Dynamic micro simulation modeling for policy analysis: an overview and some applications

Gijs Dekkers
Federal Planning Bureau and
Katholieke Universiteit Leuven

Overview of this presentation

1. What is that, microsimulation? A short methodological overview and an even shorter overview of models in Europe

2. A short history of MIDAS_BE

3. MIDAS_BE and its role in the policy making process in Belgium (keeping one eye on Europe).

4. An application: an assessment of recent policy measures on the development of inequality and poverty among the elderly in Belgium.
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1. What is that, microsimulation?

The essential function of (dynamic/static) microsimulation models...

...is the imputation of (prospective/alternative) microdata

Dynamic microsimulation: imputing prospective data
1. What is that, microsimulation?

The essential function of (dynamic/static) microsimulation models...

...is the imputation of (prospective/alternative) microdata

Static microsimulation: imputing alternative data
A classification of microsimulation models

Start

Standard Simulation Models

Micro Simulation Models

Static

Dynamic

Static Ageing

Dynamic Ageing

Cross-sectional ageing

Longitudinal Ageing

Base-data: population

Base-data: cohort

Open

Closed

MIDAS

http://www.plan.be
An overview of dynamic models

Table 2: Simulation properties of pension microsimulation models used by European administrations (source PENMICRO; 2009)

<table>
<thead>
<tr>
<th>Country</th>
<th>Cross-sectional vs. cohort / longitudinal</th>
<th>Ageing process</th>
<th>Initial database</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVID</td>
<td>longitudinal</td>
<td>dynamic</td>
<td>sample of administrative</td>
</tr>
<tr>
<td>CAPP_DYN</td>
<td>cross-sectional</td>
<td>dynamic</td>
<td>survey</td>
</tr>
<tr>
<td>DESTINIE</td>
<td>cross-sectional</td>
<td>dynamic</td>
<td>survey</td>
</tr>
<tr>
<td>MICROS</td>
<td>cross-sectional</td>
<td>static and dynamic</td>
<td>survey</td>
</tr>
<tr>
<td>MIDAS</td>
<td>cross-sectional</td>
<td>dynamic</td>
<td>Survey / Sample of administrative</td>
</tr>
<tr>
<td>MiMESIS</td>
<td>cross-sectional</td>
<td>dynamic</td>
<td>sample of administrative</td>
</tr>
<tr>
<td>??? *</td>
<td>-</td>
<td>Static</td>
<td>sample of administrative</td>
</tr>
<tr>
<td>NYIKA</td>
<td>cross-sectional</td>
<td>Dynamic</td>
<td>Administrative</td>
</tr>
<tr>
<td>MIDAS_LU*</td>
<td>cross-sectional</td>
<td>Dynamic</td>
<td>Administrative</td>
</tr>
<tr>
<td>PENSIM2</td>
<td>cross-sectional</td>
<td>Dynamic</td>
<td>sample of administrative</td>
</tr>
<tr>
<td>PRISME</td>
<td>cross-sectional</td>
<td>Dynamic</td>
<td>administrative</td>
</tr>
<tr>
<td>SADNAP</td>
<td>cross-sectional</td>
<td>Dynamic</td>
<td>administrative</td>
</tr>
<tr>
<td>SESIM</td>
<td>cross-sectional</td>
<td>Dynamic</td>
<td>sample of administrative</td>
</tr>
</tbody>
</table>

http://www.plan.be
### Table 2: Simulation properties of pension microsimulation models used by European administrations


<table>
<thead>
<tr>
<th>Country</th>
<th>Initial database</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAW</td>
<td>Denmark</td>
</tr>
<tr>
<td>MIMOSIS</td>
<td>Belgium</td>
</tr>
<tr>
<td>???</td>
<td>U.K.</td>
</tr>
<tr>
<td>REDIS</td>
<td>Luxemburg</td>
</tr>
</tbody>
</table>

...but there are plenty of other static models around, including **EUROMOD**...
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2. A short history of MIDAS_BE


• 2008-2011: a lot has been/is being done...

• 2011 - ? The future looks promising indeed...
Some technical characteristics of LIAM/MIDAS

• Alignment

• The labour market module

• The marriage market
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Institutional context

1. Government:
   - ‘Silver-paper’ (Zilvernota)
   - Stability program, of which the ‘long-term part’

2. High Council of Finances (Hoge Raad van Financiën, Afdeling « Financieringsbehoeften »):
   - Annual Report (the financement of the budgetary costs of ageing),
   + budgetary targets on the middle-long term (input Silver fund)

3. Study Committee for Ageing:
   Annual Report:
   - Budgetary and social consequences of ageing
   - Specific studies (ex. 2nd pension pillar, …)
Technical/Institutional context

MALTESE

MIDAS

Study Committee for Ageing

AWG

Alignment
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4. An application: the adequacy or “social sustainability” of pensions.

1. What is the impact of current legislation, ageing and economic growth on:
   1. Budgetary costs of ageing
   2. The adequacy of pensions

3. Between 2006 and 2007, the minimum right per career year as well as the old age guaranteed minimum income have increased by 17 and 14% respectively. What is the impact of these policy changes on the sustainability and adequacy of pensions?
An application: the adequacy or “social sustainability” of pensions (report 2010 of the Study Committee for Ageing).

<table>
<thead>
<tr>
<th>Key demographic hypotheses</th>
<th>2007</th>
<th>2030</th>
<th>2050</th>
<th>2060</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fertility</td>
<td>1.81</td>
<td>1.76</td>
<td>1.76</td>
<td>1.77</td>
</tr>
<tr>
<td>Life expectancy at birth</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>77.3</td>
<td>81.2</td>
<td>84.0</td>
<td>85.3</td>
</tr>
<tr>
<td>women</td>
<td>83.3</td>
<td>87.0</td>
<td>89.7</td>
<td>90.9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Key macro hypotheses</th>
<th>Up to 2011</th>
<th>2011-2014</th>
<th>≥ 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yearly productivity</td>
<td>0.01%</td>
<td>1.28%</td>
<td>1.50%</td>
</tr>
<tr>
<td>Unemployment rate</td>
<td></td>
<td>14.75 in 2014</td>
<td>Decreasing towards 8%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Social policy hypotheses</th>
<th>2009-2010</th>
<th>≥ 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wage ceiling</td>
<td>Current legislation</td>
<td>1.25%</td>
</tr>
<tr>
<td>Minimum right per working year</td>
<td></td>
<td>1.25%</td>
</tr>
<tr>
<td>Welfare adjustment non-lump-sum benefits</td>
<td></td>
<td>0.50%</td>
</tr>
<tr>
<td>Employed and self-employed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Welfare adjustment of lump-sum benefits</td>
<td>0.50%</td>
<td>1.00%</td>
</tr>
</tbody>
</table>
4.1. What is the impact of current legislation, ageing and economic growth on: Budgetary costs of ageing

<table>
<thead>
<tr>
<th></th>
<th>Base scenario (1,5% increase of productivity)</th>
<th>Variant (1,75% increase of productivity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retirement benefits</td>
<td>5,3</td>
<td>4,5</td>
</tr>
<tr>
<td>Health care</td>
<td>4,2</td>
<td>4,2</td>
</tr>
<tr>
<td>Other</td>
<td>-1,4</td>
<td>-1,7</td>
</tr>
<tr>
<td>Total</td>
<td>8,2</td>
<td>7,0</td>
</tr>
</tbody>
</table>

Pension Exp. GDP = \( \frac{\text{Population} > 65 \times \text{Number of Pensioners} \times \text{Population 15 – 64}}{\text{Population 15 – 64} \times \text{Employment} \times \text{Average Pension}} \)

<table>
<thead>
<tr>
<th></th>
<th>Dependency ratio</th>
<th>Coverage ratio</th>
<th>1/employment rate</th>
<th>Benefit ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base-variant (1.50% prod.gr.)</td>
<td>5.3</td>
<td>1.1</td>
<td>-0.8</td>
<td>-0.7</td>
</tr>
<tr>
<td>Simulation variant (1.75%)</td>
<td>4.5</td>
<td>1.1</td>
<td>-0.8</td>
<td>-1.4</td>
</tr>
</tbody>
</table>
4.2. What is the impact of the two policy measures on the budgetary costs of ageing?

1. The budgetary impact of increasing the minimum right per career year is small because
   1. Its impact is not retrospective
   2. It pertains only to a limited number of beneficiaries.

Hence: +0.01% bbp in 2010,
       +0.05% bbp in 2030,
       +0.07% bbp in 2060.
4.2. What is the impact of the two policy measures on the budgetary costs of ageing?

2. The budgetary impact of increasing the means-tested minimum pension is more important because
   1. Its impact is retrospective
   2. It potentially pertains to all beneficiaries.

Hence:
4.2. What is the impact of the base-variant on the adequacy of pensions?

31. Poverty risk rate

Source: MIDAS
4.3. What is the impact of increasing the minimum right per career year on the adequacy of pensions?

1. Poverty risk

![Graph showing poverty risk over time](http://www.plan.be)

Source: MIDAS

2. Inequality (Gini)

![Graph showing inequality over time](http://www.plan.be)

Source: MIDAS
4.3. What is the impact of increasing the means-tested minimum pension on the adequacy of pensions?

1. Poverty risk (60% median)

Source: MIDAS
5. Conclusions

1. Dynamic microsimulation is an increasingly popular technique in the assessment the adequacy of social security systems in Europe

2. MIDAS_BE is a dynamic microsimulation model that has proved its worth in Belgian policy support, which is why the FPB continues to invest in its development

3. Also on the European level is there an increasing realization that there is need for models assessing (pension) adequacy.

4. Keep an eye out for LIAM 2!
Thank you for your attention
Grazie per il vostro attenzione
Danke für Ihre Aufmerksamkeit
Dank voor uw aandacht
Merci pour votre attention
A short history of MIDAS_BE (1/3)

Alignment to AWG projections and assumptions:
- fertility
- mortality
- proportional size of working population
- inactive states
- labour productivity
- social policy hypotheses

DIW
- labour market module
- pension module Germany

FPB
- management and coordination
  - Demographic module
  - pension module Belgium

Geert Bryon
Cathal O’Donoghue

LIAM-MIDAS

ISAE
- pension module Italy

http://www.plan.be
A short history of MIDAS_BE (2/3)

Since AIM, a lot has been done on MIDAS

1. The basis of alignment from AWG to MALTESE

2. All relevant social security measures taken between 2001 and 2010 are now included in the model

3. Extension of alignment procedures
   1. Private sector/public sector
   2. Civil servants
   3. Monetary alignment specified to gender

4. Extension of coverage
   1. Unemployment benefit
   2. Disability benefit
   3. Welfare benefit
A short history of MIDAS_BE (3/3)

4. Current projects or projects
   1. An administrative sample of 300,000 individuals
   2. 2nd pension pillar
   3. Gross-net trajectory

5. Methodological advances
   1. Immigration and emigration of individuals in households
   2. Sample weights in dynamic microsimulation with dynamic ageing
   3. Option value approach to the retirement decision, taking into account alignment
6. Progress project MiDaL (Grant VS/2009/0569):
   • **LIAM DMS**
     • CEPS/INSTEAD (general manager)
     • General Inspectorate for Social Security (financer)
     • FPB (developer)
     • Advisors: Cathal O’Donoghue, Jinjing Li, Howard Redway.
   • One ascii-file instead of ≥ 200
   • Capacity: no idea...
   • Simulation time: a matter of seconds
   • Open source (hdf-5, Python), which means ...
...sooner or later, you are going to get it for free!

show_collar: "showtable(groupby([collar, 10 * workstate + education_level], grpcount()))"

indeducation_process:
- show_work: "show(grpsum(workstate < 5))"
- show_ineducation: "show(grpsum(workstate == 5))"
  # decide ineducation upon age and education_level
- workstate: "where((workstate!=8) & 
  ((age < 16) |
  ((age < 19) & (education_level == 3)) |
  ((age < 24) & (education_level == 4)))
  , 5, workstate)"
- show_ineducation: "show(grpsum(workstate == 5))"
  # unemployed if left education
- workstate: "where((workstate==5) & 
  (((age == 16) & (education_level == 2)) |
  ((age == 19) & (education_level == 3)) |
  ((age == 24) & (education_level == 4)))
  , 6, workstate)"
- show_ineducation: "show(grpsum(workstate == 5))"
- show_work: "show(grpsum(workstate < 5))"
- show_workstate: "showtable(groupby([workstate, 10*workstate+education_level, lag(workstate)], grpcount()))"

table_inwork:
- t_inwork : "showtable(groupby([inwork, workstate], grpcount()))"
- all : "showtable(groupby([inwork, workstate, lag(workstate)], grpcount()))"
  
  #
  - agegroup: "showtable(groupby([agegroup, workstate, workstate*10+education_level, lag(workstate)], grpcount()))"

inwork_process:
- before_job: "show(grpsum(inwork ))"
- before_no_job: "show(grpsum(workstate < 5))"
Alignment

- **Alignment of state variables:**
  - Procedure to have the model respect or ‘mimic’ exogenous aggregates while respecting individual probabilities in the occurrence of the event
    - Behavioral equation determining the probability of the transition
    - Individuals are ranked depending on the obtained probability (from the highest to the lowest)
    - The number of selected individuals reproduces targeted aggregates

- **Monetary alignment or ‘amount alignment’:**
  - Proportional adjustment of first-run values of earnings to match exogenous macroeconomic productivity growth rates

- **Uprating**
  - Of social security benefits
The marriage market I

- person is 'selected' to find a partner
  - 'marriage market'
    - link individuals
    - create a new household

Marriage or cohabitation?

- Divorce?
  - yes: Divorced
  - no: Married

- Separation?
  - yes: Single
  - no: Cohabiting

Marriage?
  - yes: Married
  - no: Cohabiting

http://www.plan.be
### The marriage market II

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>...</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(p(1,1))</td>
<td>(p(1,2))</td>
<td>(p(1,3))</td>
<td>...</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>(p(2,1))</td>
<td>(p(2,2))</td>
<td>(p(2,3))</td>
<td>...</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>(p(3,1))</td>
<td>(p(3,2))</td>
<td>(p(3,3))</td>
<td>...</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
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<tr>
<td>...</td>
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</tr>
</tbody>
</table>

- **Females selected for the marriage market**
- **p = partnership** \((♀x, ♂y) = \max \{p(x,y|x)\}\) of the remaining \(y\)

**Notes:**
- Age, age difference
- Dummy of working
- Dummies for educational attainment levels