Knowledge Laboratory of the Early life Course

Barry Milne and COMPASS team

10th Research Colloquium
Statistics NZ, Conference Room
1 August 2016
Outline

- What is microsimulation?
  - A simple example

- MEL-C
  - Key features, Results, Insights & observations

- Knowledge Lab of the Early Life Course
  - Aims
  - 3 models: Obesity, Education & Mental health
  - Web deployment using Shiny
What is Microsimulation?

- Simulates plausible data for micro-level units (i.e., people, businesses, ...)
- It (typically) uses empirical data as a basis to simulate real or alternative worlds, and their futures
- It enables experimentation in a virtual lab
Microsimulation: A virtual world

• Start with a real (or realistic synthetic) sample of people

• Apply statistically-derived rules to reproduce patterns via a stochastic process

• We have created a virtual world (our simulation model)

• Predict what might happen if conditions were to change (i.e., by altering parameters)
A simple worked example (made up)

- Suppose every child born has the same probability of attending early childhood education (ECE)
  - \( p = 0.50 \)

- And that those who **do attend** have the probability of leaving school with qualifications (SCQUAL):
  - \( p = 0.80 \)

- And that those who **don’t attend** have the probability of leaving school with qualifications:
  - \( p = 0.50 \)
A simple worked example

- Simulation is a **stochastic** process, so you get different results each time
  - On each simulation run, different units may be simulated as
    (i) attended ECE
    (ii) left school with qualifications

- Best to take a number of runs and average...

- For 5 runs & 20 units
  - Av=10.2/20 attended ECE
  - Av=13.2/20 left school with qualifications
A simple worked example

- Suppose an intervention is suspected to increase the probability of children attending ECE to
  - $p = 0.80$
- But the probability of leaving school with qualifications remains the same (p=0.80 for attenders; p=0.50 for non-attenders)
- What would happen??
A simple worked example

- For 5 runs & 20 units,
- \( \text{Av}=\frac{16}{20} \) attended ECE
- \( \text{Av}=\frac{14.8}{20} \) left school with qualifications, an increase from \( \frac{13.2}{20} \) (8% increase)

- A very simple model for which simulation probably not needed…
  …But if lots of factors affect ECE attendance, and its association with school qualifications (through potentially multiple pathways)

Microsimulation can capture this in one model, and allows counterfactuals to be tested
1. Goals … what did we do?
- Developed a software application as a decision-support tool for policy-making

2. Rationale … why did we do it?
- To improve policymakers’ ability to respond to issues concerning children and young people

3. Means … how did we do it?
- By building a computer simulation model (n=5000) with data from existing longitudinal studies to quantify the underlying determinants of progress in the early life course
MEL-C
- Conceptual framework

Structural level

Child characteristics
• (age)
• gender
• ethnicity

Parental characteristics
• age at birth of child
• ethnicity
• education level

Socio-economic position
• SES at birth of child
• (single-parent status at birth)

Intermediate level

Family/household characteristics
e.g. single-parent status, number of children, household size

Employment
e.g. parental employment, welfare dependence

Material circumstances
e.g. housing: accommodation type, owned-rented, bedrooms number

Psychosocial factors
e.g. family functioning: change of parents, change of residence

Behavioural factors
e.g. parental smoking

Other factors
e.g. perinatal factors

Outcome

Health service use
e.g. GP visits, hospital admissions, hospital outpatient attendances

Education
e.g. reading ability

Social/Justice
e.g. Conduct disorder

Other factors
e.g. perinatal factors
MEL-C - Insights

- Able to model early life-course very well

- Changing factors in children’s lives often had weak effects on child outcomes
  - Is that just the reality of policy impact?
  - Need to change multiple factors?
  - Most important factors sometime not the most policy amenable (maternal education)

- Policy relevance increased by increasing range of outcomes & factors
Astute observation 1

There are many well-established estimates for factors that impact the lives of children, but these exist in isolation; micro-simulation offers a way to bring these together.

– John Lynch, Professor of Public Health, University of Adelaide

Astute observation 2

‘Best’ estimates are thought to be derived from systematic reviews/meta analyses, but it is difficult to test their validity.

– David Gough, Professor of Evidence Informed Policy and Practice, Institute of Education
Knowledge Laboratory - Aims

- Identify key determinants of child and adolescent outcomes

- Integrate estimates from systematic reviews/meta analyses into working model of early life course
  - Developed from MEL-C (n=5000); extended in breadth (more determinants and outcomes), and length (to age 21)

- Use as knowledge laboratory
  - Test the validity of ‘best’ estimates
  - Test policy scenarios using validated model
End user engagement

Important role of policy reference “End User” group
- Engage key people from government agencies
- Use their expertise to get better model & policy-relevant scenarios

Seven agencies involved
- Health
- Education
- Social Development
- Justice
- Te Puni Kōkiri
- Children’s Commission
- SuPERU
Knowledge Lab - Outcomes

- Focus on three outcomes
  - Obesity
  - Education
  - Mental Health

- For each outcome
  - Determine conceptual framework
  - Get NZ prevalences and inter-relations for each predictor in the conceptual framework
  - Get meta-analytic estimates for each path in the conceptual framework
    - Harder than you might think…
    - Quality assessments undertaken
Obesity - Conceptual framework
Obesity model
- Summary

- Modest effects of breakfast consumption and maternal obesity

- Effect of risk factors on population obesity determined by
  - Size of effect of risk factors
  - Prevalence of risk factor in population
  - ...as such, often small population effects, though bigger effects for the group that has been changed
Education - Conceptual framework

Socioeconomic Status of parents

- In-utero environment
- Gestational age
- Speech/language/hearing problems
- ECE
- Deviant behaviour
- Deprivation
- Behavioural disability
- Aspirations, expectations
- Sex
- Breast feeding
- Early Cognitive Ability
- Cognitive ability
- Exam performance
- NEET
School and region effects

- To allow school interventions to be modelled
  - Education, but also Obesity and mental health
- And to allow for school- and/or teacher and/or peer-level effects

- Nest children within schools in the simulation
  - More realistic simulation as can account for dependence in data
  - Child who attend same school more similar

- One (easiest?) way to do this:
  - Assign children to regions (deterministically)
  - Assign children to schools within regions (stochastically)
School and region effects

■ 5000 Children

■ 16 Regions

■ 100 Schools (from 479)
  ■ 69 Secondary, 31 Composite
  ■ 79 Co-ed, 12 Girls, 9 Boys
  ■ 7 Kura Kaupapa
  ■ 3 Designated Character
Education Scenario: 1. Breastfeeding

Breastfeeding

- Base: 35.7% never breastfeed, 23.1% breastfed >6 months
- Scenario: Decrease never breastfed to 18%; Increase breastfed >6 months to 40%

<table>
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<tr>
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<th>Cognitive Development (IQ)</th>
<th>NCEA 2 Attainment (%)</th>
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2. Otitis media

- Base: 40% of children, at least episode age <5 years
- Scenario: Reduce to 20%

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Education Scenario: 3. Early Childhood Education (ECE)

- ECE Enrolment
  - Not enrolled 95.9%; Enrolled 4.1%

- What if the small number of children not receiving ECE ALL received it?

Setting the Scenario

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<th>Variable Adjustment</th>
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<td><strong>Level</strong></td>
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<tr>
<td>Yes (%)</td>
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Education Scenario:
3. Early Childhood Education (ECE)

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<td>60.1</td>
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</table>
Mental health - Conceptual framework

- Prenatal/Birth
- Infancy
- Childhood
- Adolescence
- Young adulthood

Factors:
- Socioeconomic Status of parents
- Stressful life events/adversity
- Parental attachment/warmth
- Peer relations
- Maltreatment
- Obesity
- ADHD
- School attainment
- Smoking
- Substance Abuse (Alcohol/Drug)
- Depression

Factors:
- Gender
- Parental substance abuse
- Parental depression
Knowledge Lab is a microsimulation model focussing on three outcomes: Obesity, Education and Mental Health

- Transitions in the model derived from meta-analytic estimates

It can be used to tests scenarios/counterfactuals

- May be policy amenable; may not be

Will be web-deployed (end 2016) using SHINY

- Sneak peak coming up!
Developing a knowledge laboratory of the early life-course using systematic reviews and meta analyses

This is a three-year project funded by the Ministry of Business, Innovation and Employment through its health and society fund in 2013.

We will identify key determinants of child and adolescent outcomes, and will integrate estimates from systematic reviews and meta-analyses for these determinants into a working model of the early life-course (developed from an existing model we have created). We will use the working model as a “knowledge laboratory” to (i) test the validity of the underlying behavioural equations and specific knowledge sources (meta-analyses, systematic reviews), and (ii) test policy scenarios by carrying out experiments on the “virtual cohort” created by the working model.

This research will involve the development of a micro-simulation model and associated computer software that allows users (policy makers, planners, analysts) to easily programme simulations and view the results. The end product will be an expert decision-support tool that will be available to the public policy community.

The research plan involves (i) identifying published systematic reviews and meta analyses relating to key outcomes for children and adolescents (to age 10); (ii) integrating estimates from these studies into, and thus enhancing, an existing micro-simulation model of the early life-course; (iii) validating the enhanced model, and thus published estimates, by comparing simulated results to published New Zealand benchmarks; and (iv) using the validated enhanced model to test the impact of various policies on key child and adolescent outcomes.

In using these best estimates to develop a micro-simulation model with which policy scenarios can be tested, our proposal will benefit NZ families/whanau by determining the policies that have the greatest impact on the lives of New Zealand children. Moreover, we will be uniquely placed to assess the impact of distinctive Maori programmes, such as Kōhanga reo and Whānau Ora.
Demonstration - Table Builder
Demonstration - Table Builder

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Demonstration - Line graph

Overweight in childhood
Demonstration
- Line graph
Demonstration - Table Builder (subgroup)
Demonstration
- Table Builder (subgroup)

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Demonstration - Naming Scenario

- Testing the effect of increasing breakfast consumption on obesity

Knowledge Lab

Variable

Name your scenario

Breakfast8to100

New scenario

Select Variable to Examine

Accommodation undetached

Select Subgroup for subgroup formula:

None
Demonstration
- Selecting vars to change

- Variable:
  - Name your scenario: Breakfast80to100
  - Select Variable to Examine: Breakfast consumption
  - Select Subgroup for subgroup formula: None
Demonstration
Demonstration

Overweight in childhood

Scenario
- Base
- Scenario

Mean

Year

Project upload

Choose Project File
Choose File
No...sen

Saved Scenarios

Select saved Scenario:
Breakfast80to100
Demonstration - ECE scenario

- Testing the effect of increasing ECE on school qualifications
Demonstration
But… School qualifications do change from 62% to 70% among those who previously had not attended ECE
Demonstration
- Saving projects

Name the Project:
breakfast scenario

Save Project
Demonstration
- Uploading projects
THANKS!!

Thanks to

- Nichola Shackleton, Kevin Chang, Jessica McLay, Martin von Randow, Roy Lay-Yee, Pater Davis, Oliver Mannion, Janet Pearson
- All members of end user group since 2011 (MELC)
  - MOH: Martin Tobias, Pat Tuohy, Jackie Fawcett
  - MOE: Ann Armstrong, Lynne Whitney, Barclay Anstiss, Jasmine Ludwig, Roger Clark
  - MSD: Evan Thompson, Christina Connolly, many others
  - MOJ: Robert Lynn, Maragaret McArthur
  - TPK: Nathaniel Pihama
  - OCC: Kathleen Logan, Donna Provoost
  - SuPERU: Jeremy Robertson, Alex Collier