SIPP

Statistics Iceland's Population Projections

Hierarchical modelling of fertility, mortality and migration data

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Problem and solution, for all components of PopProj:
migration, fertility, mortality (by age, time, Z)*

- ***Problem**:*
- *estimating and predicting* in the presence of:
- small area/population issues,
- expert assumptions
- rare events/ shocks
- while reporting *uncertainty*

- ***Solution***:
- Modeling and combining (prior) information

Status and new results

Current: *functional, ARDL & bsts/brms models f(age, time)*

- smoothing and orthogonal expansions for *Fertility and Mortality*
- disjoint predictions:
    - econometric / decay models for short / intermediate term Migration
    - time series / assumptions for long term Migration

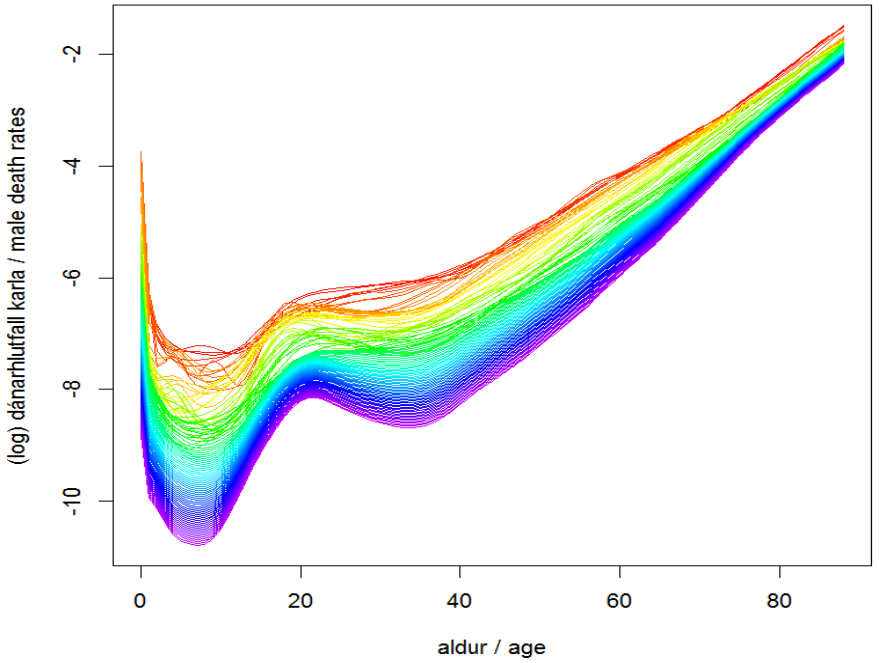
New & testing: *hierarchical/multilevel* (*Bayesian and freq.) models*

- smoothing/processes (t, age,…)
- complex correlation structures, spatial, demographic, social, … characteristics
- incorporate quantitative & qualitative info: *priors*

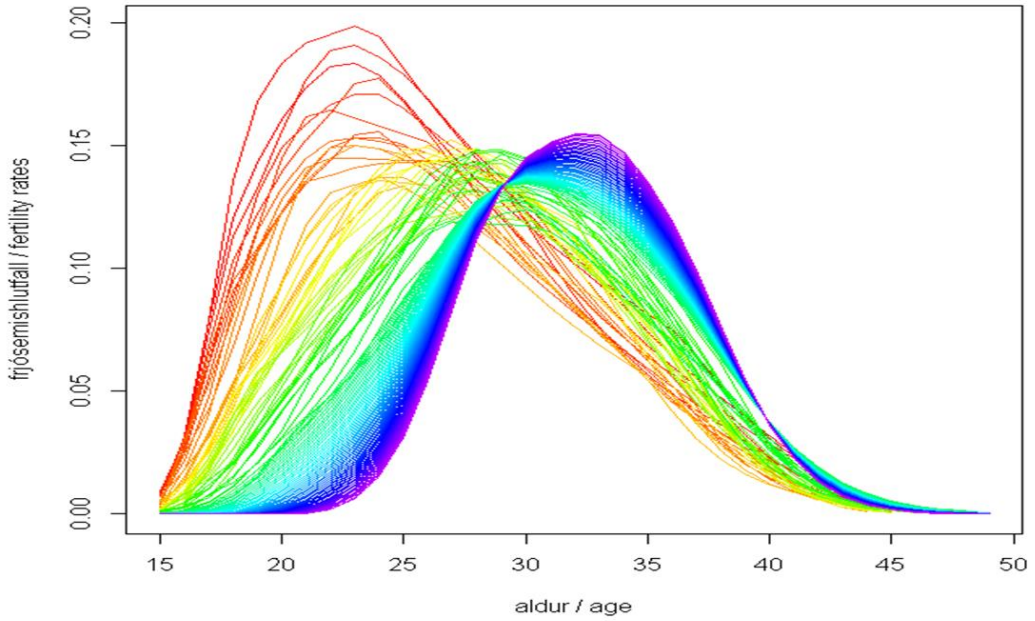
** *Model averaging options*

Typical results of functional models

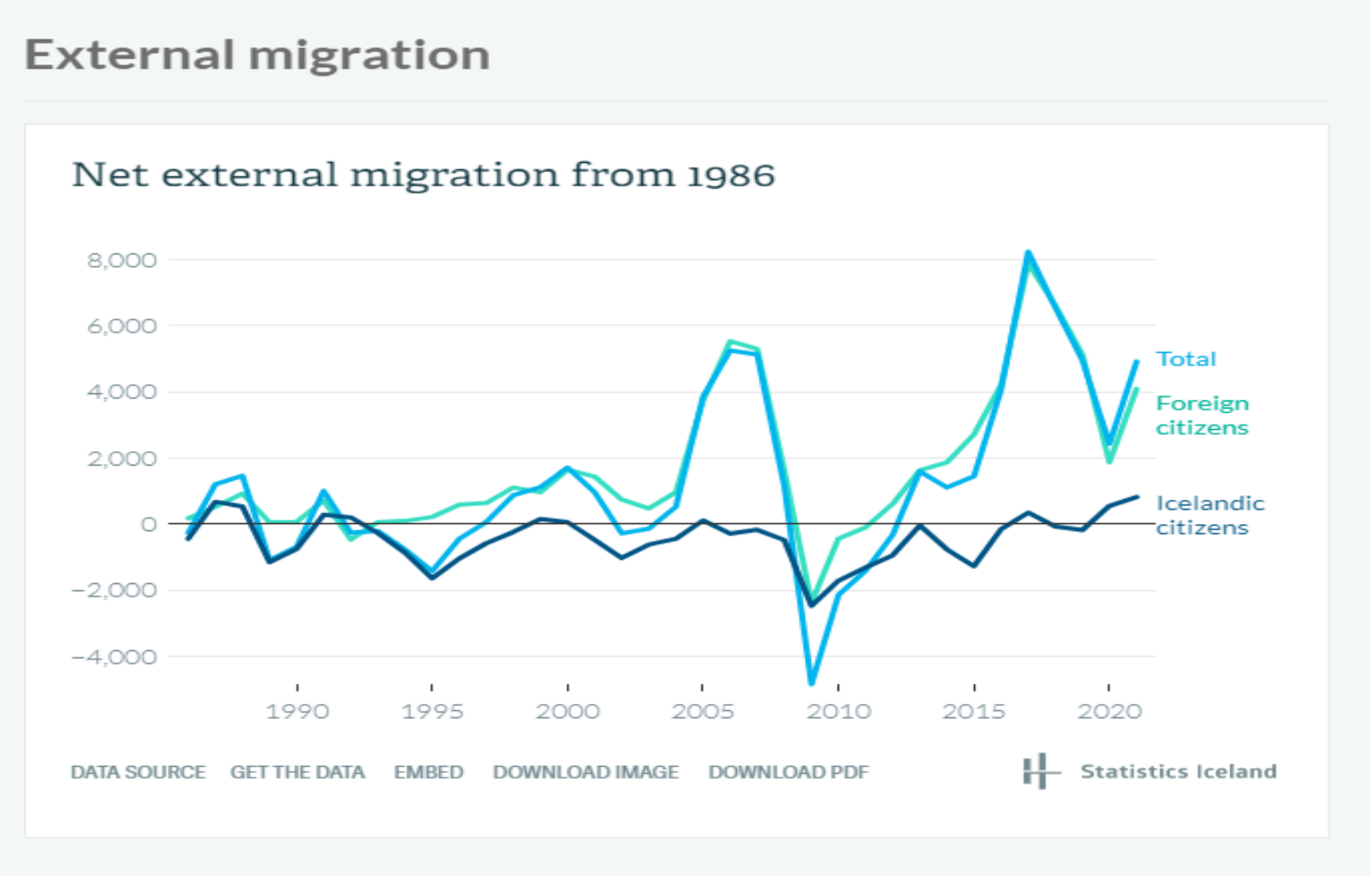
Mortality rates



Fertility rates



Migration issues and models



Past approach:

Long and short term migration predictions:

disjoint!

Future:

New Models:
P(Y|a) =F1(X) where P(a|b)=F2(c) where…

- Type: **Hierarchical/Multilevel** as Bayesian / frequentist

  individual or aggregated response versions, depending on available input data

- Why:

  „all (components/prior information/characteristics/local&total) in one“ & uncertainty report

- ***R***-Tools:

  several *Stan*-running R packages like ***brms***, arm, bayestestR, …

  and the faster *lme4, gamm4* - for frequentist / initializations, …

Hypotheses tests via modeling

- Variability of:

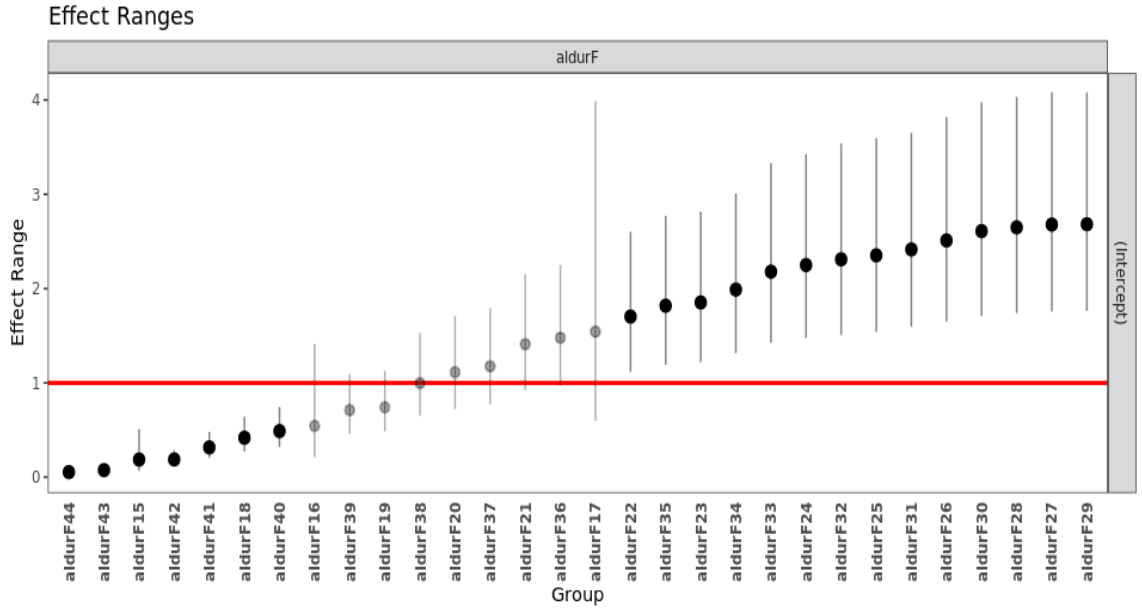
  fertility, mortality, migration

- through (+auto-correl):
  - ***Time & age*** *(s(t) , gp(t, age), t2(t, age), …)*
- by:
  - **Municipality**, Region – significant for: migration but not for fertility, mortality
  - Other characteristics: education, family related, municipality attributes, …
  - More characteristics/dimensions (ut/is, im/e, f/m)

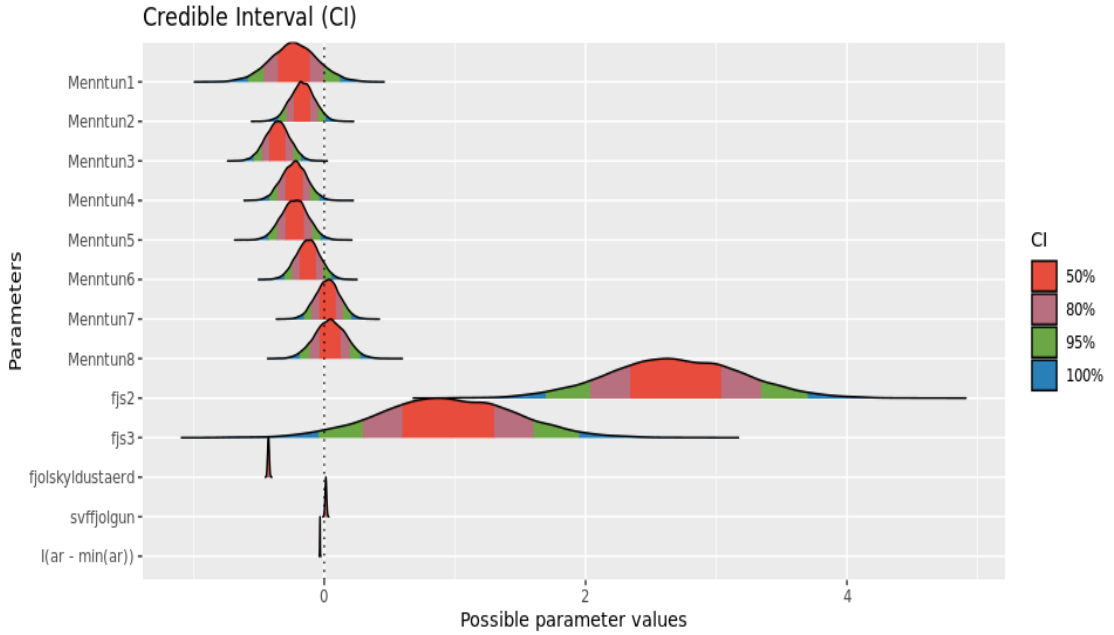
V1. Microdata input

V1.1.Microdata: fertility. Testing hypotheses

Age group effect on fertility (o.r. units)

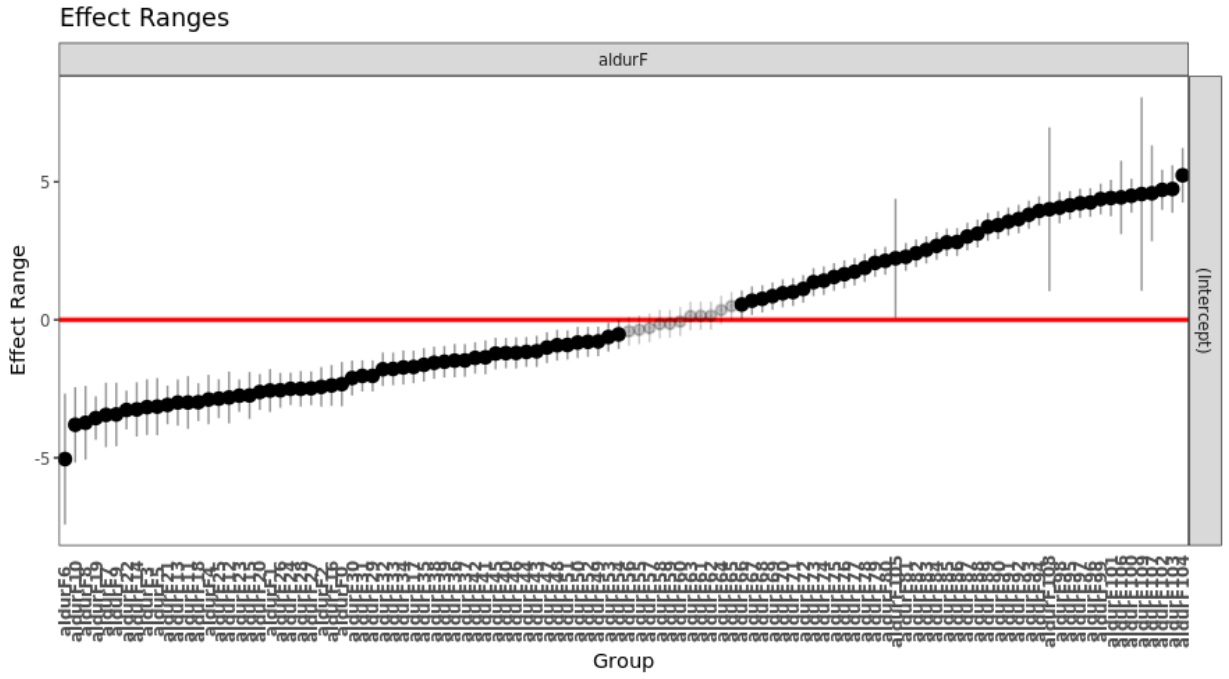


Characteristics‘ effects on fertility

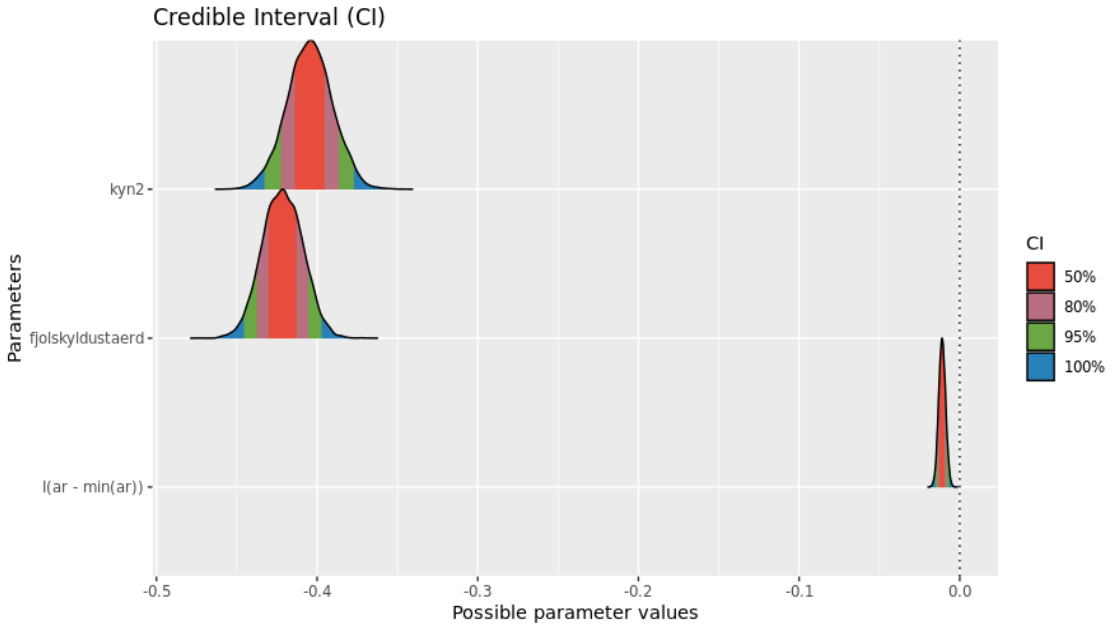


V1.2. Microdata: mortality. Testing hypotheses

Age group effects

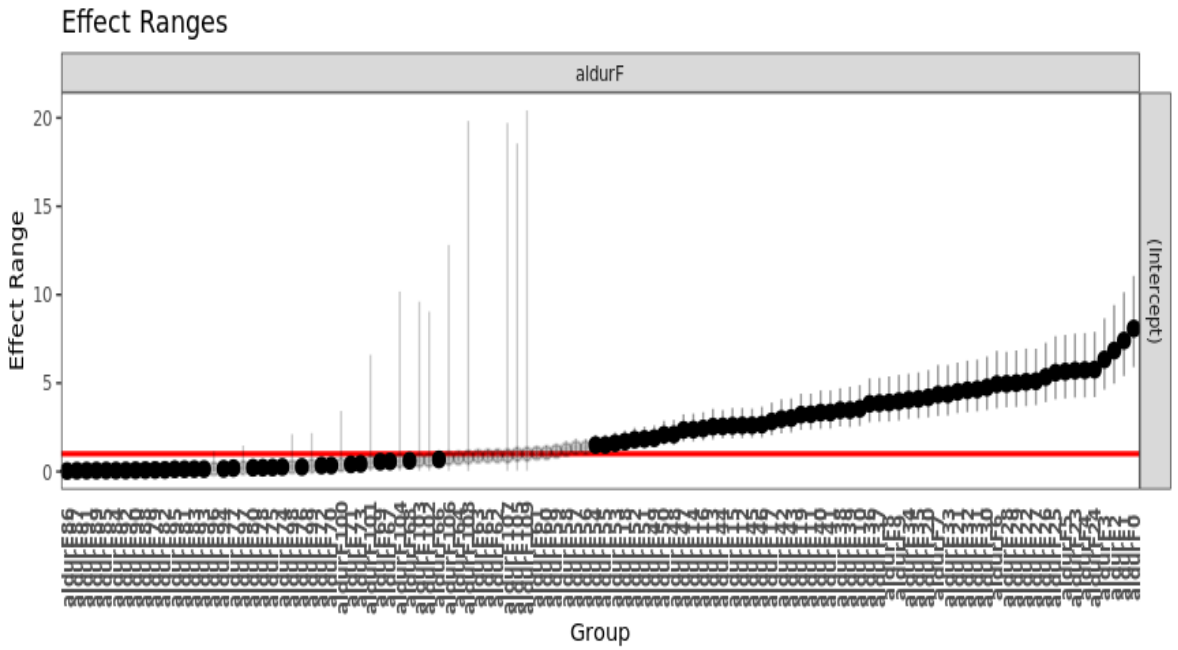


Characteristics‘ effects on mortality ☺

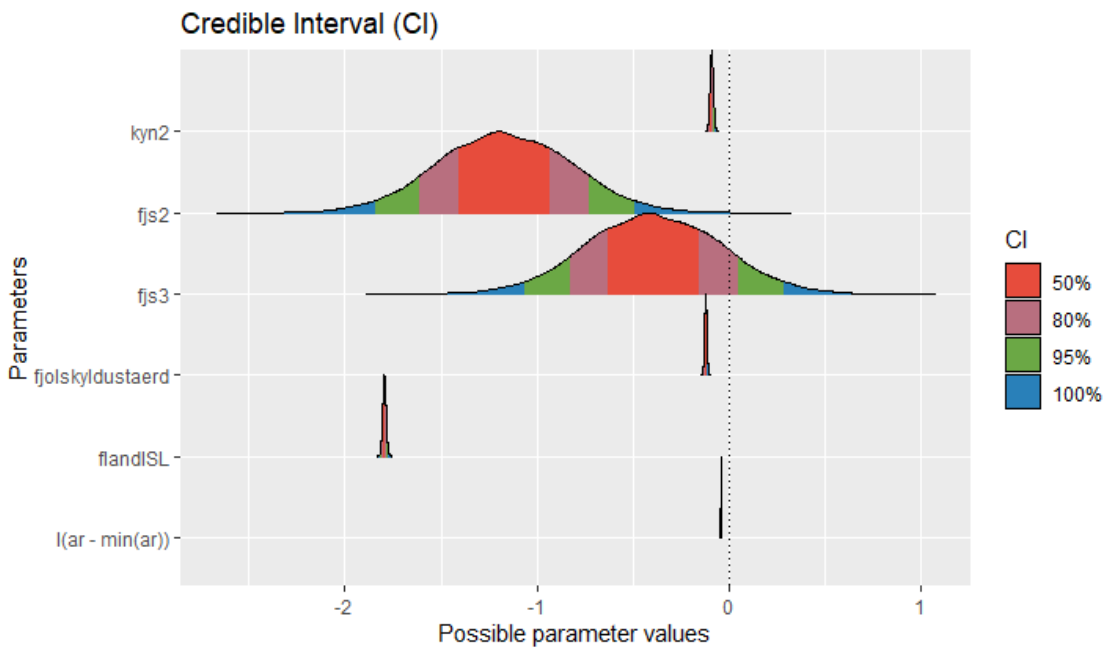


V1.3. Microdata: migration. Testing hypotheses

Age group effects

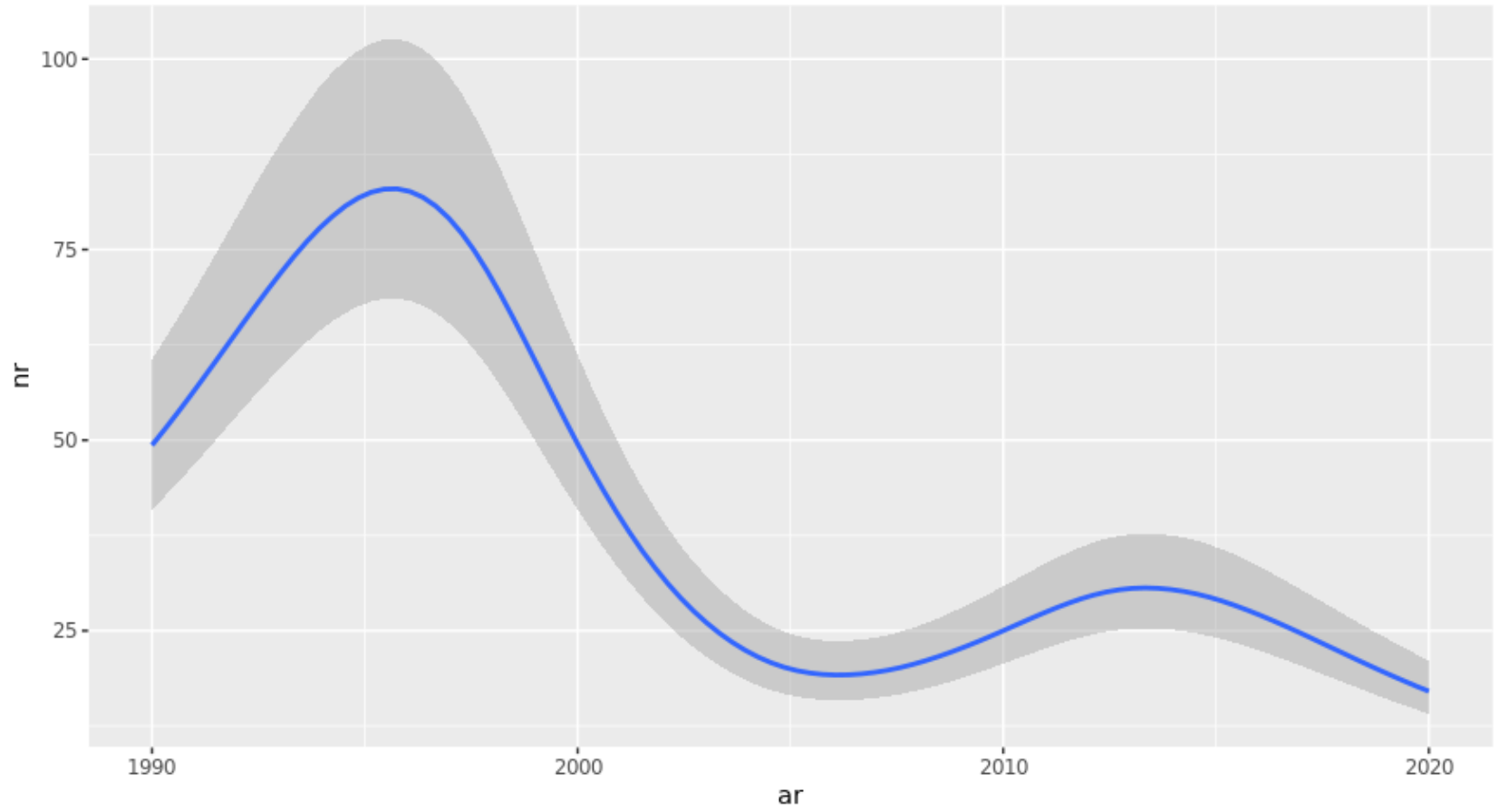


Characteristics‘ effects on *emigration*

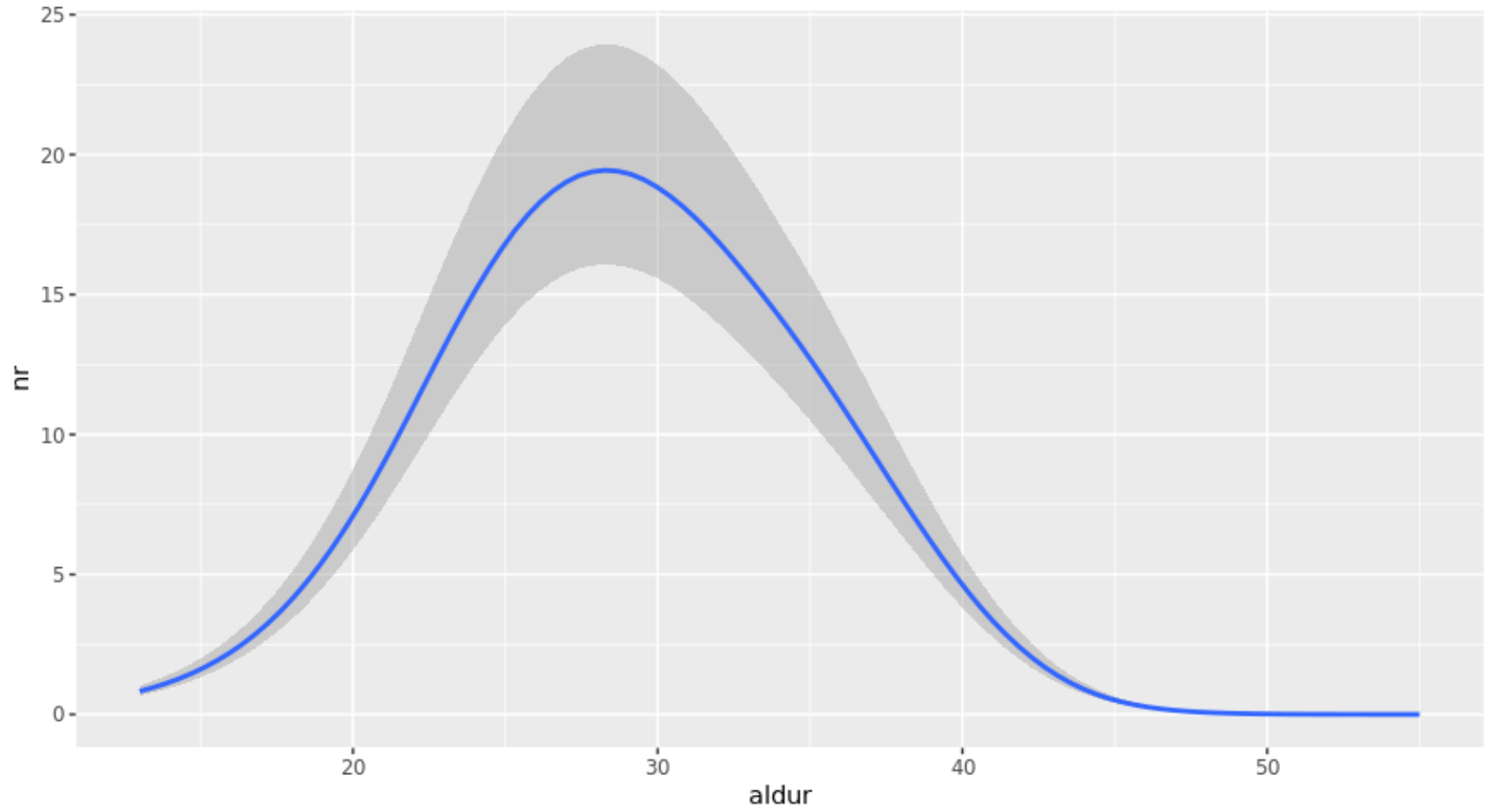


V2. Count data input

V2.1. Count data and rate models: fertility

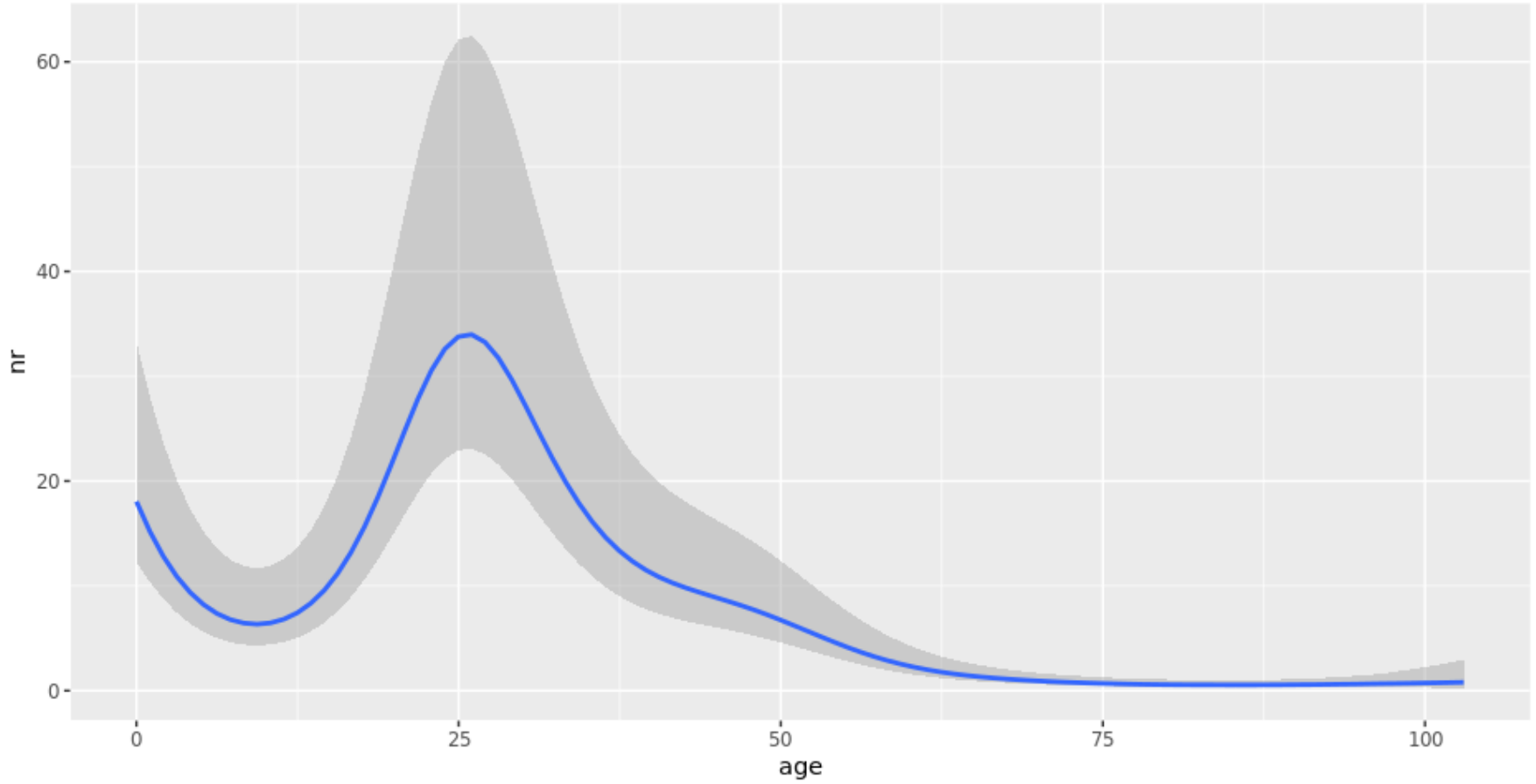


Count data and rate models: fertility

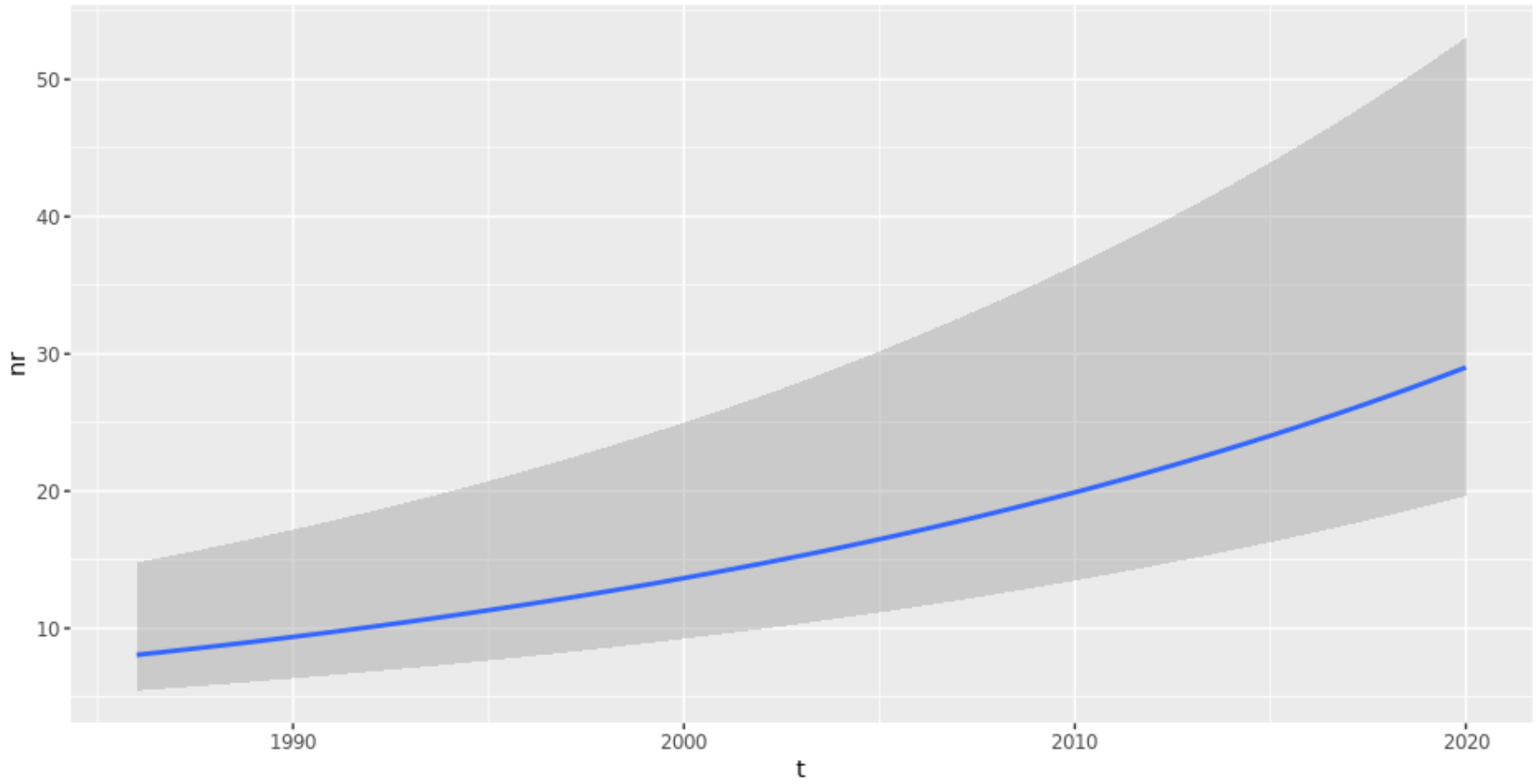


V2.2. Count data and rate models: migration

({im, em, ut, is, f, m}) Ex. ***categ****.: f_em_ut*

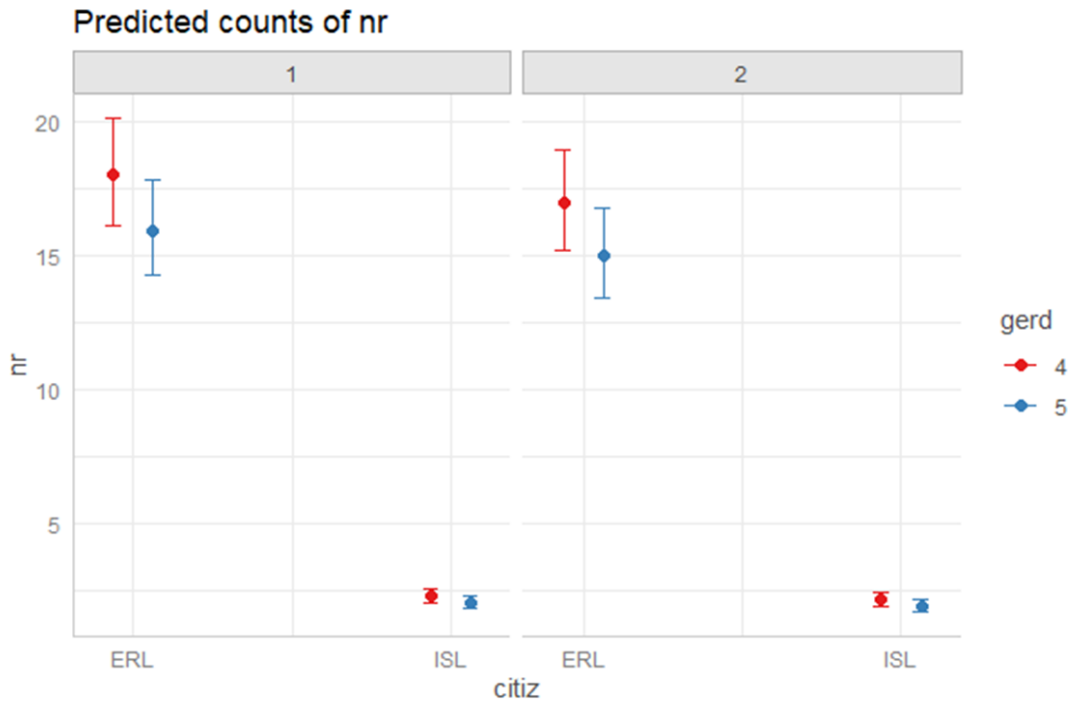


Continued: time trend

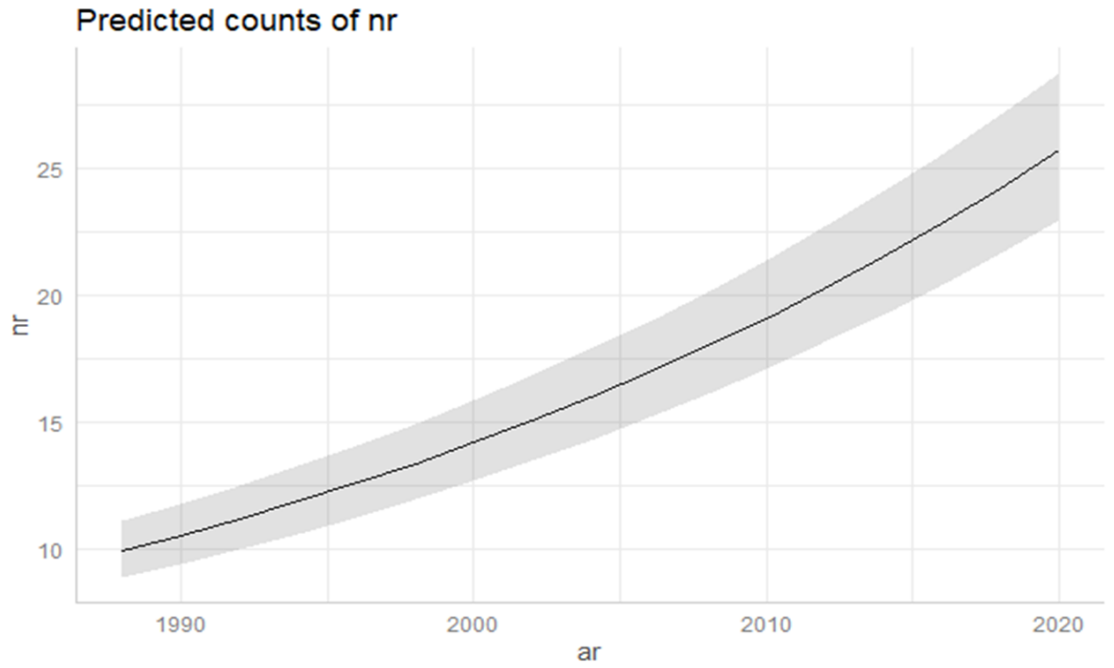


Migration model fit: frequentist

Effects of: gender, citizenship, type(imm/em)

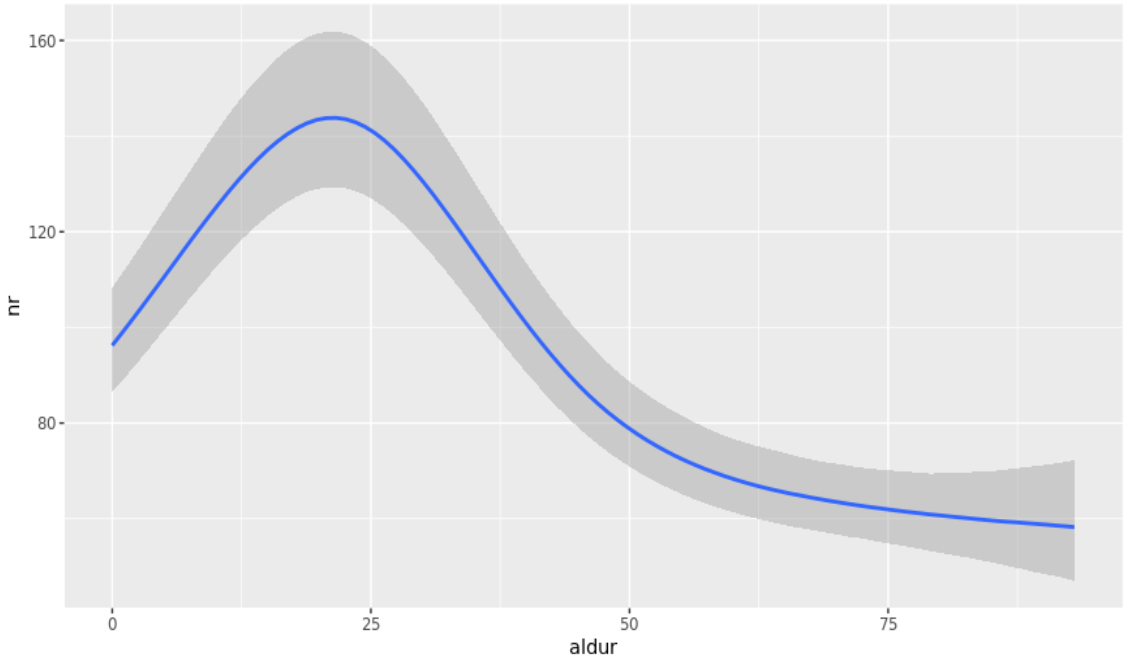


Trend, overall

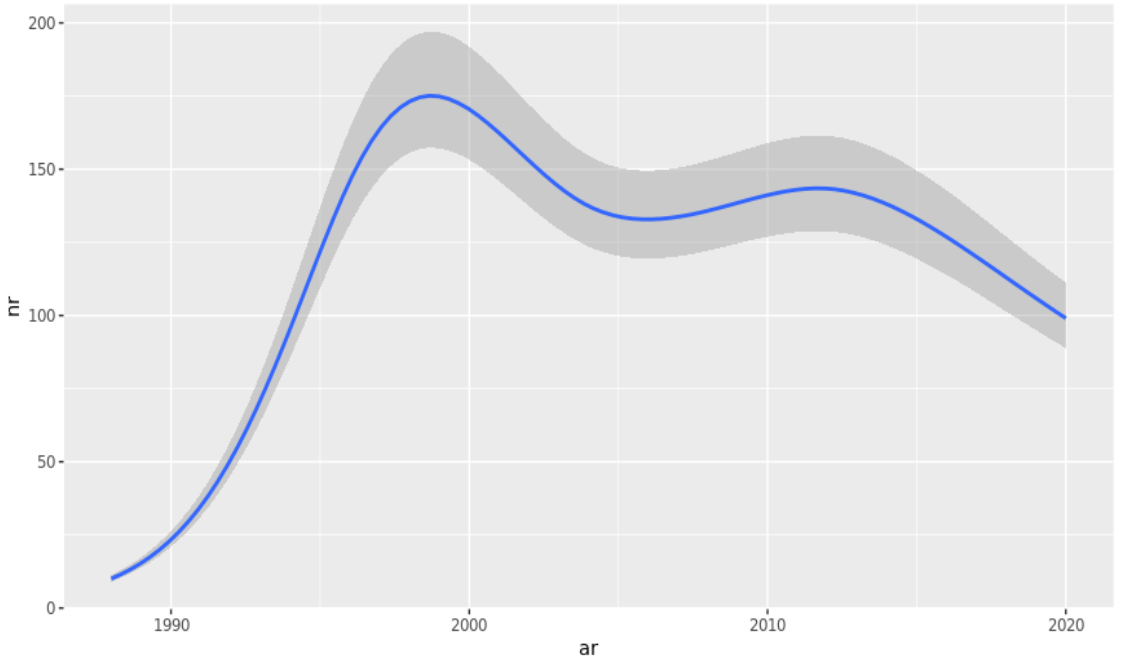


*Migration rates - Bayesian model fitting (**all** comp)*

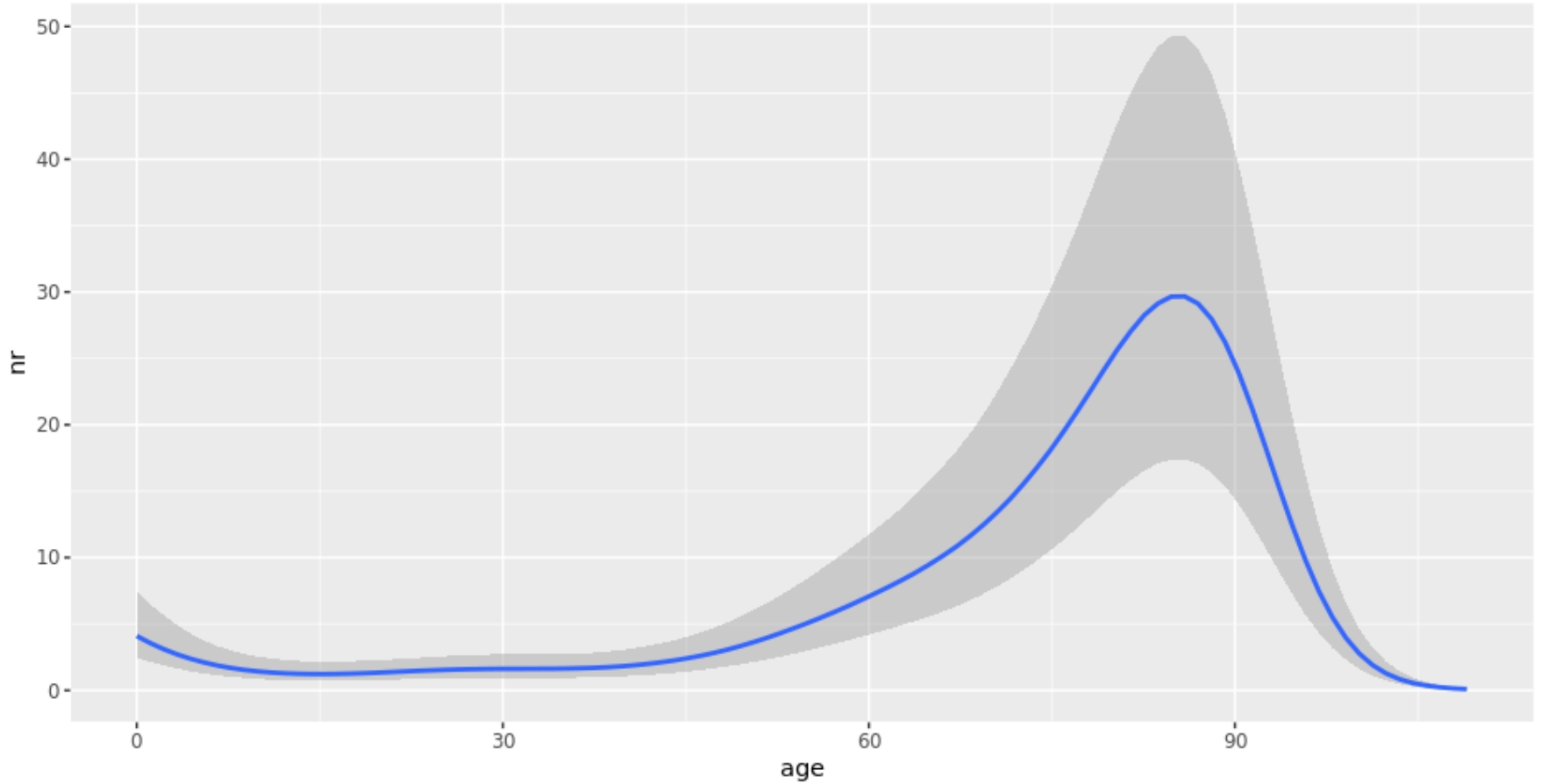
Age effect



Time evolution

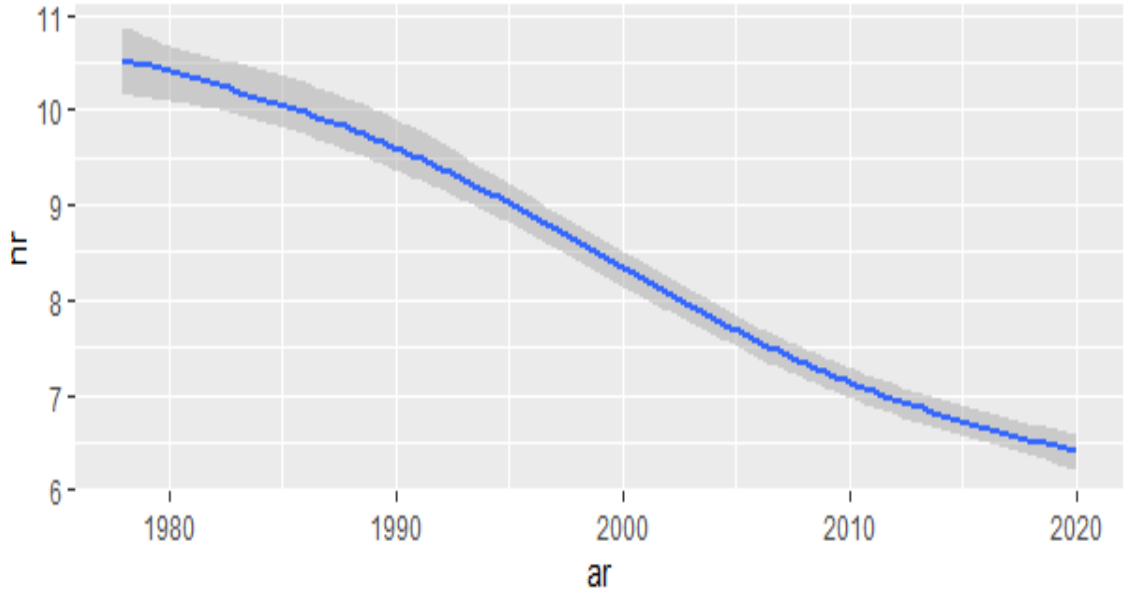


V2.3. Counts and rates: mortality

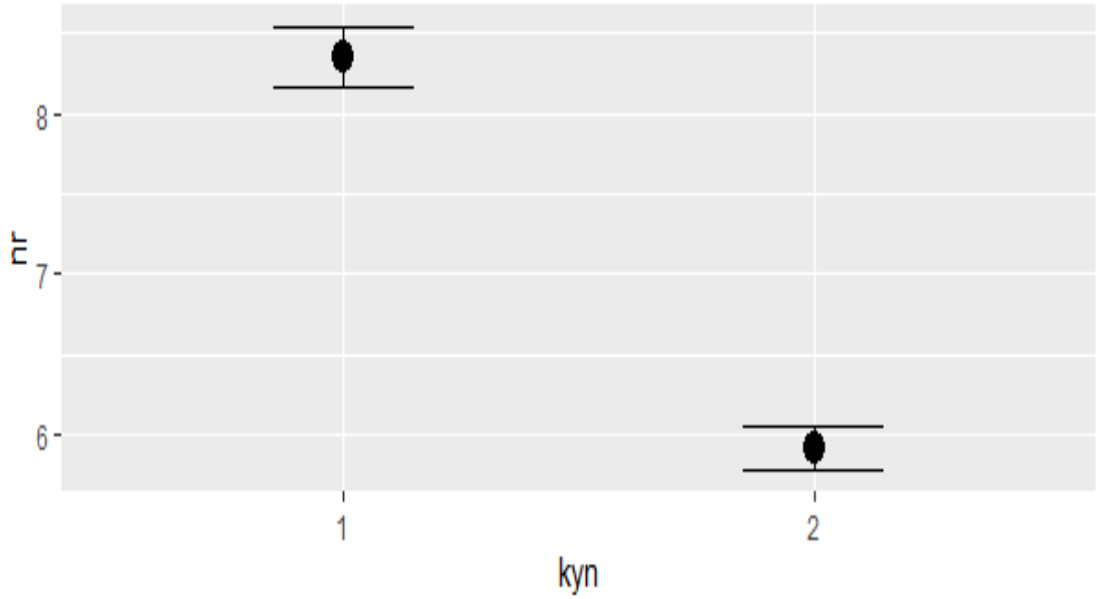


Mortality rates continued (Bayesian model fit)

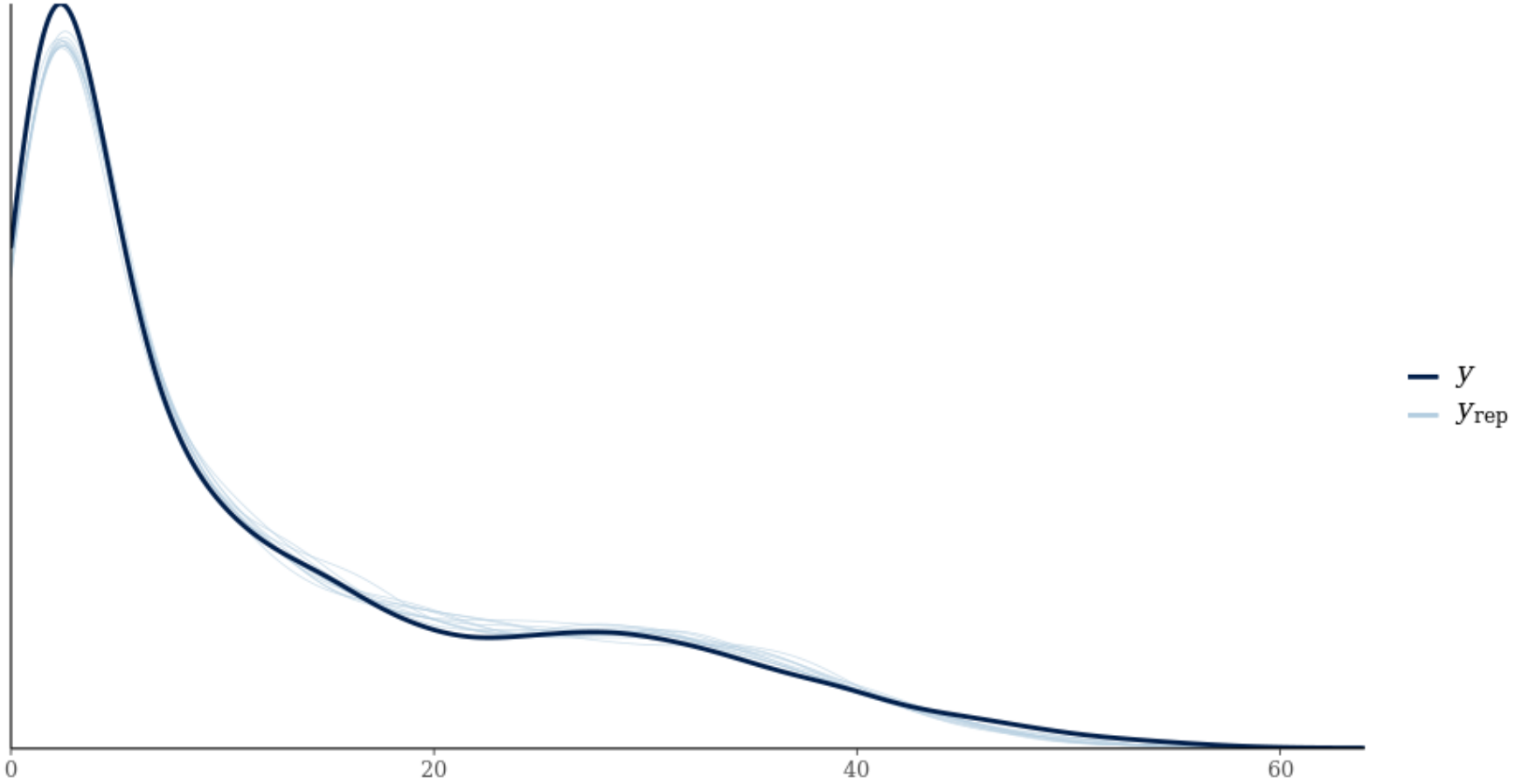
Time evolution



Gender effect



Next:
model predictions and evaluation
Example: check posterior



Thank you!

Sharing:

https://github.com/violetacln/SIPP

References

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