

DYNAMIS

**A Portable Dynamic Socio-Demographic
Microsimulation Model for Developing
Countries**

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DYNAMIS-POP-NPL

- **DYNAMIS**

- Dynamic Micro-Simulation

- **POP**

- Focus on Population projections
- The demographic core for other applications

- **NPL**

- Country application for Nepal
- First version was for Mauretania DYNAMIS-POP-MRT
<http://ihsn.org/projects/dynamis-pop>

What is Dynamic Micro-Simulation?

Computer-simulation of a society in which the population is represented by a large sample of its individual members and their behaviors.

- Macro Models project cell-sizes
- Dynamic microsimulation projects individual life courses and the interaction between people

When does it make sense?

When macro models are technically too restrictive

- Number of variables
- Types of variables (non-categorical)
- Process types (non-Markov)

When longitudinal consistency is required

- Realistic life-courses
- Longitudinal accounting

Modeling of interactions

- Life course interactions and downstream effects
- Linked lives, transmission
- Policies

Limitations

Transitory limitations

- Computer power
- Development costs
- Data requirements

Randomness affecting prediction power

- Prediction power depends on model specification and randomness which increases with detail
- Difficulty to find optimal point between too simple models (misspecification error) and too detailed models (randomness)
- **Not a limitation for population projections**

How are MS Models Created?

- Start from a **population data base**
 - Individual characteristics
 - Links to other persons
- **Behavioral models** for updating individual characteristics
 - Discrete time models: updates in fixed time steps using models of probabilities
 - Continuous time models: competing risk approach based on rates and corresponding waiting times.
- **Accounting** routines
 - Aggregated model output tables
 - Tax-benefit accounting

DYNAMIS– Characteristics & Philosophy

- **Portable platform**

- Based on data available for most countries
- Refinable, extendable & adaptable to specific contexts

- **Modularity**

- Library of analysis tools and models
- Selection of models, geographic depth, variables to be included in country context
- Automated generation of model parameters

DYNAMIS– Characteristics & Philosophy

- **Start from the ,known‘** (available macro projections)
 - Model can reproduce macro models: same assumptions, parameter tables -> same outputs
 - More refined models can be added and selected with and without alignment to macro projections
- **Reproducible**
 - Step-by-step documentation (stats & programming)
 - Freely available software (R, Modgen, DYNAMIS)

DYNAMIS – Characteristics & Philosophy

- **User friendly**

- Fully documented GUI and model (help files)
- Parameters typically have intuitive interpretation
- Scenario management: parameters stored together with results

- **Analysis tool**

- Easy to specify meaningful scenarios
- Overall trends vs. trends in relative differences
- Downstream effects
- Decomposition of effects
- Composition vs. behavioral effects

DYNAMIS – Characteristics & Philosophy

■ Rich Output

- Extendable hierarchical list of tables
- Micro-data output (projected cross-sectional and panel data)
- Database of individual histories for graphical visualization (BioBrowser)

■ R-Integration

- Data analysis and parameter file generation
- DYNAMIS can be run from command line/from R
- Post-processing of simulation results

DYNAMIS – GUI

microDP - D:\Dropbox\WORLDWANK\REPORT\microDP\microDP_Step18_VS15_ModelOutputCont\Base.sceex

Scenario Edit View Window Help

Parameter Groups

- Starting Population file
 - File name of starting population
 - File size of starting population
 - Use weights in starting population file
- Mortality
 - Child mortality model selection
 - Overall mortality
 - Mortality hazard by age
 - Life Expectancy
 - Child mortality
 - Child mortality model selection
 - Child mortality baseline risk
 - Child mortality relative risk
 - Child mortality time trend
- Fertility
 - Fertility model selection
 - Fertility Model A: Macro approach
 - Age distribution of fertility
 - Total fertility rate
 - Sex ratio (male per 100 female)
 - Fertility Model B: Micro approach
 - First Births
 - Higher order births
 - Birth Trends
- Microdata output
 - Write micro-data output file Y/N
 - File name micro-data output file
 - Time(s) of micro-data output
 - Output variable selection
- Primary Education
 - School entry age primary

Parameter: File name of starting population

m_micro_input.csv

Parameter: Mortality hazard by age

Rows: Columns:
Age range Sex

| | Female | Male |
|----|--------|------|
| 0 | 0.076 | 0.0 |
| 1 | 0.012 | 0.0 |
| 2 | 0.012 | 0.0 |
| 3 | 0.012 | 0.0 |
| 4 | 0.012 | 0.0 |
| 5 | 0.003 | 0.0 |
| 6 | 0.003 | 0.0 |
| 7 | 0.003 | 0.0 |
| 8 | 0.003 | 0.0 |
| 9 | 0.003 | 0.0 |
| 10 | 0.002 | 0.0 |
| 11 | 0.002 | 0.0 |
| 12 | 0.002 | 0.0 |
| 13 | 0.002 | 0.0 |
| 14 | 0.002 | 0.0 |
| 15 | 0.002 | 0.0 |

Parameter: Life Expectancy

Rows: Columns:
Projected calendar years Sex

| | Female | Male |
|------|--------|-------|
| 2013 | 61.80 | 58.30 |
| 2014 | 62.00 | 58.40 |
| 2015 | 62.30 | 58.60 |
| 2016 | 62.50 | 58.70 |
| 2017 | 62.70 | 58.80 |
| 2018 | 63.00 | 58.90 |
| 2019 | 63.20 | 59.10 |
| 2020 | 63.50 | 59.20 |
| 2021 | 63.70 | 59.30 |
| 2022 | 63.90 | 59.40 |
| 2023 | 64.20 | 59.60 |
| 2024 | 64.40 | 59.70 |
| 2025 | 64.60 | 59.80 |
| 2026 | 64.90 | 59.90 |

Parameter: Total fertility rate

Columns:
Projected calendar years

| | 2013 | 2014 | 2015 | 2016 | 2017 |
|--|-------|-------|-------|-------|-------|
| | 4.300 | 4.267 | 4.233 | 4.200 | 4.167 |

Parameter: Age distribution of fertility

Rows: Columns:
Fertile age range Projected calendar years

| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|----|--------|--------|--------|--------|--------|------|
| 10 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14 | 0 | 0 | 0 | 0 | 0 | 0 |
| 15 | 1.8340 | 1.8240 | 1.8160 | 1.8060 | 1.7980 | 1.78 |
| 16 | 1.8340 | 1.8240 | 1.8160 | 1.8060 | 1.7980 | 1.78 |
| 17 | 1.8340 | 1.8240 | 1.8160 | 1.8060 | 1.7980 | 1.78 |
| 18 | 1.8340 | 1.8240 | 1.8160 | 1.8060 | 1.7980 | 1.78 |
| 19 | 1.8340 | 1.8240 | 1.8160 | 1.8060 | 1.7980 | 1.78 |
| 20 | 4.7040 | 4.7060 | 4.7080 | 4.7100 | 4.7120 | 4.71 |
| 21 | 4.7040 | 4.7060 | 4.7080 | 4.7100 | 4.7120 | 4.71 |
| 22 | 4.7040 | 4.7060 | 4.7080 | 4.7100 | 4.7120 | 4.71 |
| 23 | 4.7040 | 4.7060 | 4.7080 | 4.7100 | 4.7120 | 4.71 |

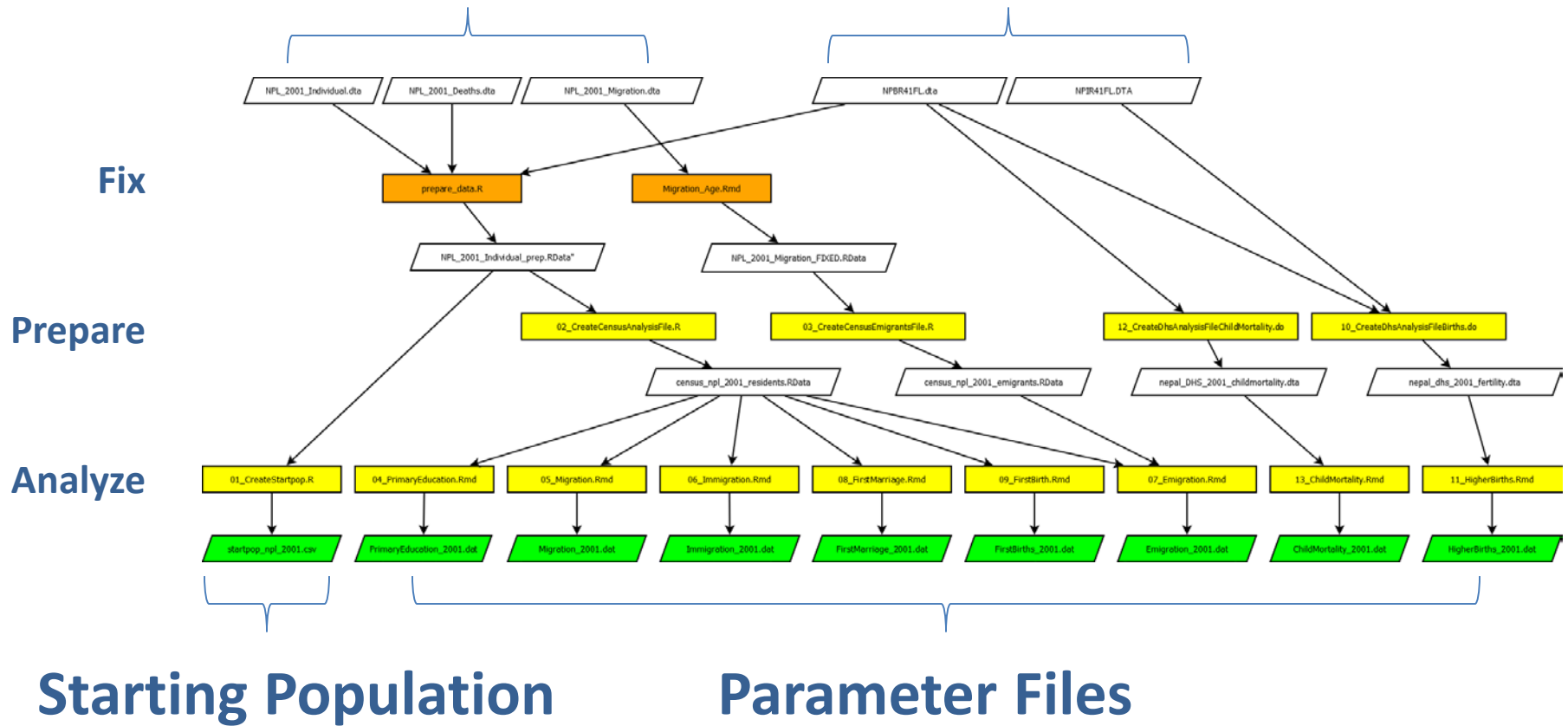
File View Group View

Ready

Data

Census Micro-Data

DHS Micro-Data



DYNAMIS – Fertility

- **Base Version**

- Age-specific fertility distribution by year
- Total Fertility Rate (TFR) by year

- **Extended Version**

- First births by age, union status, education, province
- Higher order births by education, time since last birth
- Separate trends by birth order

- **Alignment Choices** (extended version)

- Not aligned
- Aligned to total births of base version
- Aligned to total births by age of base version

DYNAMIS – Mortality

- **Base Version**

- Standard life table of age-specific rates by sex
- Life expectancy by calendar year and sex

- **Refined child mortality model** (ages 0-4)

- Age baseline
- Relative risks by mothers education and age group
- Age-specific overall trends

- **Alignment options** (refined model)

- Without
- Initial alignment to base model – trends from base
- Initial alignment to base model – specific trends

DYNAMIS – Internal Migration

- **Base**

- Probabilities to leave by province, age group and sex
- Distribution of destinations by origin, age, sex

- **Refined**

- Education added to probability to leave

DYNAMIS – Immigration and Emigration

- **Immigration**

- Immigration numbers by year and sex
- Age distribution by sex
- Destination distribution by sex and age

- **Emigration**

- Emigration rates by province, age and sex

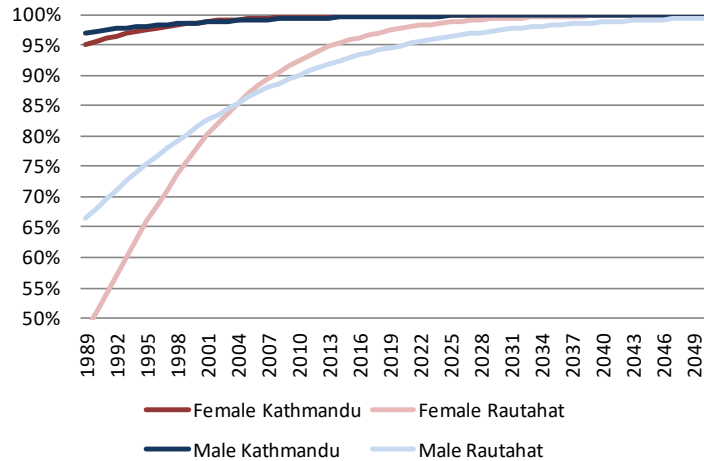
DYNAMIS – Primary Education

- **Base:** Probabilities of school entry and graduation by year & province of birth, sex
- Based on proportional models (logistic regression)
- Typically high and persistent inter-provincial differences
- **Refinements:**
 - Choice of geographical level (region, district)
 - Transmission: adding mothers education
 - Grade system: tracking of students by grade

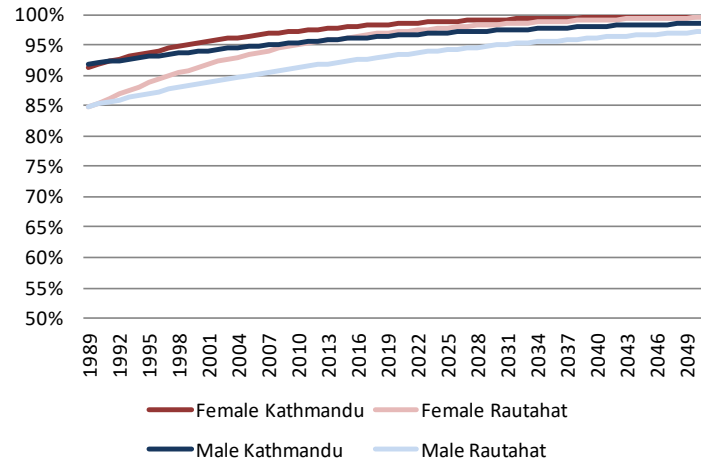
DYNAMIS – Primary Education

■ Nepal

Primary School Entry

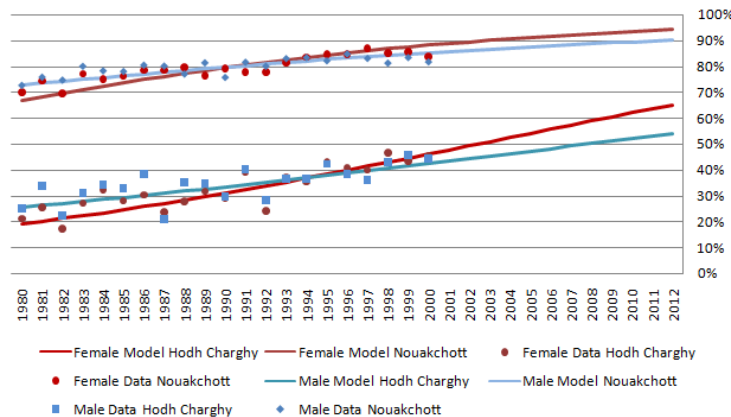


Primary School Retention

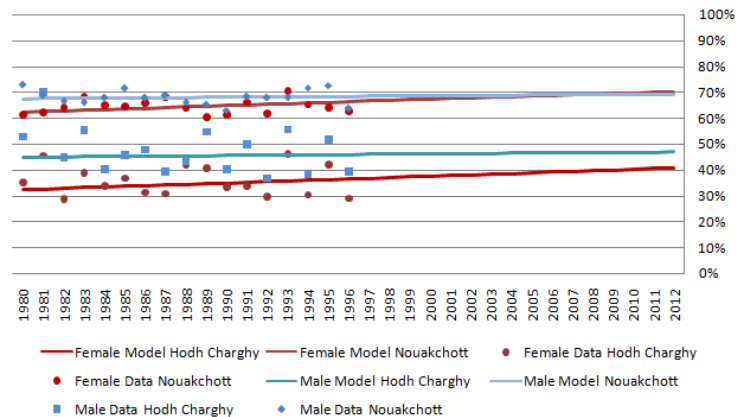


■ Mauretania

Probability to enter Primary School

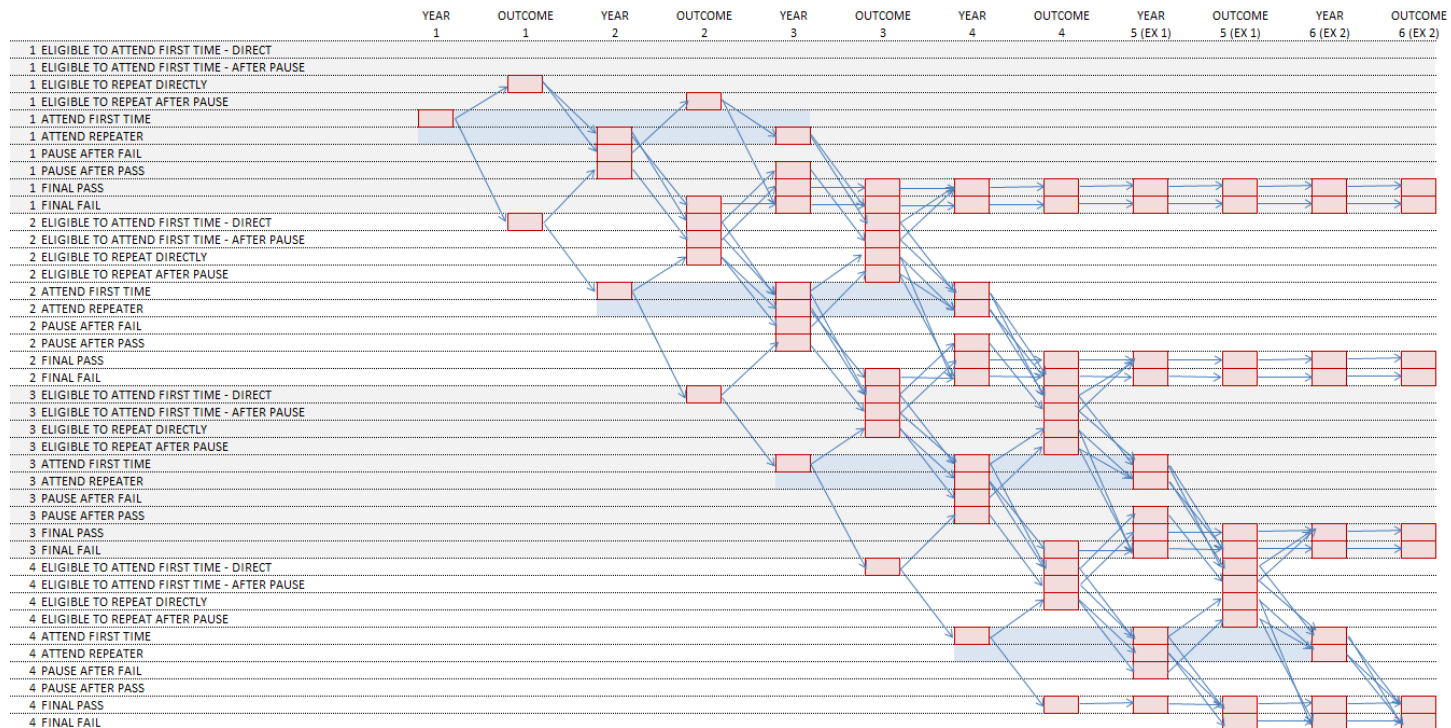


Retention in Primary until Graduation



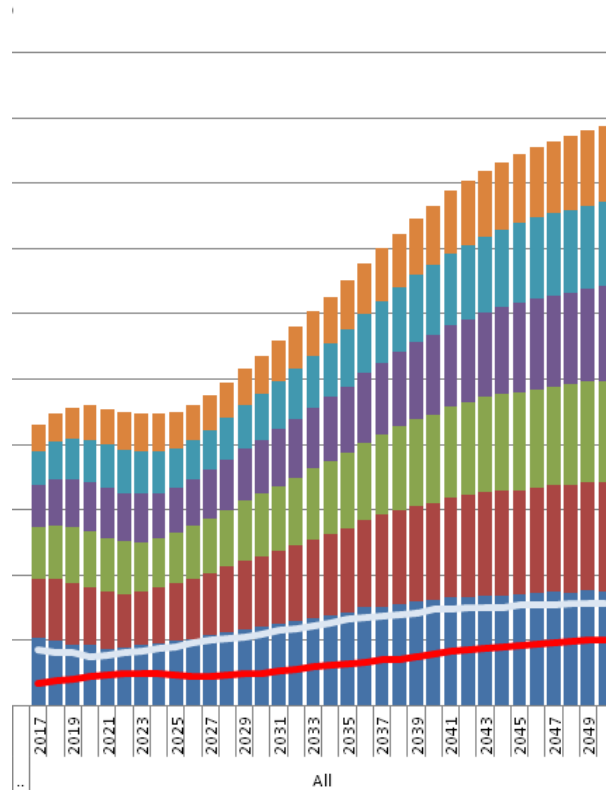
DYNAMIS – School Progression

- Parameters for intake, success, progression, repetition
- ...or a „best guess“: optional automatic calibration to meet target graduation rates.

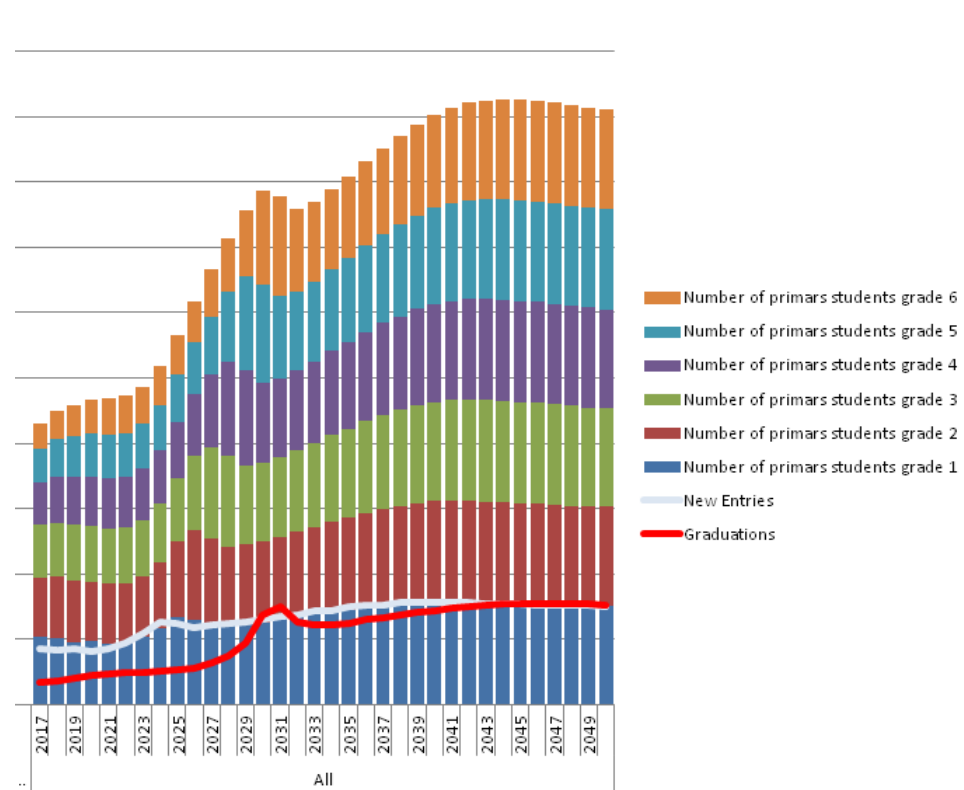


DYNAMIS – School Progression

- Illustration: Primary students by grade in Mauretania



- Scenario 1:
Current trends

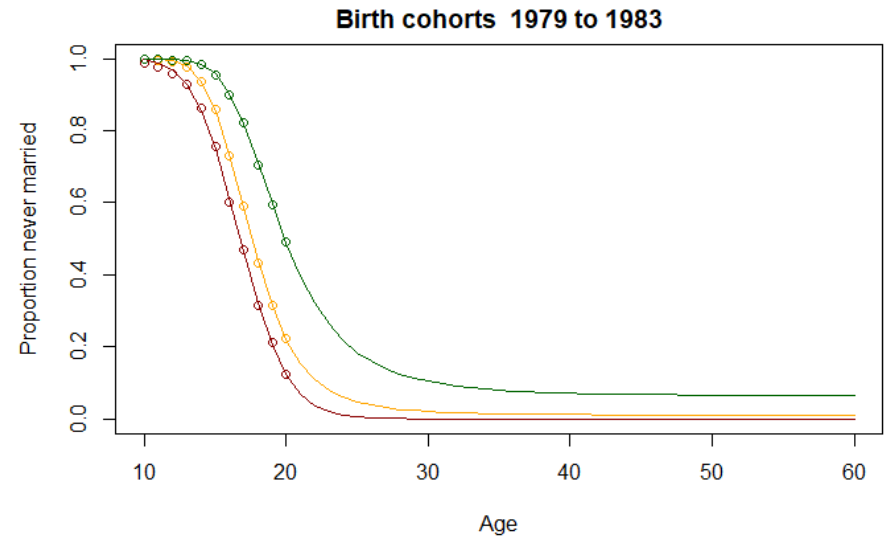


- Scenario 2: Improvements
towards universal graduation

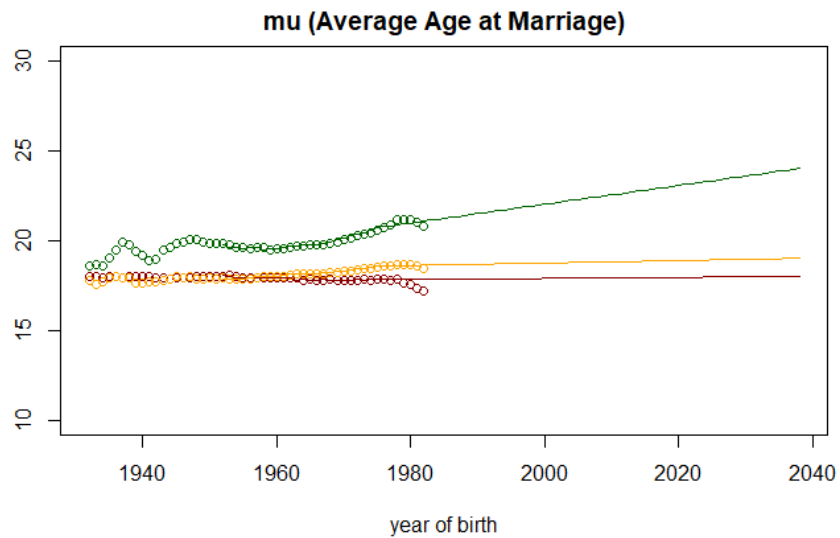
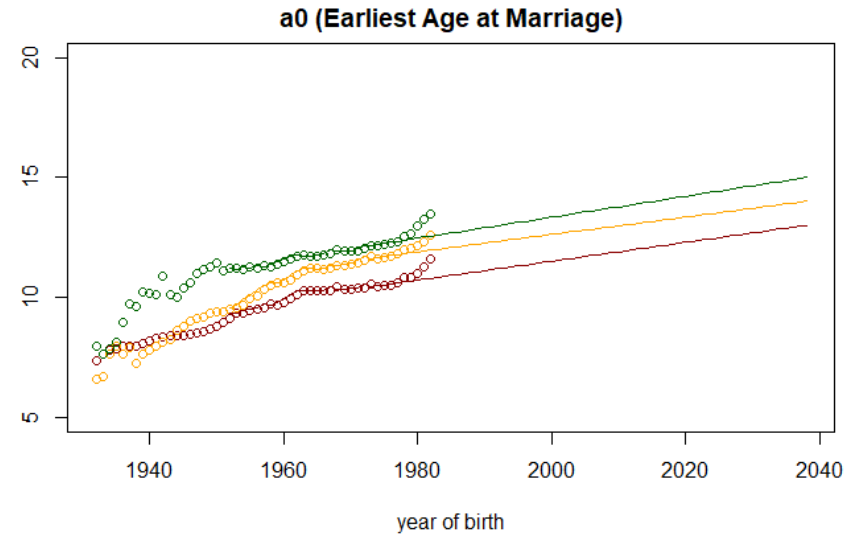
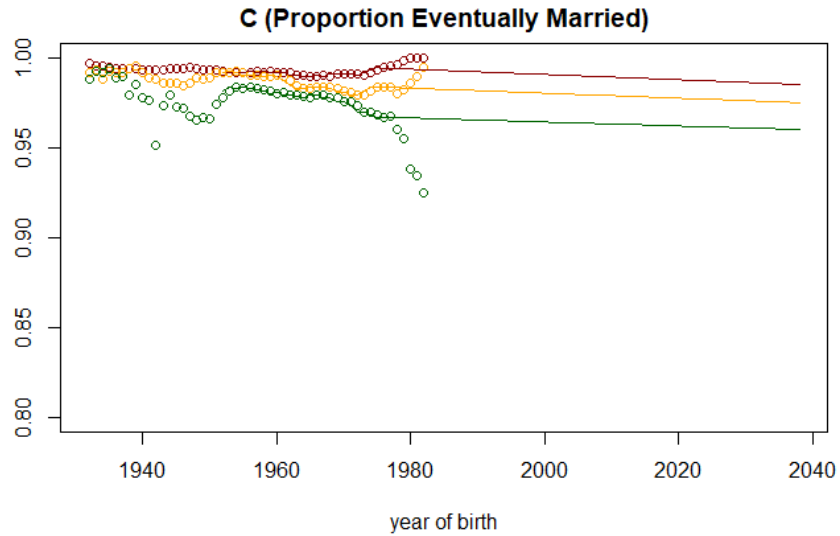
DYNAMIS – First Union

- **Option A:** Age-specific rates
- **Option B:** Parametric model by **Coale & McNeil**
 - Parameters: lowest and average age at first union formation and final outcome of ever entering a union
 - Simulation results can be used as base for option A (which can be easily modified e.g. to a scenario banning child marriages)

DYNAMIS – First Union - Analysis



DYNAMIS – First Union - Analysis

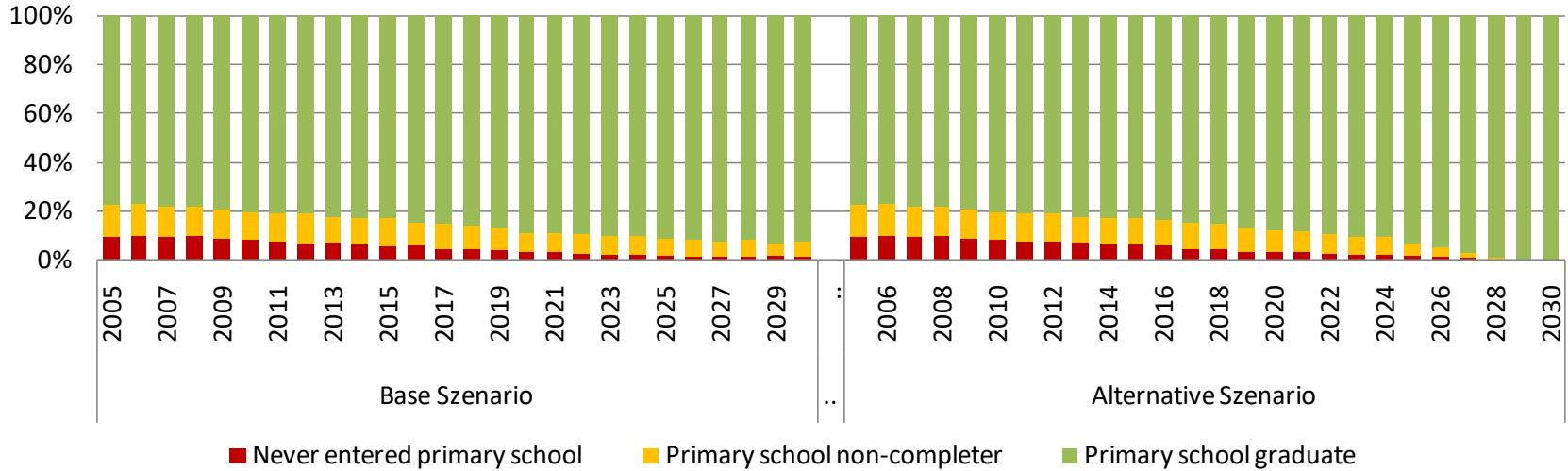


Example: Effects of Education

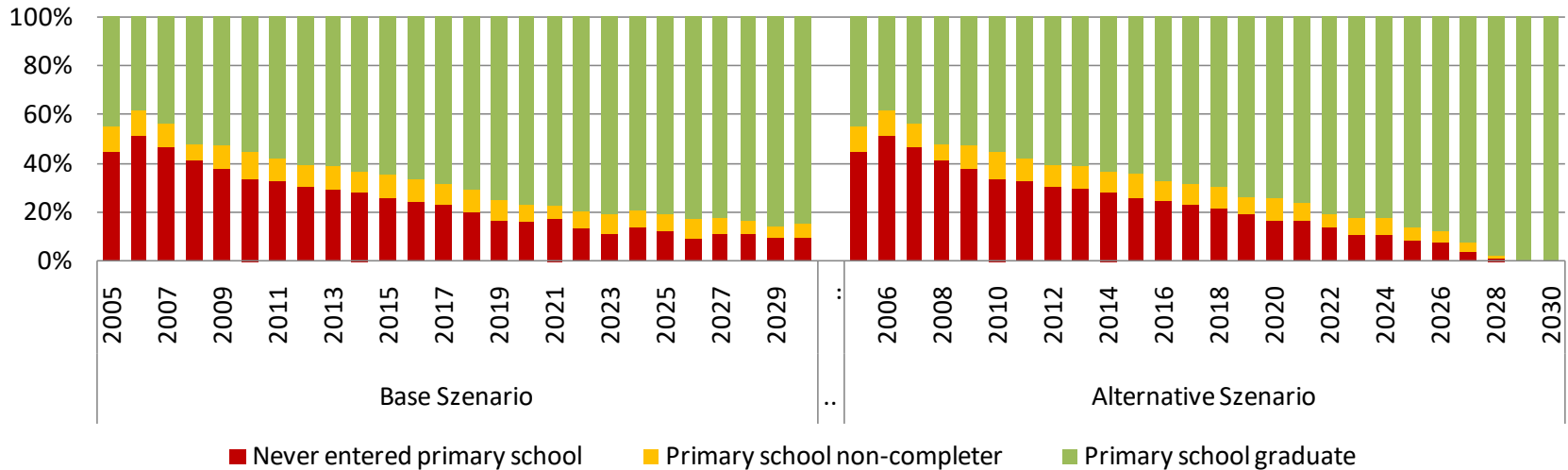
- **2 Scenarios:**
 - **Base:** Continuing observed trends
 - **Alternative:** Phased-in universal primary, cohorts 2005-2010

Example: Effects of Education

Primary Education Of 18 Year Old - Kathmandu

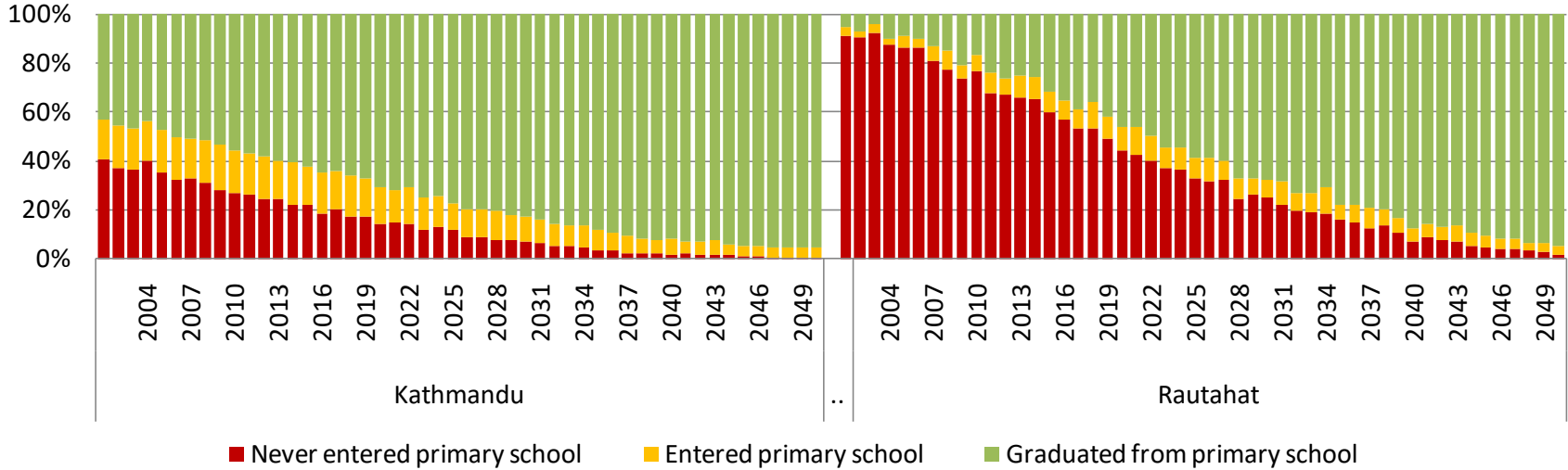


Primary Education Of 18 Year Old - Rautahat

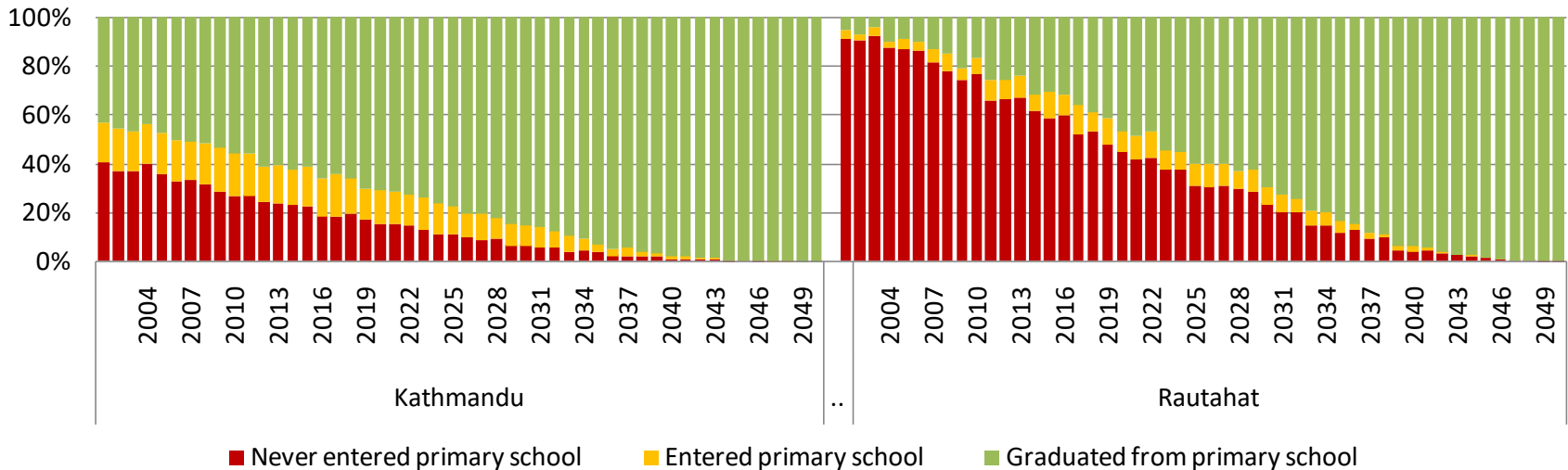


Example: Births by Mother's Education

Distribution of Births by Mother's Education - BASE SZENARIO

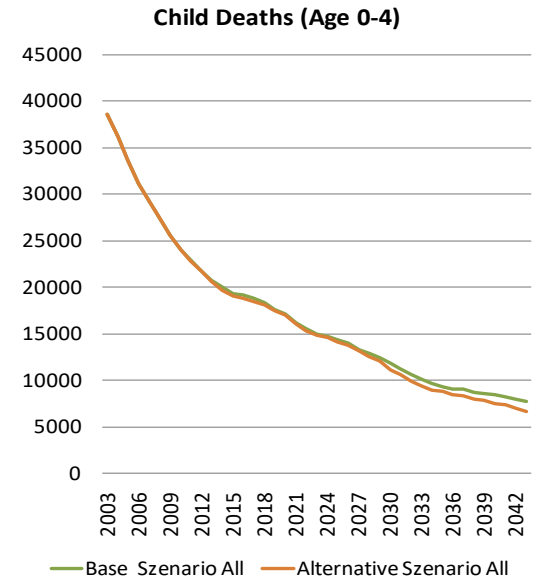
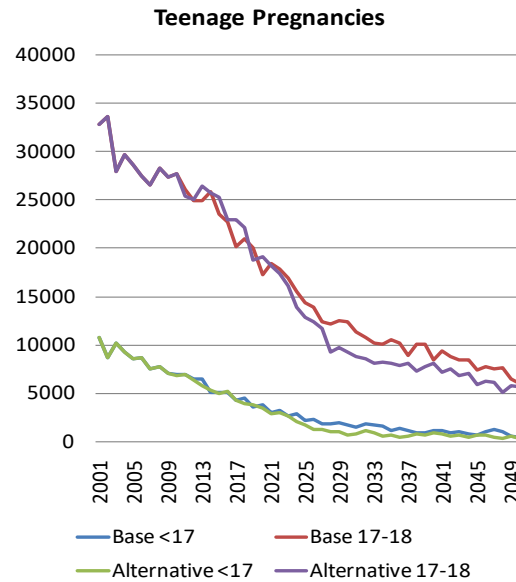


Distribution of Births by Mother's Education - ALTERNATIVE SZENARIO

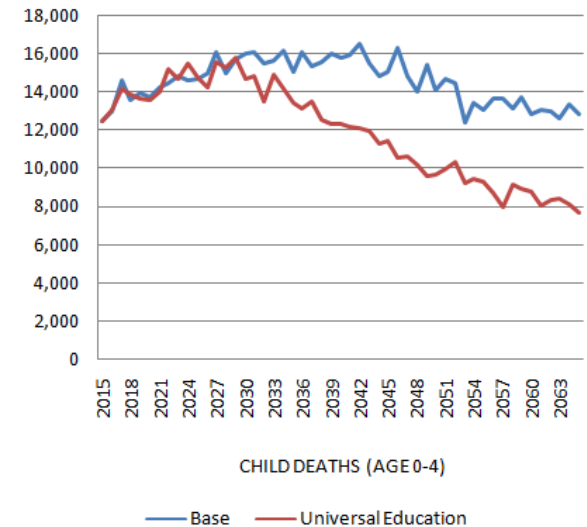
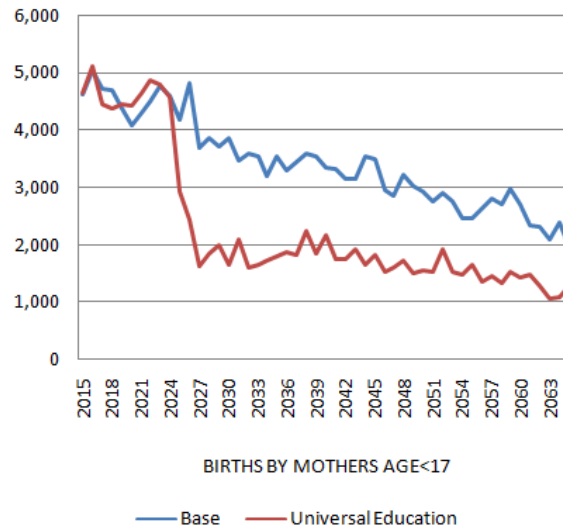


Example: Teenage Births, Infant Deaths (0-4)

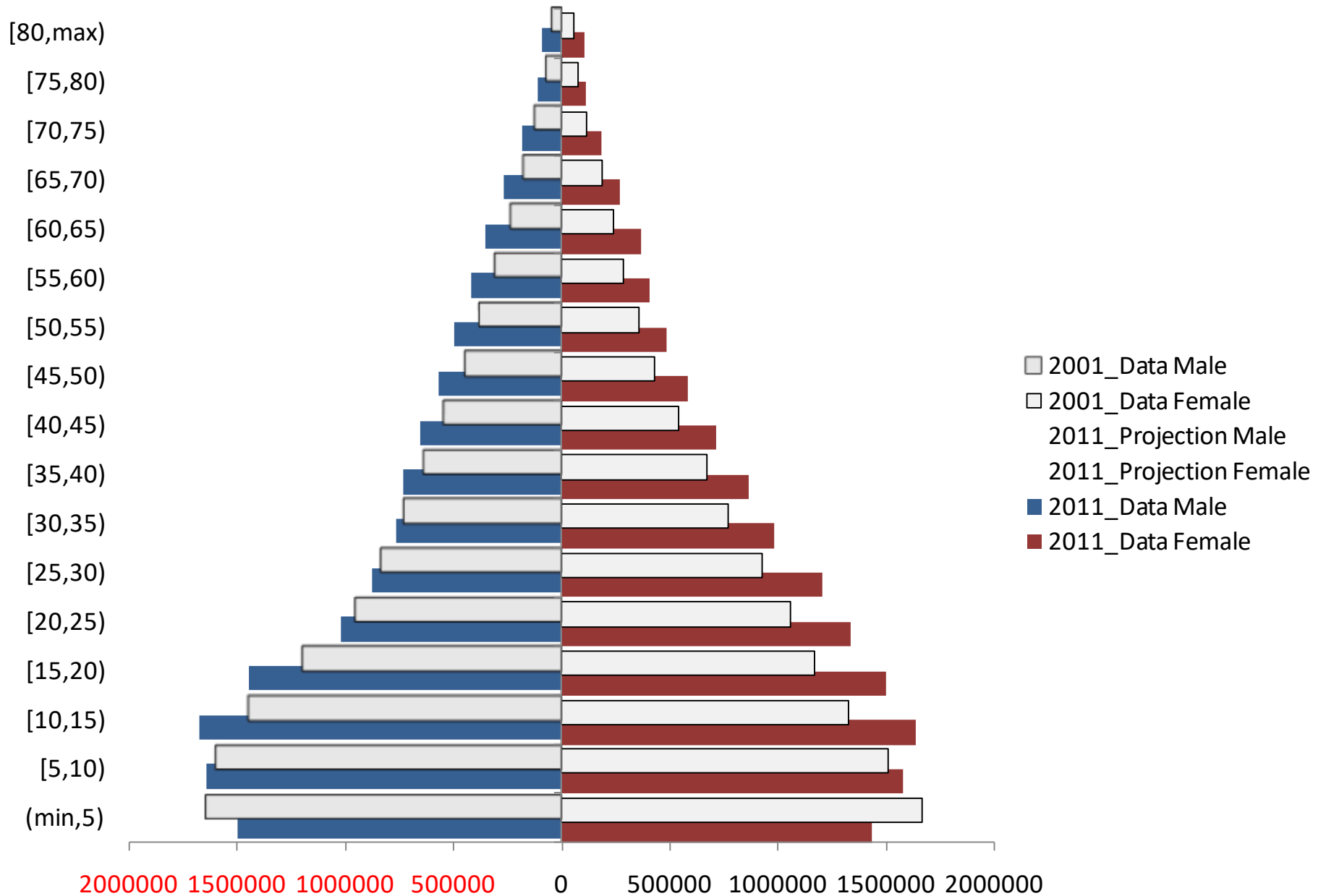
■ Nepal



■ Mauretania



Validation - Nepal



Next Steps

- Current work on model improvements
 - Ethnicity (in Nepal: Casts) as additional dimension
 - Refined models for migration: temporary work migration, scenario building
 - Refinements of fertility models: regional and ethnic differences
 - Full R integration: post-processing of output
 - Model validation
- New applications
- Research collaborations