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# Using microsimulation to improve the quality of the official Austrian population projection

**Hannah Diethard, Pauline Pohl, Philip Slepecki**

Statistics Austria

**Martin Spielauer**

Austrian Institute of Economic Research (WIFO)

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# Background

- Microsimulation is not new (Orcutt, 1957, Orcutt et al., 1961)
- Nor is it new in the context of population projections (Van Imhoff and Post, 1998)
- Several NSIs use microsimulation models (e.g. Demosim (Statistics Canada, 2022), MOSART (Andreassen et al., 2020), DESTINIE (Blanchet et al., 2011), MikroSim (Münnich et al., 2021))
- Nevertheless, official population projections are rarely computed using microsimulation methods
- The cohort-component method **remains the standard model**

# Motivation

- The **cohort-component method** (CCM) is the standard model for computing population projections in official statistics

- However, it cannot:
  - account for complex and dynamic (demographic) processes
  - model interactions between individuals
  - produce results for a variety of individual-level characteristics (only aggregates)

- In the **microsimulation**, individual life-courses are simulated over time
  - build on the **characteristics of individuals** instead of cohorts
  - simulation of (somewhat) **realistic life paths**
  - can model **complex** (demographic) **processes and interactions**

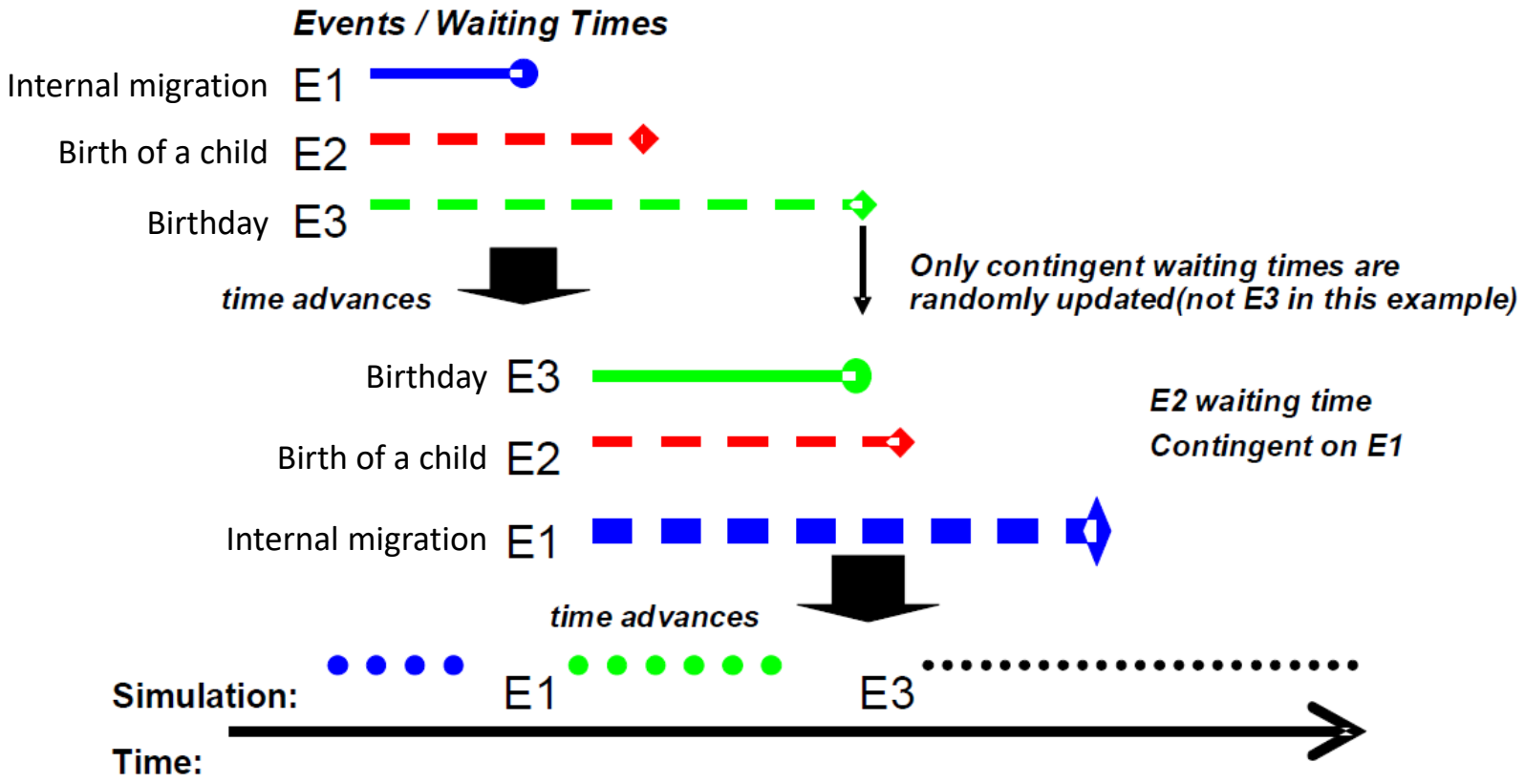
# Method

## Simulating demographic events

- Dynamic, case-based model in continuous time; Implementation in Modgen[1] (developed by Statistics Canada, coded in Visual Studio)
- We use administrative (micro) data for the entire Austrian population
- The **CCM** uses **event rates** to determine the projected paths of fertility, mortality and migration (e.g. mortality rates by age, sex, domestic/foreign-born)
- In our **microsimulation** model, these rates are converted into **waiting times** using the inversion method (inverse transform sampling)

[1] https://www.statcan.gc.ca/en/microsimulation/modgen/modgen

# Evolution of a simulated life course



# First model extension: International emigration

- Moving from the CCM to a microsimulation model constitutes a fundamental methodological change → Gradually develop and extend individual model elements

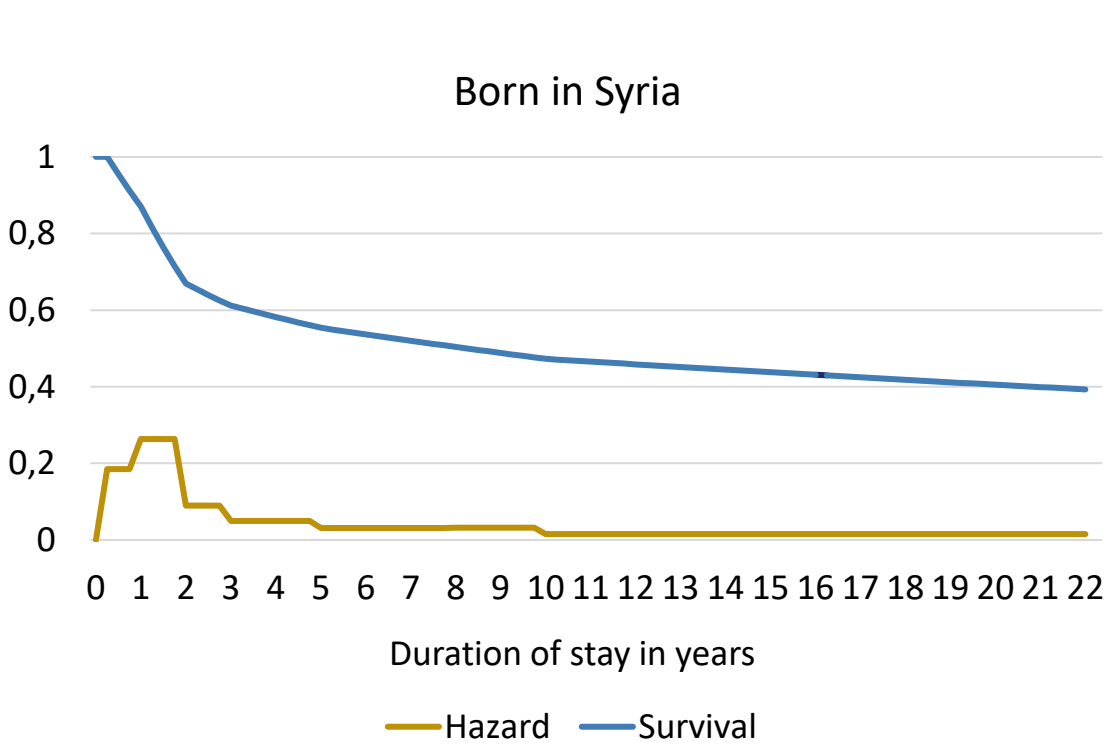
- **First model extension**:
  - Estimation of **piecewise constant hazards** for emigration by sex and country of birth
  - **Country of birth clustered** into 17 country groups
  - Using **age**, the federal **province of residence** and the **duration of stay** in the host country as input variables

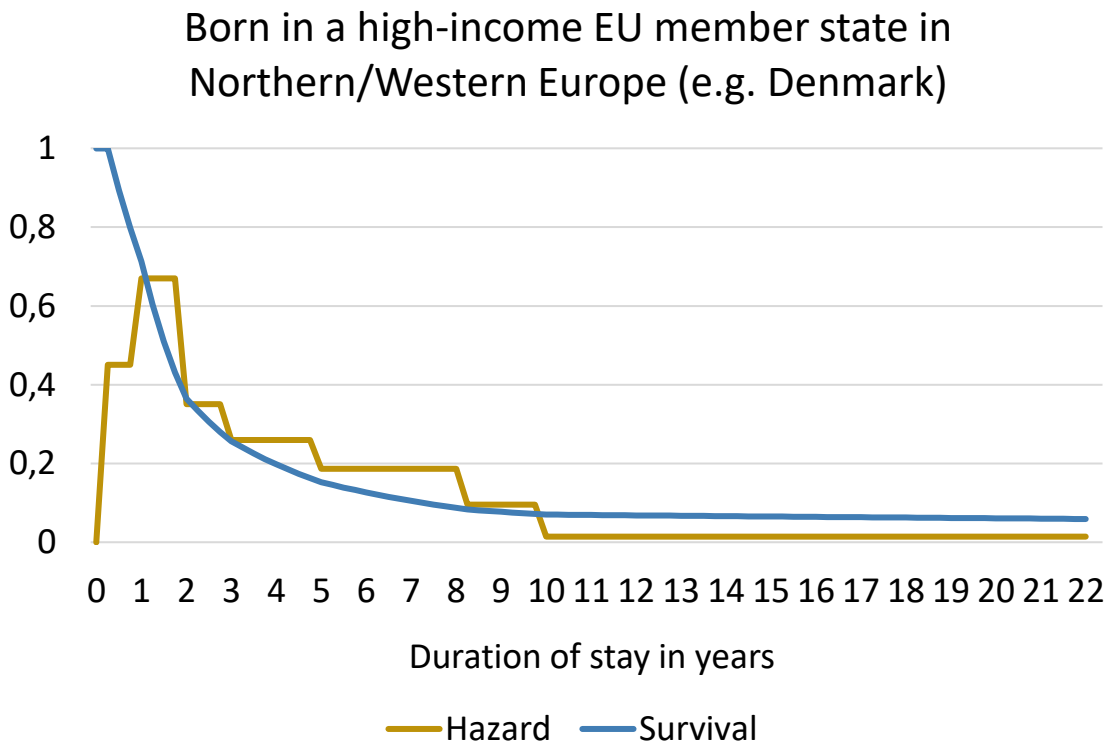
→**Easy** to implement, does not require much additional data

→Relevant because emigration patterns differ based on individual characteristics

# Differences in emigration behaviour by country of birth and duration of stay

## Example: 18 year old male immigrates to Austria and lives in Vienna



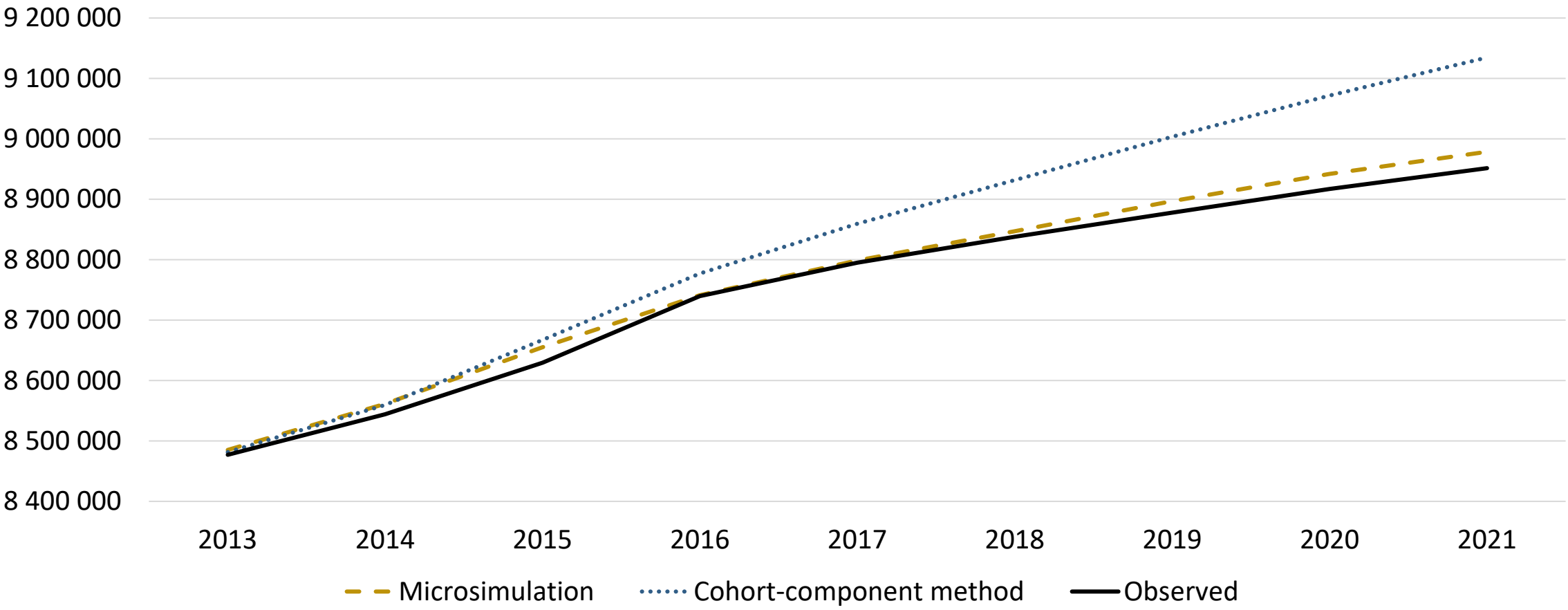




*Hazard*: Rate at which a person emigrates in a given time interval.
*Survival*: Proportion of individuals who do not emigrate until a given point in time.

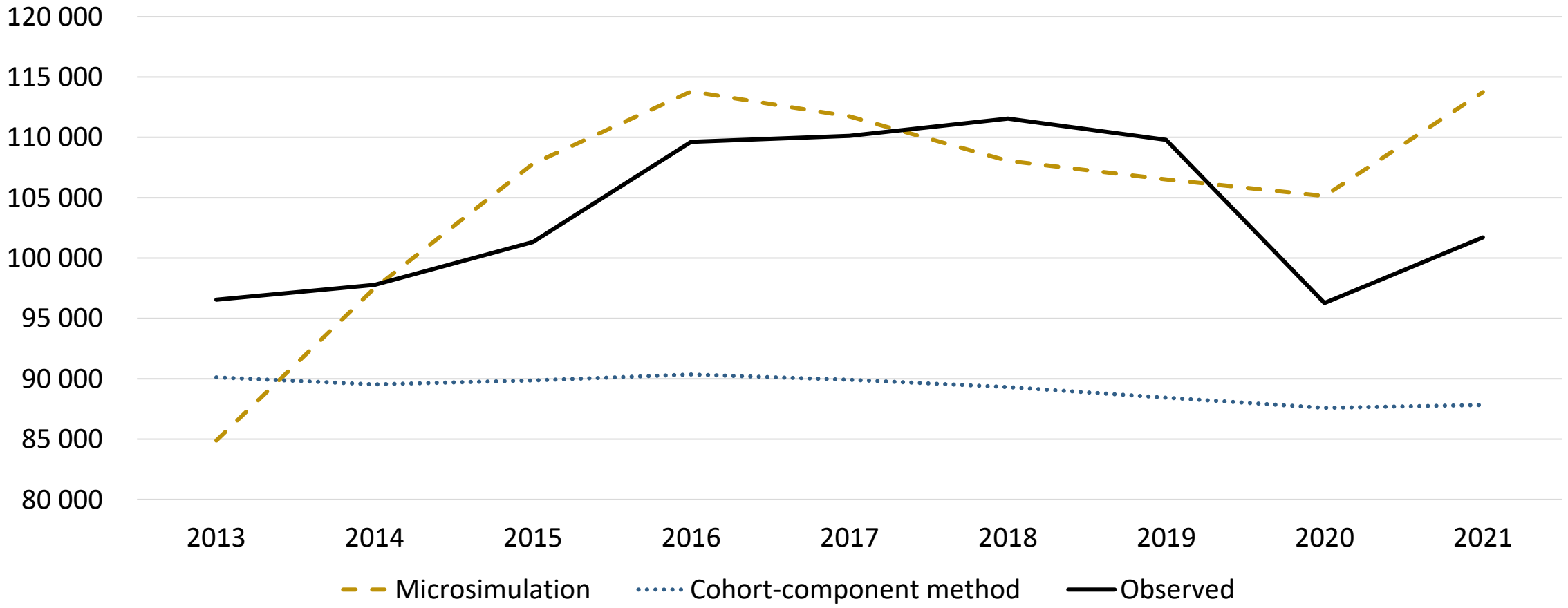
# Model validation

Comparing the cohort-component method with the microsimulation model in an ex-post validation

# Projected and observed population of Austria 2013-2021, based on the cohort-component method vs. the microsimulation model



# Projected and observed emigration from Austria 2013-2021, based on the cohort-component method vs. the microsimulation model



# Model Extension

# Model extensions

- At the moment two additional modules are being developed:
  - **Cancer Module**
    - Projecting prevalences for 15 different cancer types
  - **Education Module**
    - Projecting number of pupils in different school types
- More extensions are possible: Employment module, including interactions between individuals, …

# Conclusion

# Concluding remarks

- Moving from CCM to Microsimulation:
  - Fundamental methodological change
  - Model extensions require additional data
  - Issues related to small-scale projections

- However, Microsimulation:
  - Allows for the modelling of more complex and dynamic (demographic) processes
  - Can produce results for a variety of individual-level characteristics
  - Allows flexibility to implement new modules

# References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For further information please contact:

Pauline Pohl
+43 1 71128 8007
pauline.pohl@statistik.gv.at

Hannah Diethard
+43 1 71128 8152
hannah.diethard@statistik.gv.at

Martin Spielauer
+43 1 798 26 01 246
martin.spielauer@wifo.ac.at

# Backup Slides

# Special case: Modelling the impact of the war in Ukarine

- Three phases:
  1. phase of increased immigration and reduced emigratiom

  2. phase of increased return migration and family reunification

  3. phase of immigration and emigration as before the war

- Microsimulation model allows us to model more complex processes, e.g. family reunification
  - In the 2022 projection, we were able to include assumptions on immigration of male partners of female Ukrainian refugees in Austria

# Drawbacks

- Fundamental methodological change, requiring:
  - a deeper understanding of model building
  - advanced statistical programming and data analysis skills
  - more resources and computation capacities.

- Model extensions require additional (administrative/register) data

- New modules require more assumptions for future developments, e.g. which school type will be popular in the future

- Microsimulation is not suited to small-scale regional projections