan voor 2040. Deze voorspelling is zowel nationaal als regionaal uitgevoerd en voor verschillende modaliteiten.

De algemene conclusie is dat de Nederlandse mobiliteit gegroeid is met ongeveer 1,1% per jaar tussen 1985 en 2010, maar dat – onder andere door demografische veranderingen – deze groei afzwakt naar zo'n 0,3% op jaarbasis in de periode tot 2040. Stagnatie van de bevolkingsgroei is hier uiteraard voor een groot deel debet aan, maar ook de veranderende samenstelling van de bevolking draagt bij aan de groeistagnatie.

In dit paper zijn twee in het oog springende (deel)conclusies nader beschreven. Ten eerste gaat het om het effect op mobiliteit door een hoger opleidingsniveau onder vrouwen en een actievere deelname in het arbeidsproces van vrouwen. Het rijbewijsbezit onder vrouwen is explosief gegroeid en dit rijbewijsbezit heeft een hoge positieve correlatie met de totale gegenereerde mobiliteit en – uiteraard – met autobestuurdersmobiliteit. Dit is vooral goed te zien wanneer leeftijds- en geboortecohorten worden afgezet tegen autobestuurdersmobiliteit.

De tweede beschreven (deel)conclusie gaat over het effect door een hogere AOW-/pensioenleeftijd. Deze wijziging is weliswaar een beleidswijziging, maar vloeit wel direct voort uit een demografische verandering van de Nederlandse bevolkingssamenstelling (namelijk de vergrijzing). Aan de hand van de beschikbare data wordt een extra mobiliteitsgroei verwacht van ongeveer 3% tegen 2040 bovenop het referentiescenario, de 'standaardgroei'.

Wat betreft (toekomstige) beleidswijzigingen is de belangrijkste conclusie dat de onzekerheid toeneemt. In gebieden waar de bevolking krimpt, neemt ook de mobiliteit af. Dit mobiliteitskrimp is echter kleiner dan de bevolkingskrimp. De kosten om de mobiliteit te faciliteren worden per persoon dus hoger. In de grote steden – waar de bevolkingsomvang groeit en de mobiliteit toeneemt – worden de kosten voor het faciliteren van mobiliteit, per persoon, waarschijnlijk hoger door een toename van complexiteit bij zowel het aanleggen en onderhouden van infrastructuur, maar ook door de grotere impact op de omgeving.

Veranderingen in bevolkingsaantallen en bevolkingssamenstelling leiden tot wijzigingen in mobiliteit: hoe kunnen we daar mee omgaan?

1. Motivations

The main topic of this paper[1] is the complex relationship between demographic changes in the Netherlands and its impact on daily mobility. The population of the Netherlands has faced major changes in its growth rate and it seems likely that the population size will even face (further) decline (in certain regions) in the near future.

However, not only the size of the population has changed and will change, but also the composition of the population has undergone and will undergo major changes. These include aging of population and a higher educated society. One of the results of the demographic transition is a higher participation of women in the paid labour force and the enhancement of the service sector. Both the aforementioned population size decline and the changing population composition is seen as the result of the end of the demographic transition[2], as described thoroughly by Dyson (2010, and 2011), amongst others.

Obviously, amongst other sources, (a) a changing size of the population; (b) aging of population; (c) enhancement of the service sector; and (d) urbanisation all have their effects on daily mobility.

Dutch population predictions[3] show that changes in population size and composition will vary in different regions. Whereas the population of the Randstad[4] will continue to grow, some rural parts of the Netherlands already have to deal with population decline; other rural parts will face shrinkage in the near future. Besides a decline in population, these so called 'shrinkage regions' are also the ones facing the largest aging of their population.

To sum up, the urbanised part will have to deal with (ongoing) population growth and hardly will have to deal with an aging population, whereas (in the most extreme cases) some rural parts will have to deal with a shrinking population and the 'remaining population' is on average older. In short, the rural population is both declining and ageing. Thus, the Netherlands will have to deal with polarisation between the urban part at one side and the rural part at another.

Although the daily mobility effects of these demographic changes are hardly being researched recently (Manting 2014), it is estimated that the (a) size of a population and (b) the composition of a population have major impact on daily mobility.

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[1] This paper is based on research, which has been conducted for my master thesis Spatial Planning at Utrecht University (Huisman 2014). This master thesis has been written to finish my studies in Spatial Planning at Utrecht University, faculty of Geosciences. In combination with an intern position at Netherlands Environmental Assessment Agency (in Dutch: Planbureau voor de Leefomgeving) research has been carried out to study the impact of demographic changes in the Netherlands on daily mobility.

[2] The demographic transition starts with significant decline of mortality, which leads to a) people becoming older, and b) less child mortality. Both lead to a significant population growth, which results in economic development. Finally this population growth and economic development leads to less fertility (per woman) and thus to a) decline of population, and b) an ageing population.

[3] In the authors' research, PEARL has been used as a predictor for relevant population size and composition figures. PEARL is an abbreviation for Projecting population Events At Regional Level. More information can be found at http://www.pbl.nl/themasites/regionale-bevolkingsprognose.

[4] See the red, orange and yellow parts in Figure 3.

Therefore, the main research question of the conducted research focusses on the kind of policy impact demographic changes have on (regionally diverse) daily mobility in 2040. The topic of this paper, however, is narrower and deals more on the geographic component of the underlying research.

First, the theoretical framework (chapter 2) and the research methods (chapter 3) will be described. Results are finally presented in chapter 4, followed by conclusions in the last chapter (chapter 5). Acknowledgements and a list of references can be found at the end of this paper.

2. Theoretical framework

By analysing existing literature, a theoretical framework has been set up. Several factors influence daily mobility, such as a) the need for mobility to be beneficial; b) personal characteristics; c) spatial settings; and other factors, such as d) economic growth. These topics are being described in this theoretical framework.

Mobility is a result of the need and desire of people to 'do things' at a different place from where they reside. Snellen (2001) states that: "Theories […] are mainly based on the notion that travel is the result of people's desire to engage in activities. Since activity locations are spatially distributed over a larger area, these activities cannot all be performed at the same location. The result is travel." The motivation to travel differs from person to person. People must have a (not necessarily financial) benefit from their travel, such as attending classes or going to work. The optimum between the costs of travelling and the value to go to a place different will finally result in mobility.

The cost/benefit optimum is different for every kind of person and it is influenced by personal characteristics, and constraints. The most important characteristics are: age, education, participation in the labour force, gender[5], and the opportunity to travel. For example, if a person has a driving license and a car, then s/he is possibly keen to travel by car; but if a person has no driving license; s/he is already *de jure* unqualified to drive a car. Being 'a member' of a certain age or date of birth cohort may show these effects of aggregated personal characteristics 'through time' (Van Dam et al 2013).

Cohorts can be sorted by age or by date (year) of birth. A fine example of an age cohort effect is that people in the group of 65-75 years old become more mobile. Whereas an example of a year of birth cohort is the variation of mobility by age through life, a person from the 1950s might be more mobile in the 1970s (his/her twenties) than in the 2000s (his/her fifties).

Besides personal settings and background, another impact factor are the spatial settings of either the origin or destination of travel. Ewing and Cervero (2010) mention five important so called D-factors: **D**ensity, **D**iversity, **D**esign, **D**estination accessibility, and

[5] Besides characteristics such as age and education, cultural background might be a value characteristic as well. It can be argued that such a factor substantially influences individual desires and thus mobility. Literature (e.g. Harms 2008) states that some foreign cultures appreciate car travel more, whereas others (for instance, native Dutch people) are keener to ride their bicycles. Unfortunately, due to practical issues such as data availability, this characteristic is not being researched.

Distance to transit. Obviously, these D-factors intermingle and influence each other as well. According to Gim (2012), *density* is the most important one, since all the other factors correlate highly with density. From a more practical viewpoint, *density* is relatively easily measurable and even predictable.

Besides a) personal and b) spatial characteristics, the c) economical context is an important factor too. In general, the economic growth leads to several consequences: a) more people being employed leads to a growing commuting potential; b) the people who are being employed are more specialised – and thus have to travel further to their employer of interest; c) people earn more – and people with a higher income intend to travel longer distances. It is estimated that economic crises are insignificant for long term (mobility) forecasts. Changes in population composition seem to be more important regarding their effect on daily travel than, for example, the current economic crises.

Finally, it is concluded that both personal and spatial characteristics influence daily mobility. Not only regarding the lengths of trips, but also the mode choice depends of these characteristics. Thus, on an aggregated level, the population size and composition have an impact on the personal characteristics and results finally in different mobility (see Figure 1).

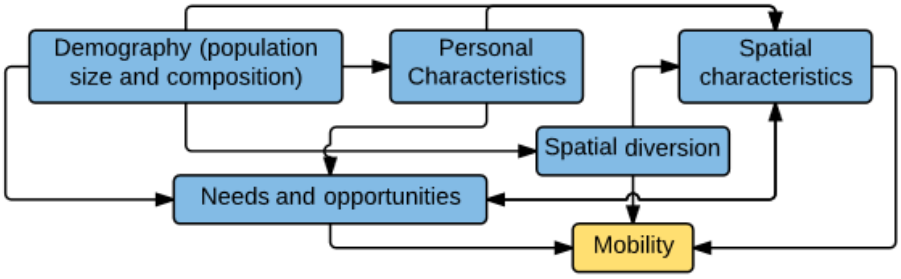

Figure 1: Conceptual framework.

3. Research method

To 'connect' demographic and mobility data and find patterns through time, extensive longitudinal data[6] has been used. The Dutch Bureau of Statistics and the Department of Public works and Water management (Rijkswaterstaat) do extensive mobility research. The first step is to find patterns between demographic and mobility data which can be retrieved from these datasets. The databases of the Dutch Bureau of Statistics and the Department of Public works and Water management are highly qualified for this task. After this first step, the second step is to apply these 'patterns of the past' for population size and composition predictions, which is available from Netherlands Environmental Assessment Agency. This finally results in a mobility prediction, but it is yet still unknown what kind of factors are responsible for the generation of daily mobility. Therefore, the third step, is to 'neutralize' (keep them constant) certain factors. These three and aforementioned steps are more extensively described in this chapter.

[6] For this research several databases from the Bureau of Statistics and the Department of Public works and Water management have been used: Onderzoek Verplaatsingsgedrag (OVG), Mobiliteitsonderzoek Nederland (MON), Onderzoek Verplaatsingen in Nederland (OVIN) en Projecting population Events At Regional Level (PEARL).

Past: 1985 – 2009

This longitudinal 'mobility research' contains all kinds of information regarding personal characteristics and daily mobility patterns of the respondent. For the purpose of this research, the data of this 'mobility research' is considered the best data source available. Although some changes have been made throughout the years, the 1985-2009[7] years seem to be fairly accurate and have no major data gaps. Thus, mobility or travelling is used as cycling, using a car (either as a driver or passenger) or public transport inside the Netherlands. Mobility of foreigners inside the Netherlands is not included in this research.

As mentioned earlier, regarding daily mobility both (a) personal and (b) spatial characteristics matter; for both characteristics, homogenous groups are made. As for personal characteristics, a distinction is made on the (as aforementioned) most important personal settings and include (a) age group; (b) level of education; (c) participation in the labour force; and (d) gender. Finally, several combinations of the mentioned personal settings results in twenty groups.

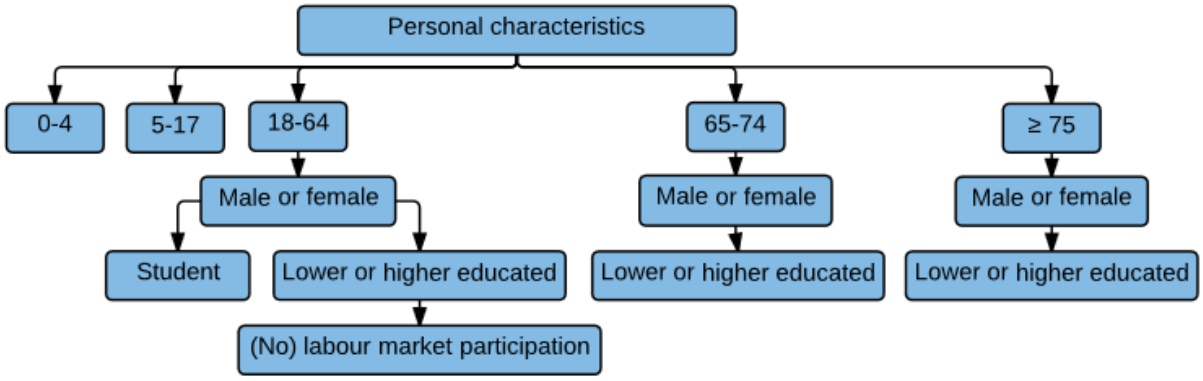

Figure 2: The used characteristics to distinguish several population groups.

Secondly, spatial differentiation is made according to (a) the distance from/to the Randstad; and (b) the area's density (on municipal level)[8]. The distance from/to the Randstad results in three groups, (a) Randstad; (b) Intermediate zone; and (c) Periphery. The area's density has been split in two (high and low density), which finally results in (3x2=) six different spatial groups. Since the characteristics of the four major Dutch cities[9] are being considered totally different than the characteristics of any other group, a seventh group is included for these four cities (see Figure 3). Unfortunately practical restrictions only made it possible to connect a municipality to just one region, even though it can be argued that municipal densities change from time to time (and thus migrate from one group to another). These restrictions unfortunately also hindered inclusion of other (more dynamic) characteristics as well.

[7] OVG: 1985-2004. MON: 2005-2009. Since the methods of research changes significantly in 2010 (OVIN: 2010-2012), these most recent years of research have not been used.
[8] Spatial differentiation is made in line with other research topics of Netherlands Environment Assessment Agency.
[9] Amsterdam, Rotterdam, The Hague, Utrecht.

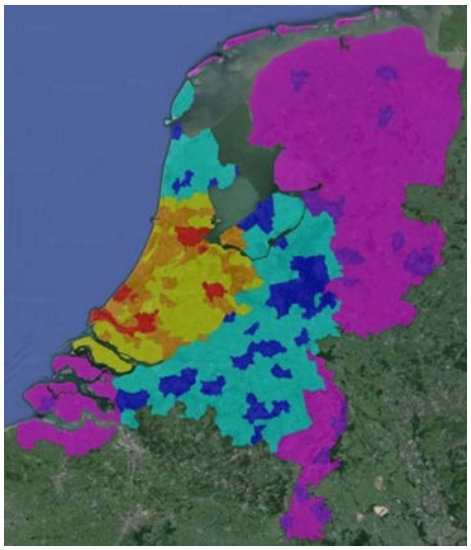

Figure 3: The Netherlands divided in seven regions on municipal level. Red: four major cities, orange: urbanised part of the Randstad; yellow: rural part of the Randstad; blue: urban part of the intermediate zone; cyan: rural part of the intermediate zone; purple: urban part of the periphery; pink: rural part of the periphery. Source map: Google maps.

With this differentiation in personal characteristics (20) and spatial characteristics (7) the datasets from the Bureau of Statistics are split and allocated to each kind of group (20*7=140). Of course it could be possible that data for certain years is missing or contain outliers, therefore five years have been averaged. The obvious downside of using a moving average is that change events are not to be seen anymore, but significant change events have been reported. An example of such an event is the implementation of a 'free' public transport card for students, the OV-studentenkaart. Since these events have been securely registered, using moving averages seems to be the best method of filling cells without data.

Future: 2009 – 2040

By connecting spatial data (density of municipalities, constant through time); demographic data (PEARL) and mobility data of the past connections are made for each demographic group in each of the seven regions. Since there are twenty personal characteristics groups, seven spatial groups and five transport modes, there is a total of (20*7*5=) 700 groups. Since this large amount of groups result in a relatively low number of responses per group, the amount of groups have been scaled down to make predictions more reliable.

First of all, national behaviour per group for the country as a whole is being calculated by using trend lines and best fit scenario's. Total mobility calculations have been done by calculating the daily distance per person travelled in combination with adding data about the population size. Since several regions are likely to deviate from the national average, a regional deviation factor has to be calculated. From then on it is possible to calculate daily mobility per group per region. Although this factor is not likely to be constant through time, another variable is included to create a more dynamic national deviation factor for each region.

From then on the mobility per group per region is predicted, which consists of regional behaviour (due to the regional deviation factor) and the regional population composition

(distracted from the population predictions)[10]. However, it is not known yet if either demographic characteristics or spatial characteristics suppresses or oppresses mobility. For example, the average of higher educated people in the four major cities is higher than in the rest of the country. Since higher educated people travel more than lower educated people, this demographic characteristic oppresses mobility. However, the spatial characteristic (city) suppresses mobility. It is likely that people in cities travel less than their rural counter parts. Thus, the demographic characteristic oppresses mobility, whereas the spatial characteristic suppresses mobility.

Therefore, to distinguish mobility effects due to spatial characteristic and from demographic characteristics, four analysis have been made per region. This is done by offsetting both regional and national population composition and daily mobility (see Table 1 for the relevant combinations). When comparing the results of the four analyses it is known if the change in daily mobility in a certain region is made by either the *behaviour* of the people living in that region (spatial characteristics) or the *composition* of the population living in that region (demographic characteristics). For example, when combination C gives a lower amount of daily travelled kilometres than A, regional behaviour must be oppressing mobility since the other factor (population composition) is a constant factor. When, at the other hand, combination B gives a lower result than A, the regional population composition must be an oppressing factor, since the population composition is considered to be constant.

Table 1: Analysis combinations to distinguish underlying mobility factors.

		Daily mobility per person per day (Km pppd)	
		Regional ($REGk$)	National ($NATk$)
Pop. comp.	Regional ($REGb$)	A: Regional behaviour, regional population composition	C: National behaviour, regional population composition
	National ($NATb$)	B: Regional behaviour, national population composition	D: National behaviour, national population composition

The same method is used when analyzing population composition factors separately: changing one of the variables into a dynamic factor (fed by the population predictions) and the other constant. This method is used for a) behaviour (for example due to spatial or economical changes); b population composition; and c) population size. The second factor, population composition, is further distinguished as can be seen in Table 2.

Table 2: Different scenario's to distinguish population size and population composition factors. V = variable is taken into account in the corresponding scenario, C = variable is kept constant.

			Scenario								
			1	1P	2	3	4	5	6	7	8	9
Km pppd	Behaviour		V	V	V	C	C	C	C	C	C	C
	Pop. Comp.	Labour force part.	V	V	C	V	C	C	C	C	C	C
		Level of edu. (m)	V	V	C	C	V	C	C	C	C	C
		Level of edu. (f)	V	V	C	C	C	V	C	C	C	C
		Level of edu. (65+)	V	V	C	C	C	C	V	C	C	C
		Age distribution	V	V+	C	C	C	C	C	V	C	C
Population size			V	V	C	C	C	C	C	C	V	C

[10] REGb * REGk in Table 1.

As shown in the 1P column the age distribution is even further distinguished with a 'variable+' scenario. This scenario considers the future retirement age change as flexible (65 years old retirement until 67 years old and further), whereas scenario 1 and 7 only isolate the influence of 'age distribution'. 1P also takes changes in, for example, the labour force and level of education into account.

Remarks

The data used from the Bureau of Statistics is considered to be reliable for the purpose of the research, although some cells are left empty and change events can 'disturb' the quality of data used. Therefore a moving average of five years has been used.

By predicting future mobility for both national and regional level, the demographic influence can be distinguished from the regional influence (for example caused by spatial characteristics). The third step is to use PEARL-data to predict future daily mobility. By either using the raw data (flexible) or keeping the data on a 2010 level a further details can be explored. The results of these explorations are being described in the next chapter.

4. Results

The results of the research are mentioned in this chapter. First of all a general overview of the results will be given, followed by two smaller paragraphs related to the change in population composition, namely a) the growing participation of women in the labour force and b) the change in the retirement age (as mentioned in column 1P before).

Population size versus population composition

As mentioned earlier, regional diffusion regarding daily mobility in a region can result from either a demographic composition or a spatial composition. It is, for example, seen that the four major cities house have a (relatively) large group of higher educated people and these people are keen to travel. However, compared with the other regions, the four major cities are also the ones with the highest density. Thus, the demographic composition in the four major cities is an oppressor for mobility (+10%), whereas the spatial characteristics act as a suppressor for mobility (-5%). In the rural region of the periphery it is the other way around, in these regions a majority lower educated and older people live (suppressor; -5%), but the spatial characteristics are an oppressor for mobility (+3%). Results are displayed in Table 3.

Eventually it is seen that mobility in all regions rises, however, the causes are different. The population composition matters more in the urban regions, whereas other factors (such as spatial ones) matter more in rural parts of the country. In general, it is concluded that mobility grows. In the first researched period (1985-1989), about 150 billion kilometres were made annually in the Netherlands. About twenty years later (2005-2009) the annual amount of kilometres has risen up to 188 billion kilometres annually. Forecasts predict a further rise until approximately 206 billion kilometres annually in 2036-2040.

Table 3 Effect of population composition and of behaviour (e.g. due to spatial characteristics) on daily mobility for seven regions for the set of years 1985-1989; 2005-

2009; 2036-2040 when compared with the national average.[11] Source data: OVG, MON, PEARL. Edited by author.

	Effect of population composition			Effect of behaviour		
	1985-'89	2005-'09	2036-'40	1985-'89	2005-'09	2036-'40
Four major cities	1,11	1,10	1,10	0,95	0,97	0,94
Randstad (rural)	0,90	0,90	0,90	0,95	0,99	1,02
Randstad (urban)	0,97	0,97	0,98	0,96	0,99	0,99
Intermed. (rural)	0,93	0,91	0,91	0,99	1,01	1,03
Intermed. (urban)	1,00	0,96	0,96	0,98	0,99	1,00
Periphery (rural)	0,95	0,96	0,96	1,03	1,03	1,05
Periphery (urban)	1,10	1,09	1,08	0,99	1,00	1,00

Table 4 Average annual growth of daily mobility in the Netherlands between 1985-1989 and 2005-2009 (left) and 2005-2009 and 2036-2040 (right). Source data: OVG, MON, PEARL. Edited by author.

	1985-'89 until 2005-'09	2005-'09 until 2036-'40
Total growth	1,14%	0,30%
Due to behaviour	-0,02%	0,00%
Due to population size	0,57%	0,30%
Due to population composition	0,49%	0,02%
Due to interaction	0,10%	-0,01%

As mentioned previously, the demographic factors are split into (a) population size and (b) population composition. The changing size of the population is by far the largest responsible factor for this growth, although population composition is responsible for a fair share in mobility growth as well. Furthermore (c) behaviour and (d) interaction variables have been added. As seen in Table 4, the growth of mobility has been approximately 1,1% in during 1985-1989 until 2005-2009 and will fall in the forthcoming period to 0,3%. The effect of the population size (0,6%) and composition (0,5%) are major in the first period, but in the second period, only the size of the population will have major impact on the growth of mobility.

In the figures below the effects on mobility due to demographic changes are shown. The first chart in Figure 4 shows the effect for the Netherlands as a whole, the two other charts of Figure 4 show the same idea for the four major cities and the rural part of the periphery. These regions are the most polarised regions and thus the most interesting to show.

An important factor of the effects on mobility due to demographic change is the age distribution of the Dutch population. It has had a positive effect on the growth of mobility, however, due to the aging society this is about to change in the near future (approximately mid 2020's). At first, the post war 'baby boom' of the 1950s joined the labour force, resulting in more mobility; since the 'baby boom' generation retires (or is about to retire) the age distribution of society will *ceteres paribus* result in less mobility.

[11] Results have been displayed for five years moving averages.

Regarding the population composition, the level of education of women is the main growth factor and therefore firstly highlighted. Furthermore, the effects of the changing retirement age have been, secondly, highlighted.

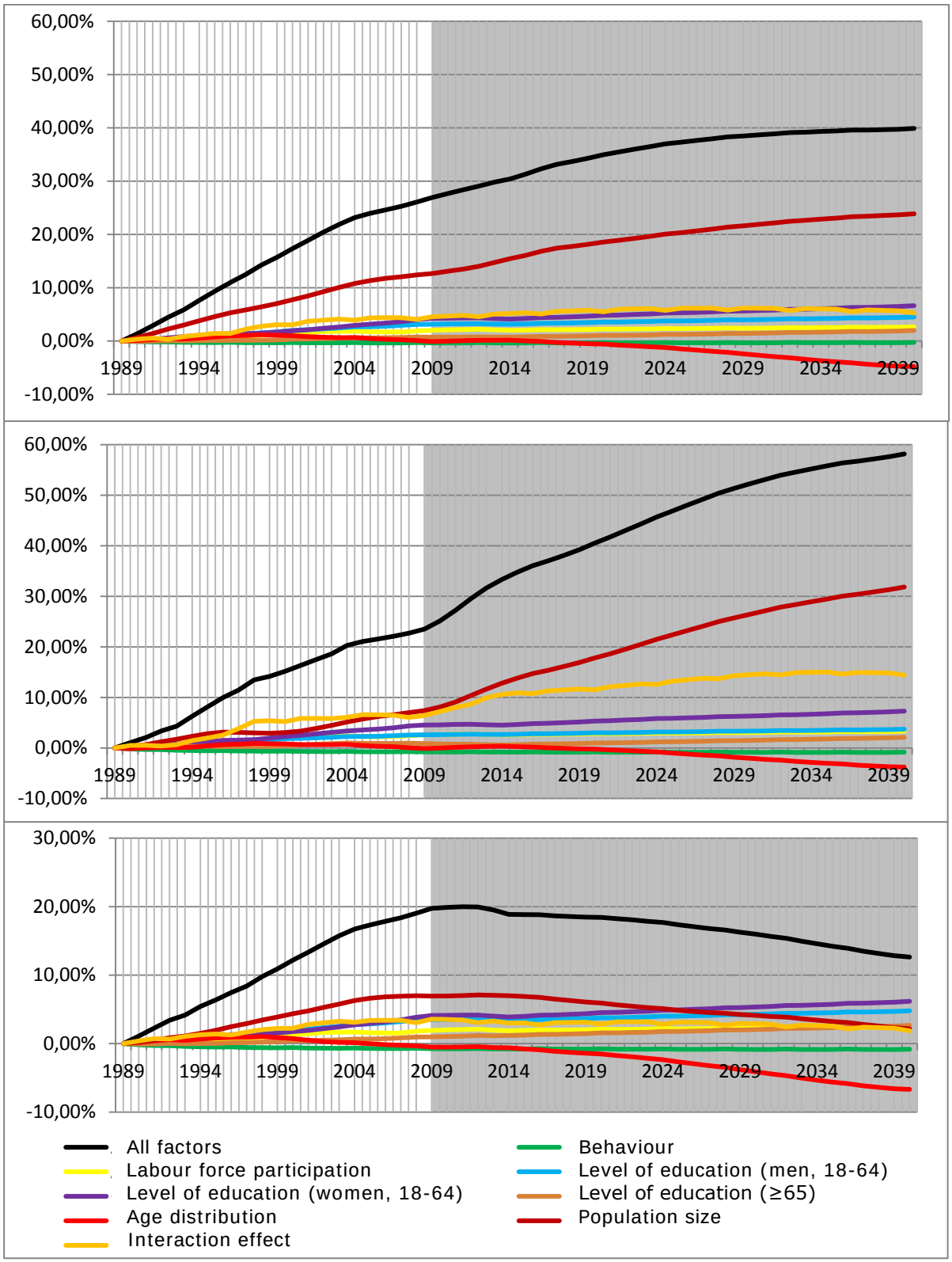

Figure 4: Demographic developments per scenario and the result of mobility growth in the Netherlands (above), the four major cities (middle), and rural part of the periphery (below). Data: OVG, MON, PEARL. Edited by author.

Gender related results

The Dutch population, women in particular, have more driving licenses than they ever had before. The growing percentage of driving licenses has a significant correlation with both participation in the labour force, and level of education. Correlation between car mobility and total mobility is significant as well. This effect of the rise of mobility can finally be seen in Table 6, in combination with Figure 7.

Table 5: Correlations regarding participation in the labour force, the level of education and the drivers licence occupancy versus car mobility (as a driver) and total mobility for the years 1985-'89 until and with 2005-'09. Driver's license occupancy and mobility (per kilometer per person per day) is displayed per gender. Correlations are significant with: **, <0,01. Data: OVG, MON. Edited by author.

	Male			Female		
	Labour force part.	Level of education	Driver's license occupancy	Labour force part.	Level of education	Driver's license occupancy
Driver's license occupancy	,901**	,915**	-	,972**	,980**	-
Car mobility	,740**	,778**	,665**	,986**	,980**	,946**
Total mobility	,762**	,794**	,802**	,973**	,972**	,968**

Table 6: Correlations regarding age cohorts and (car)mobility within the Netherlands. Correlations are significant with: **, <0,01; *, <0,05; ns, not significant. Data: OVG, MON. Edited by author.

	Total mobility				Car mobility			
	Total	Men	Female	n	Total	Men	Female	n
0-99	0,41**	0,288**	0,555**	205	0,687**	0,597**	0,801**	174
0-17	-0,621**	-0,617**	-0,613**	31	-	-	-	-
18-64	0,295**	-0,067 ns	0,745**	98	-0,318**	-0,487**	0,199*	98
65-74	0,637**	0,577**	0,643**	21	0,840**	0,795**	0,891**	21
75+	0,113ns	0,173 ns	0,021 ns	55	0,614**	0,542**	0,712**	55

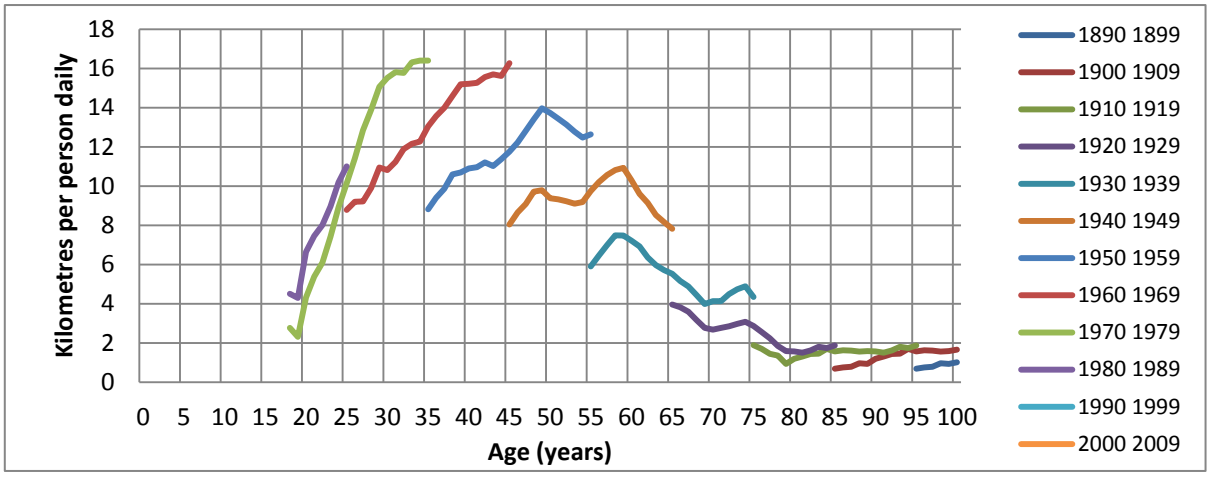

Figure 5: Car mobility of women (by year of birth) in the Netherlands displayed by age. Data: OVG, MON. Edited by author.

Entitled retirement age

The earlier presented results presume a *ceterus paribus* situation considering many events, including the change of entitled retirement age. Changes regarding entitled retirement will result in a proximate extra rise of about two to three percent in 2036-2040, resulting in approximately 212 billion travelled kilometres annually. When a constant retirement age is taken into account, the total travelled kilometres annually tops, according to prediction, 207 billion travelled kilometres.

Growth is mainly caused due to a relatively higher participation in the labour force and thus of the mobility related to 'working'. Especially car transport and public transport kilometres are responsible for the mobility growth. Both modes have an extra growth (on top of the index growth) of approximately 4% in 2036-2040.

The added growth is mainly seen in the intermediate zone, whereas the four major cities and the cities in the periphery grow less. It should, however, be noticed that solely the entitled retirement age has been changed in the model. Even though it can be argued that people who still participate in the labour force, favour to reside within or closer to economic vital regions. Further research should be carried out if a change of other influential variables (such as moving) should be taken into account as well.

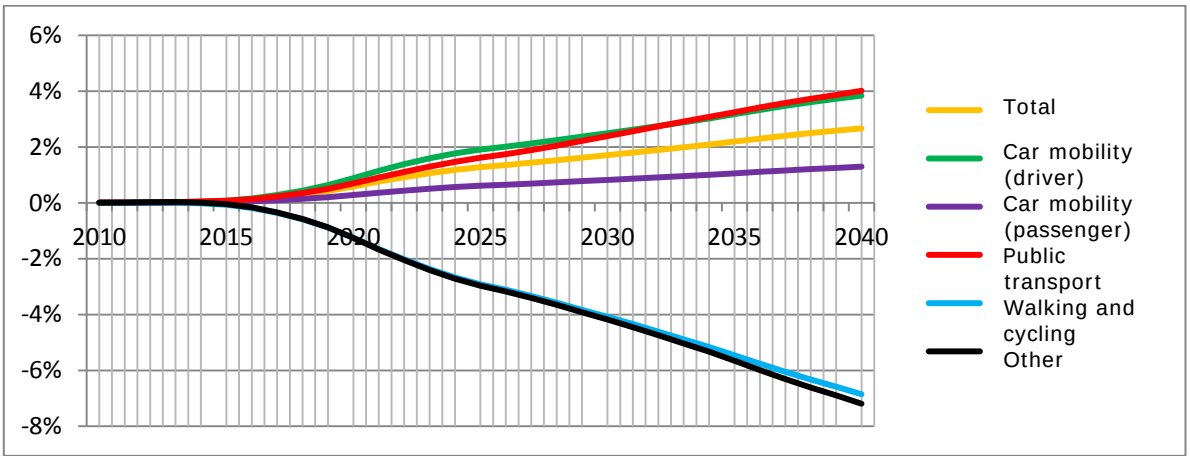

Figure 6: Growth of the annual mobility per transport mode in the Netherlands due to changing entitled retirement age for the years 2006-'10 until 2036-'40 (on top of the index growth). Data: OVG, MON. Edited by author.

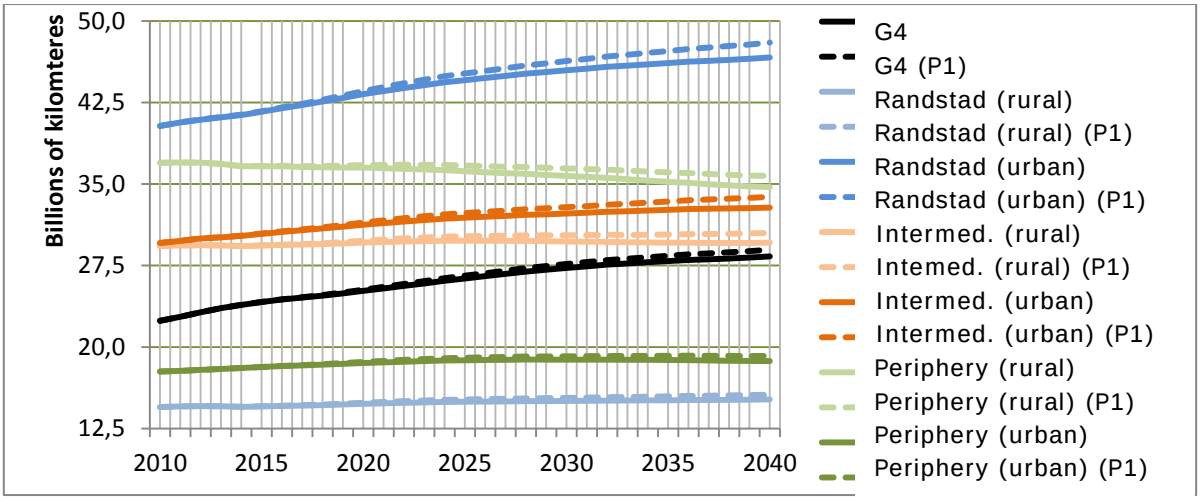

Figure 7: Forecast of the annual mobility without (non-dashed) and with (dashed) differentiation regarding entitled retirement age. Data: OVG, MON. Edited by author.

5. Conclusions

This paper gives a brief insight into the effects on mobility caused by demographic changes, such as population growth and changes within the population composition. Exploring and analysing existing data deeper leads to conclusions such as: a declining growth of mobility within the Netherlands, b) the large effects population size, population composition, and spatial characteristics have, especially when compared with a static behaviour variable.

On a more detailed level, it can be said that the rising level of education of women is the largest population composition effect on mobility. Although growth is also caused by a larger (and correlated) labour force participation. Over time, just one factor acts as both an oppressor and a suppressor of mobility: age distribution of society. The most important reason is the enrolment of the baby boom generation into the labour force from the 1970s onwards and the entitled retirement of the same baby boom cohort, obviously resulting into more mobility at first and less at last.

For infrastructure and mobility planners, the most relevant conclusion is that uncertainty rises. The ‘mobility will certainly grow’-paradigm of the past will have to be abandoned, growth will either change into (a) growth; or (b) shrinkage; or (c) stabilisation. Both the first and the second scenario will face major challenges regarding liveability and financial support of both infrastructural needs and public transport. Most likely the cities are about to grow, whereas the rural part of the Netherlands will face shrinkage. Especially in the urban regions, with high population densities and intensive (rail)road network usage, it will be challenging to build and maintain transport infrastructure. Mobility will shrink less than the population in the rural parts of the country. Thus the *per capita* costs of infrastructure and public transport will rise here. New infrastructure should mainly be build because of liveability and social issues. Demand for new infrastructure is not necessarily caused by quantitative reasons. The third scenario, stabilisation, comes with major uncertainty about the future. Will mobility eventually rise or shrink? In this case smaller no regret measures are being favoured above bigger projects.

Further research should focus on factors that are considered constant in this research. Amongst others these are a) a more ethnic diverse distribution of society; and, b) the change of land use and density group over time. The termination and rise of new modes of transport, such as electric powered bikes or automatic vehicles will add another ‘layer’ to the model. It would be interesting to have a larger diversity of population groups, for example by dividing the 18-65 years old group into groups of ten or even five years. Unfortunately the used data sources are unable to provide enough data for further separation of these groups, while maintaining significant results. Hopefully new data gathering techniques encourage researches to continue researching this topic.

Another interesting variable to add are change events in people’s life. For example, what happens with mobility someone generates when a couple marries (or separates), or when they have kids? Within different classes of society these change events may occur at different ages, but it can be argued that these change events are (even more) influential than *sec* the cohort people belong to. Hopefully these questions inspire people to continue researching effects on mobility caused by demography.

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