Planbureau voor de Leefomgeving

The demographic projections of the Netherlands Environmental Assessment Agency (PBL) and Statistics Netherlands (CBS)

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Plan for the day

1. Population projections: definition, relevance
2. Uncertainty and scenarios
3. Projection of trend
4. The cohort-component model and growth components
5. The Regional population projections by CBS/PBL 2019 Link
6. Accuracy of previous projections

Who am I

- Norwegian, living in the Netherlands for 10 years
- PBL for 3.5 years
- Working with the population projections for 1.5 year
- Economist by training (VU Amsterdam)

Why am I working with this

- It's my job...
- Population change is important for economic questions
- Challenging topic: large uncertainties
- Population growth and migration is a never ending source of relevant research questions

Source: https://img.clipartxtras.com/03843abee543e741be870c4ada22c760_free-to-use-public-domain-cauldron-clip-art-witch-cauldron-clipart_500-500.png

Definition of projections

- Van Dale: *statement about the probable course or the probable outcome or outcome of elections, competitions and the like.*
- Projections $\neq$ forecast $\neq$ scenario studies
- Projections are, almost by definition, wrong: population projections with no error are most likely result of coincidence
- Think of projections as an attempt of establishing the *most probable* trajectory of population change
- Anyone working with population projections should have this in mind

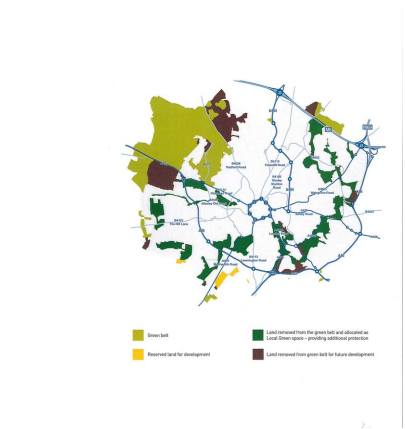
Why do we make demographic projections?

- Population change is important in other settings: house prices and rent in Amsterdam are high because many people want to live in Amsterdam
- Policy makers use them: plans for new residential areas, schools, location of hospitals...
- Economists use them: gdp growth = population growth + productivity growth
- Important: normative (is population growth good or bad?) versus descriptive (what are the main drivers of population growth?) analysis

Why do we make (regional) demographic projections?

- National projections: population in the Netherlands is projected to grow
- Population growth is not uniformly distributed: which regions will grow and which will decline?
- What is the regional impact on population of trends in the components? Will the trends continue into the future (subjective)?

Why do we make demographic projections?



Source: `https://www.coventrytelegraph.net/news/coventry-news/revealed-swathes-green-belt-lost-10674329`

Based on population projections from the UK ONS, the city council of Coventry is planning to develop its Green Belt. Not everyone is happy

> *Population projections might have some value in projecting school numbers five years ahead (although recent experience in the Council might cast doubt on that) but projecting twenty years up to 2031 is completely unrealistic.* Link

Demography and projections

- Demography: description of the past
- Projections: best guess of the future
- Population and households:
  - *Amount*: number of households and people
  - *Composition*: distribution by gender, age, ethnicity/background, household position
  - *Spatial distribution*: world, country, region (province, COROP, municipality, neighbourhood)
  - *Changes*: birth, death, immigration, emigration, departure or arrival, transitions between household positions
- Cohort-component model: population change from trends in growth components

The origins and definition of uncertainty

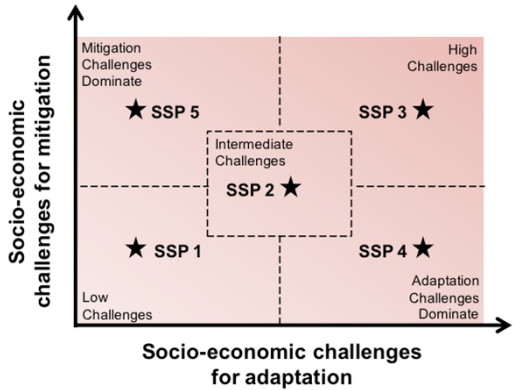
- Typology: Unknown knowns; known unknowns; unknown unknowns.
- Population projections only account for the first type
- The cohort-component model is a book-keeping system; per definition no uncertainty
- However, substantial uncertainty in the trend of the growth components
- Incorporating uncertainty: create projection interval with possible outcomes (according to the model)

Uncertainty in the projections

- Circularity: what you are trying to project might be affected by your projection
- Self-fulfilling prophecy: building plans reflect projections, projection becomes true
- ...or self-denying prophecy: policy makers do not like projection and restrict migration, projection is wrong

Scenarios versus projection

- Scenario's are quantification of future *story lines*, not necessarily the *most likely* outcomes
- A way to structure discussion of possible futures, for example about the impacts of climate change



Source: https://climate4impact.eu/files/SSPs.png

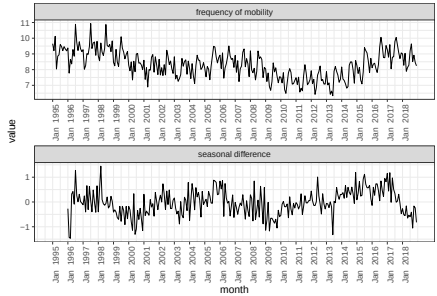
Projecting of growth components: requirements

In order to make a *quantitative* projection, the following two conditions need to be satisfied:

1. Historic data of what we are projecting is available
2. We can reasonably assume that patterns and relationships from the past will (at least to some degree) extend into the future

Projecting growth components: models

Let's say we want to project internal migration frequency (moves per 1000 inhabitants) into the future. Three possible models:

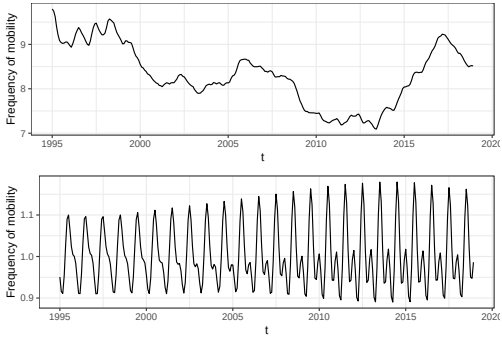


- $\text{frequency}_{t+1} = f(\text{frequency}_t, \text{frequency}_{t-1}, ..., \text{error}_t)$
- $\text{frequency} = f(\text{housing-market}, \text{labour-market}, \text{month}, ..., \text{error})$
- $\text{frequency}_{t+1} = f(\text{frequency}_t, \text{housing-market}, \text{labour-market}, \text{month}, ..., \text{error}_t)$

Projecting growth components: time-series decomposition

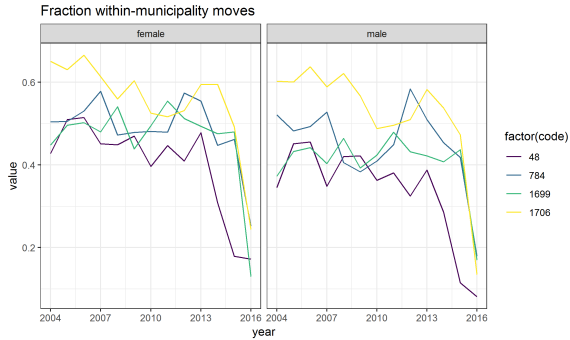
Trend + seasonal + cycle + error

- *Trend*: a long-term increase or decrease in the data, does not have to be linear
- *Seasonal*: time series is affected by seasonal factors such as the time of the year or the day of the week. Seasonality is always of a fixed and known frequency.
- *Cycle*: data exhibit rises and falls that are not of a fixed frequency. Fluctuations are usually due to economic conditions



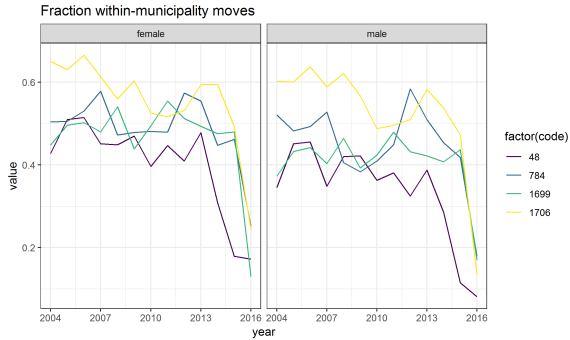
Identifying the trend

The fraction of within-municipality moves for some municipalities hosting an asylum-seeker centre. What is the fraction in 2028?



Identifying the trend

The fraction of within-municipality moves for some municipalities hosting an asylum-seeker centre. What is the fraction in 2028? Relatively small municipalities where a large proportion moved from another municipality and moved quickly to another municipality.

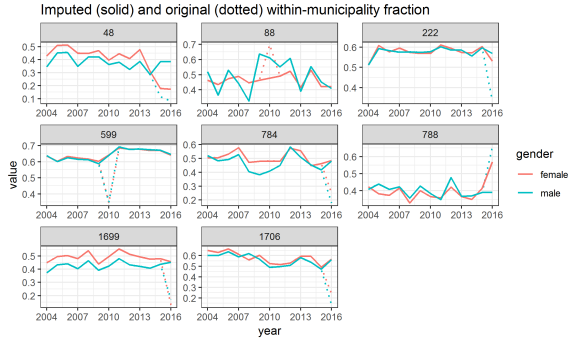


Questions

1. Is the large drop in within-municipality moves a trend, a cycle or noise?
2. How can we conceptually think about this? Which of the three models is most appropriate?
3. Which assumptions do we need to make in order to estimate the fraction of within-municipality moves in 2018?

Identifying the trend

One solution: impute the outliers with a regression model. Many other methods available



Cohort-component model (national)

$$P_{t+1} = P_t + B - D + I - E$$

P_t: population in t

B: births in the interval $(t, t+1)$

D: deaths in the interval $(t, t+1)$

I: immigration in the interval $(t, t+1)$

E: emigration in the interval $(t, t+1)$

X typically calculated as $\frac{X_t + X_{t+1}}{2}$

Growth components

Cross-sectional (calendar year)

- Changes related to the business cycle
- Fluctuations in birth rates
- Stricter immigration policies
- Enlargement of the EU (work-related migration)
- War (asylum seekers)

Longitudinal (cohort)

- Structural changes
- Average number of children from 3 to 2
- People live longer

Growth components at different scales

World: births and deaths

National: births, deaths, net migration

Regional: births, deaths, net migration, arrivals and departures

Source: http://4.bp.blogspot.com/-8pNWCR1SJhY/T83V8A2HzXI/AAAAAAAADuM/aRub2XdIBEo/s1600/Planet+Earth+8.jpg

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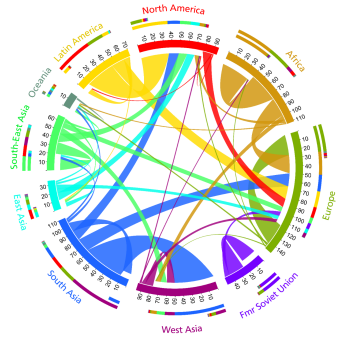

Source: http://www.slate.com/content/dam/slate/blogs/the_world_/2014/04/02/world_on_the_move_five_years_of_global_migration_in_one_chart/circular_plot_flows_between_world_regions_200510_1.png.CROP.cq5dam_web_1280_1280_png.png

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Source: https://i.ytimg.com/vi/68nvHI10BdA/maxresdefault.jpg

Regional population projections

Top-down: disaggregate national numbers to the region
+: straight forward to implement
+: per definition consistent with national numbers
–: little/no insight into determinants of regional population change

Bottom-up: calculate regional numbers consistent with national numbers

+: insights into determinants of regional population change
–: heavy data and time requirements
–: extra step required to ensure consistency with national numbers

Question

1. In a parallel dimension, a (much smaller) earth is populated by 100 people in year t. In $t+15$, the maximum population aged 15 and above is 100. What else do we need to know in order to project the exact population in $t+15$?
2. The population is evenly distributed between two countries: A and B. What do we need to know in order to project the population in A and B in $t+15$?

Regional population projections

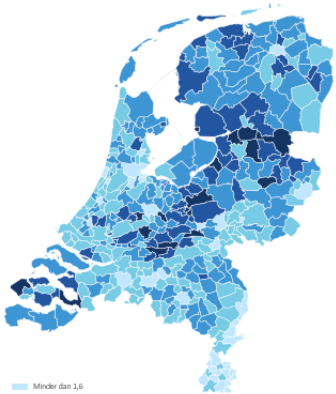
- Projections of population, households and demographic events in Dutch municipalities until 2040
- Carried out every three years: most recent edition published last week!
- Regional projections (PBL/CBS) are made consistent with the national projections (CBS)
- The projections made with the cohort-component model PEARL (Projecting population Events at Regional Level)
- Trends in components of population growth and transition rates between household positions are projected separately as inputs to the model

Total fertility rate

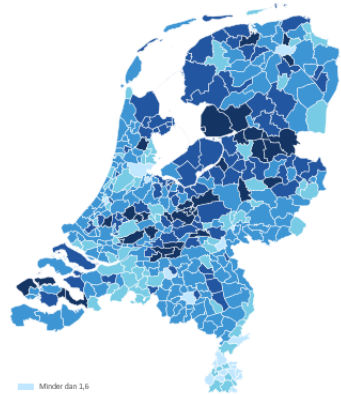
- TFR = average number of children per woman for each municipality
- Regional variation due to
  - share of singles among women in age group 20 - 40 (-)
  - share of votes for Christian parties (+)
  - share of people on social benefits (-)
  - building construction (+)
- Changes in the share of single women and building construction affect projected TFR

Total fertility rate in 2016 and 2035

TFR in 2016



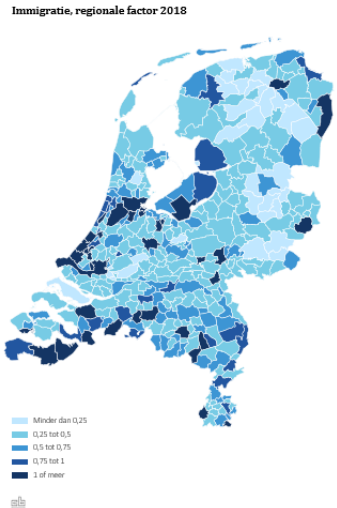
TFR in 2035

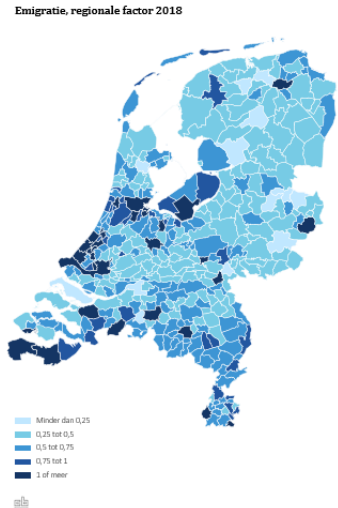


Immigration and emigration

- Since 2015 asylum migration has declined, but total migration still grows. Primarily from EU countries, primarily for work, study or reuniting with family
- Emigration often follows immigration in size (many return), but this time to a lesser extent
- Assumption: the current high net migration is a cycle-effect, immigration will decrease and emigration will increase
- Regional: concentration index of immigration and emigration
- $CI_r = \frac{immigrants_r / \sum_r immigrants_r}{population_r / \sum_r population_r}$

Immigration and emigration





Short-distance migration and the dwelling stock

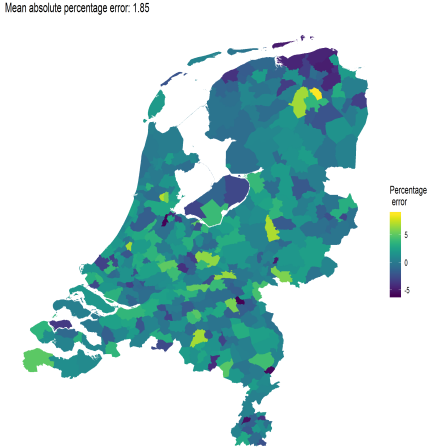
- PEARL distinguishes long- and short distance migration (cut-off 35 km)
- Long distance migration probability matrix extrapolated from past observations
- Distribution of short-distance migration predicted with a spatial interaction model, with population at destination, distance between origin and destination and building construction at destination as explanatory variables.

Short-distance migration and the dwelling stock

- Strong relation between population growth and the number of dwellings: effect of new construction is particularly strong in municipalities with a shortage of housing
- Short-distance migration in PEARL:
  1. Potential moves estimated with spatial interaction model
  2. Actual migration calculated by taking into account housing availability (potentially moving back to 1...)
- Building plans are obtained through a combination of desk research and consultation with municipalities and provinces

Link

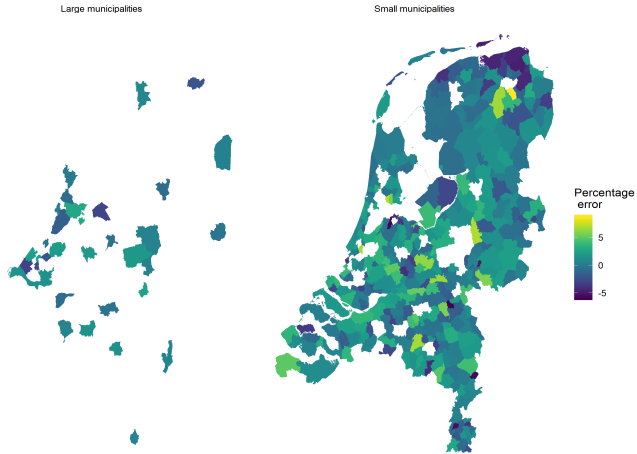
How accurate were previous projections? [1] [2]



1 Population in 2017 according to the 2013 edition, compared with the data.

2 $error = \frac{actual - prediction}{actual} * 100$

How accurate were previous projections?[3]



3 Large: >100000 inhabitants

Explaining deviances

- 2012 was, in terms of the housing market, still very much a crisis year
- Plans for future building by municipalities and provinces were likely pessimistic
- The sour mood worked through the projections of short-distance migration into the population projections!
- The deviations were larger in small municipalities (still PEARL did better than a naive forecast)

Link

Questions

- So...projections are, almost by definition, wrong. Why do we bother?
- Municipalities and provinces base their building plans on them, should they?
  ▸ Link
- An alternative is judgmental forecast: project developer decides what/where/how much should be built.
- What can possibly go wrong here...?

Conclusions

- *Prediction is difficult, especially about the future* Niels Bohr (?)
- *Essentially all models are wrong, but some are useful* George Box
- Uncertainty is inherent in any projection, and projections are almost never exactly accurate.
- Population projections are nevertheless useful for policy making. And it is not clear whether the alternative (judgmental forecast) is better.
- Regional population projections of CBS/PBL: check out the link of page 2!