



# Using Microsimulation Techniques to Enrich Demographic Modelling

Presentation at the Australian New Zealand  
Population Workshop, Canberra, 12-15 October 2009

Binod Nepal  
Research Fellow  
15 October 2009

# Presentation overview

- The tool box
- Microsimulation
- Projection
- Spatial modelling
- Prospect

# The tool box

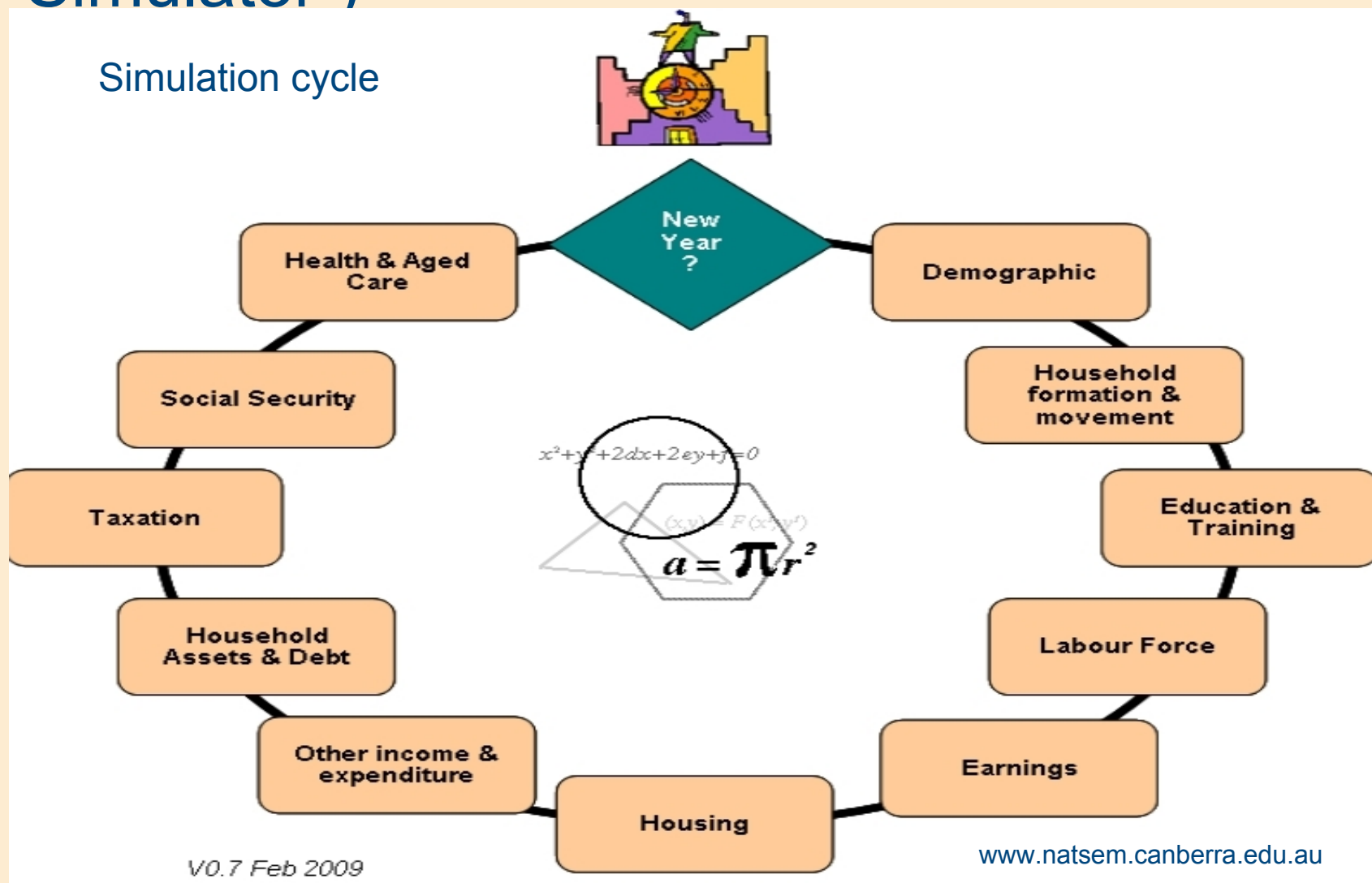
- Mathematical methods
  - Growth model
  - Ratio methods
- Cohort component method
  - National
  - Subnational
- Multistate methods
  - States and transitions
- Microsimulation
  - Projection – national/subnational
  - Spatial

# Microsimulation modelling

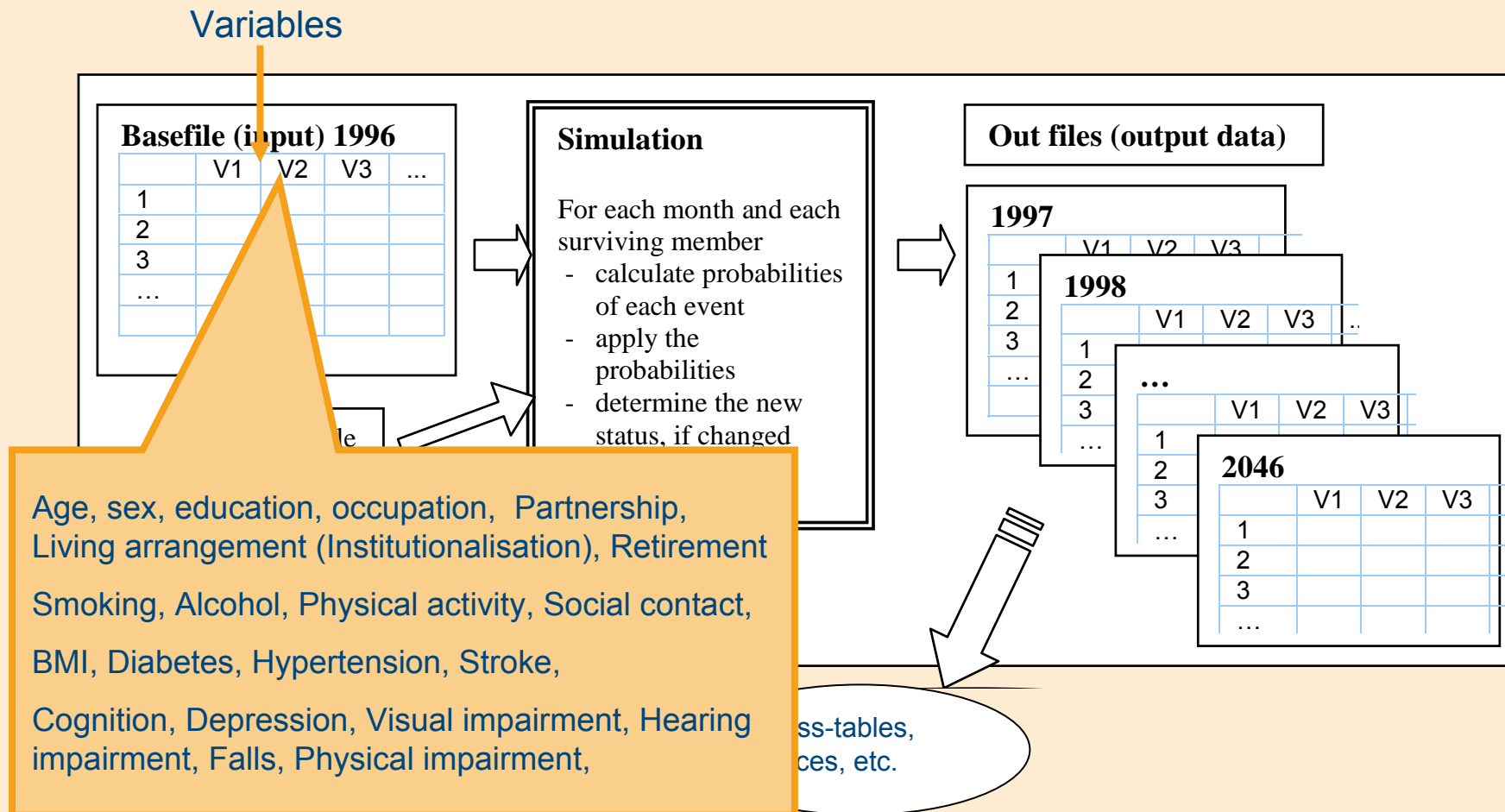
- Micro units (thousands - millions) representing a defined population
  - Persons, households, firms
- Unique identifiers and associated detailed attributes
  - Demographic, social, economic, health
- Bottom up
  - Macro level outcome from micro-level behaviours
- Life cycle
  - Simulation of events across the life cycle

# APPSIM (Australian Population and Policy Simulator)

Simulation cycle



# Microsimulation modelling: in – out



Source: Brown et al. 2009

# Types of MSM – static vs dynamic

- Static

- a few basic attributes updated - age, income
- Short term projections
- E.g. STINMOD

- Dynamic

- Change of status – e.g. partnership, living arrangement
- Change in one attribute triggers a change in another attribute
- Transition probabilities are used to update status
- Long term projections
- E.g. APPSIM, DYNOPTASIM

# Types – national/subnational vs spatial

- Generally national level modelling
  - APPSIM (State/Territory, Capital city/Regional) – late stage
    - Cross sectional snapshot of Australian population 2001-2056
  - DYNOPYASIM (national) – early stage
    - Follows a cohort aged 45+
- Growing interest in spatial modelling
  - SLA level estimates of poverty and housing stress by NATSEM
    - By a number of characteristics (family type, age group, income)
    - Annual (which is not available from Census)
  - SLA level estimates of disability and care needs (CareMOD)
  - NATSEM is developing dynamic feature of spatial modelling



# Value added by MSMs

- **Heterogeneity**: Captures population heterogeneity
- **Distributional analysis**: Effects/changes at finer subgroups of population
- **Interaction**: Simulates interactions among multiple, between individuals
- **Flexibility**: Can accommodate a large number of variables – easy to add or remove variables/modules
- Can handle **continuous variables** – e.g. income
- **Richer output**: Micro data: aggregate, cross-tabs, individual life course

# Current applications

- Economics - mainstream
  - Taxation
  - Labour force projection
  - Ageing, pension
- Health – emerging
  - Disability, health status, diseases
- Demography
  - Demographic variables in other MSMs – commonly
  - Demographic module in other MSMs – APPSIM
  - Dedicated demographic MSMs – SocSIM

# Prospect of MSM as a standard tool for population projection

- Mathematical equations -> cohort component -> MSM
- Feasibility of MSMs as a standard tool depends on:
  - Computing infrastructure
    - Powerful computers : yes
    - Programming language: yes
  - Unit record data: yes (Census, linking censuses)
  - Panel data for calculation of transition probabilities: increasing
    - E.g. HILDA, ALSA, LSAY, LSAC

Household, Income and  
Labour Dynamics in  
Australia (HILDA) Survey

Australian Longitudinal  
Study of Ageing (70+)

*Longitudinal Surveys of  
Australian Youth*

Longitudinal Study of  
Australian Children

# MSM for population projection

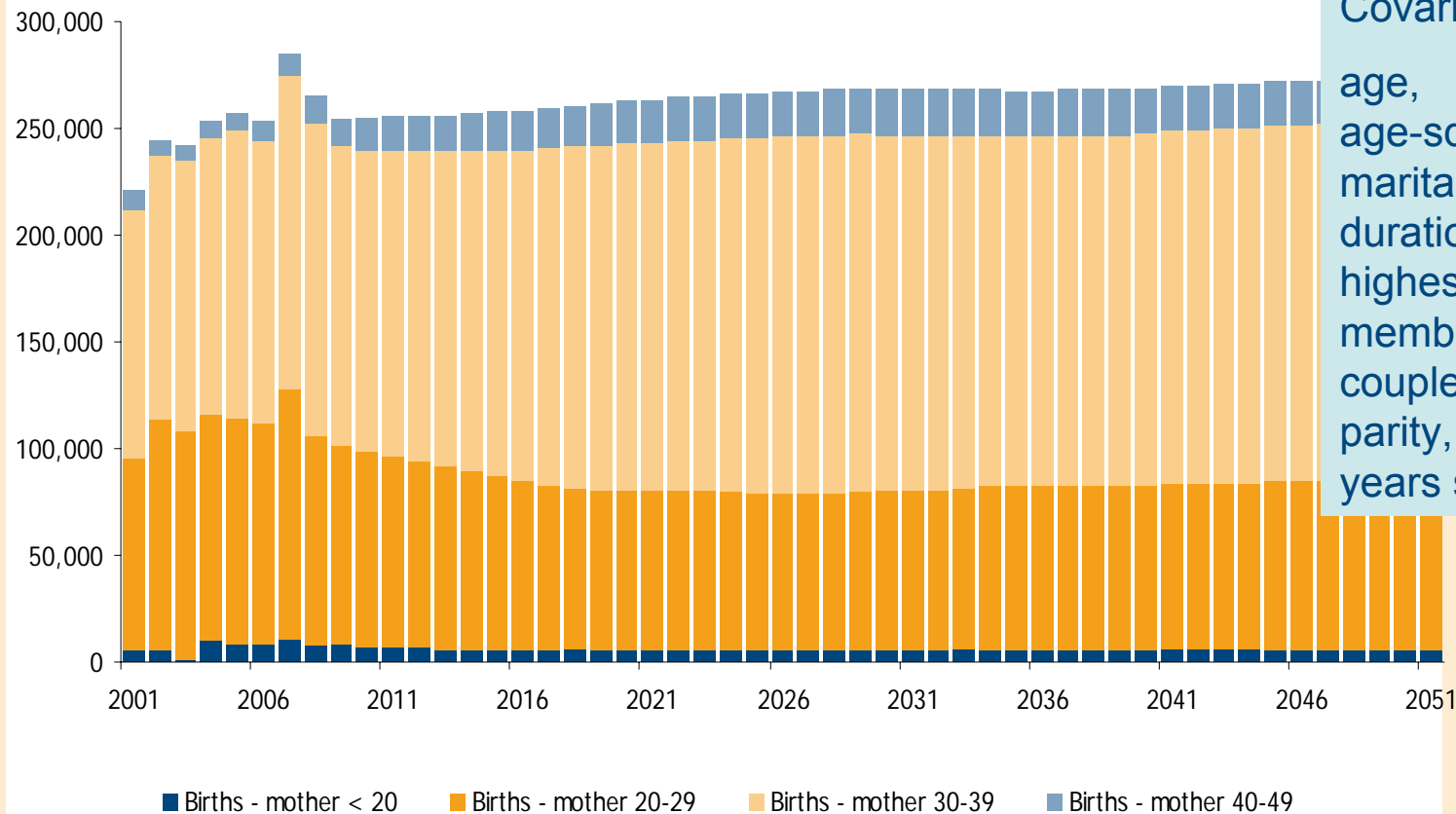
- MSM vs Cohort component
  - Sample vs total population
  - Individuals vs groups
  - Repeated random experiments vs average fractions
    - Probabilities of births (1<sup>st</sup>, 2<sup>nd</sup>, ...) vs age-specific fertility rates
- MSM can help
  - endogenize key parameters such as fertility
  - broaden the scope by adding key economic, social factors
    - Education, labour force participation
  - conduct population and household projection together
- Micro-macro link: cohort-component + MSM

# APPSIM projection of births

Logistic regression  
used to simulate  
births.

Covariates:

age,  
age-squared,  
marital status  
duration,  
highest qualification,  
membership of a  
couple,  
parity,  
years since last birth



Note: NATSEM simulation using APPSIM. APPSIM is still under development and all output should be treated as experimental

# MSM for spatial analysis

- Spatial microdata created from national microdata and spatial census profiles = as if a sample survey conducted in each spatial unit
- Static MSMs are well developed
  - CareMod
  - HouseMod
- Dynamic MSMs are being experimented
- Spatial MSMs can better capture internal migration
  - Age, sex, family type, labour force status

# Spatial microsimulation modelling: in-out

A set of national household weights from the HES Survey file are converted into ...

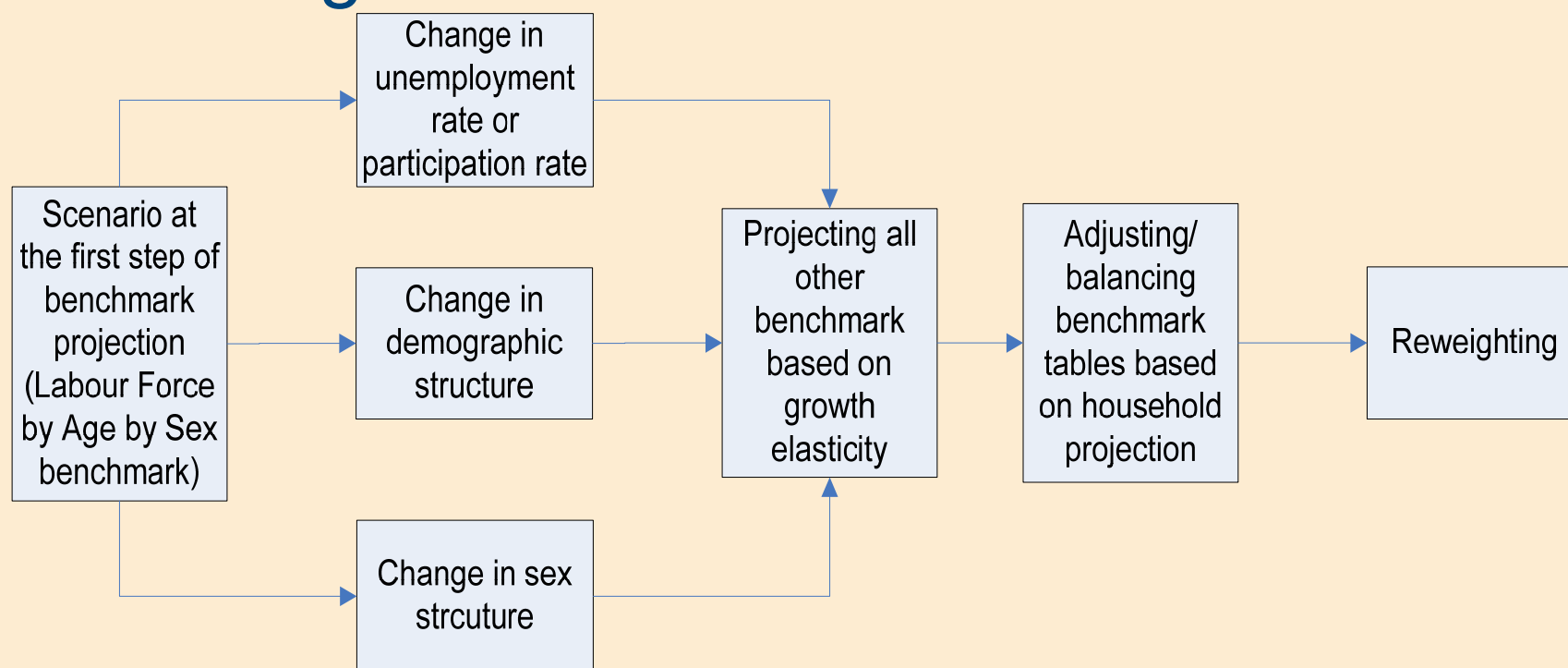
Household ID	Weekly income	Weekly rent	Other variables	Household weight
1	-	-	-	1029
2	-	-	-	157
3	-	-	-	1003
4	-	-	-	70
5	-	-	-	0
6	-	-	-	703
7	-	-	-	1335
8	-	-	-	1315
9	-	-	-	1247
10	-	-	-	1249
6,892	-	-	-	-
				7.1 m
				Num of households in Aust

... sets of household weights for small-area (SLA)

Household ID	NSW SLA1	NSW SLA2	NSW SLA3	NSW SLA n
1	0	0	6.24	
2	0	0	0	
3	4.36	26.21	14.51	
4	0	0	0	
5	0	0	0	
6	7.25	0	6.91	
7	0	0	0	
8	4.10	0	2.70	
9	1.53	0	0	
10	3.90	0	2.57	
6,892	-	-	-	-
				12,465
				25,853
				27,940
				Num of households in SLA

Source: Chin and Harding 2006

# Projection of benchmark profiles for spatial modelling



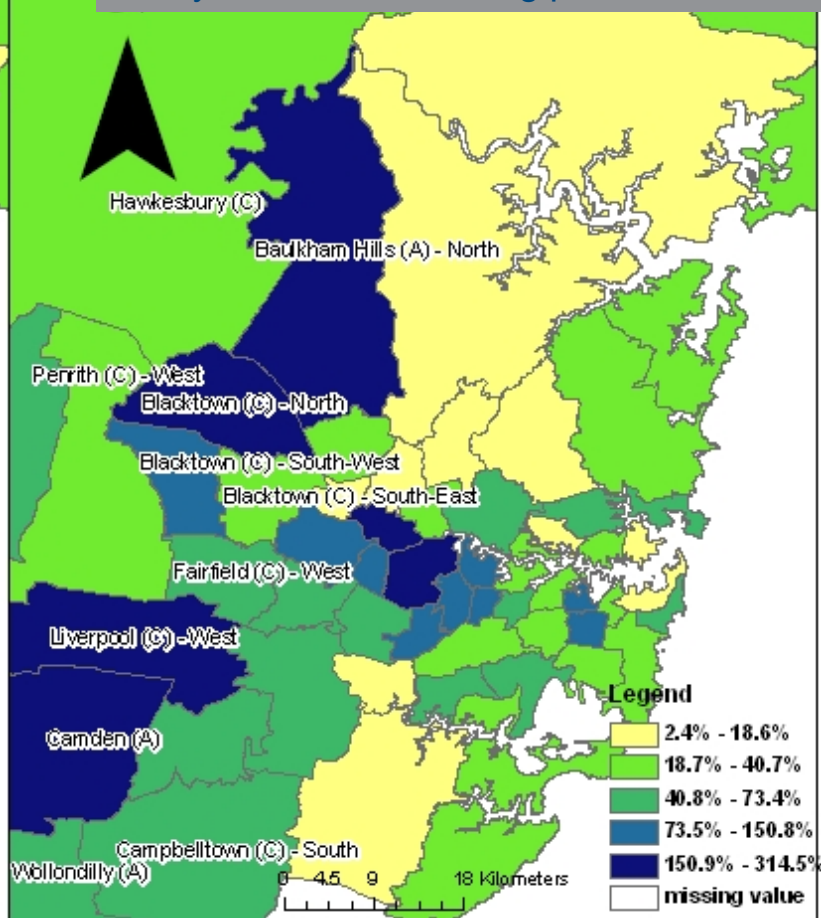
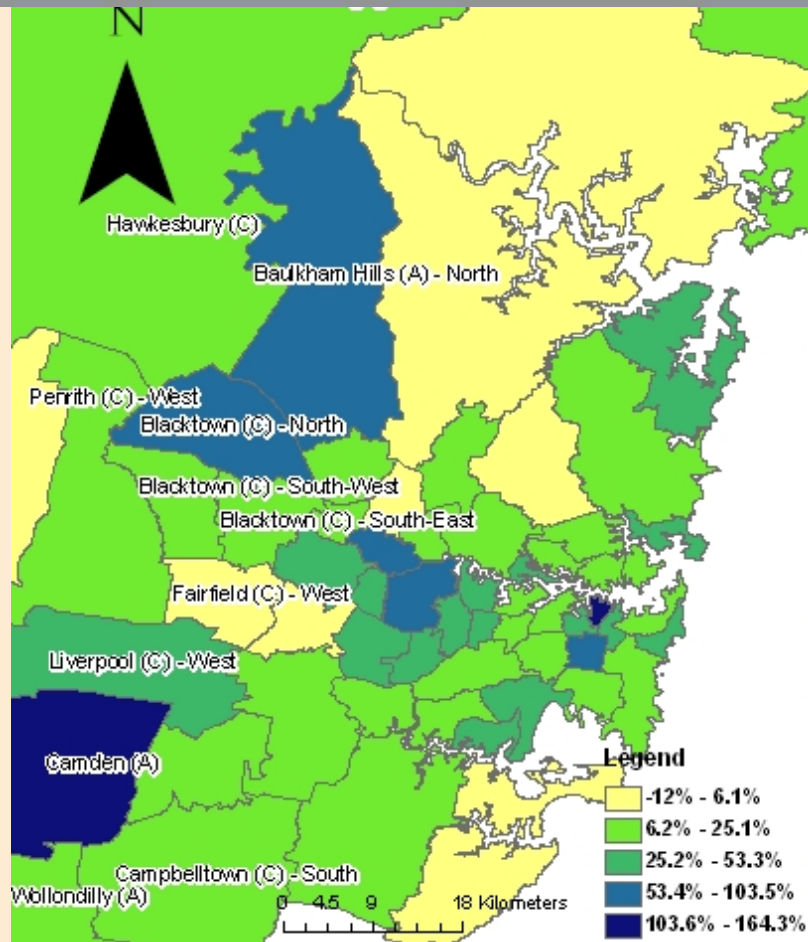
Source: Vidyattma and Tanton 2009



# Spatial projections

DoH projection of Growth in 3-4 year old 2006-2027

NATSEM SpatialMSM projection of Growth in 3-4 year old with working parents 2006-2027



Source: Vidyattama and Tanton 2009

# Limitations and challenges

- Resource
  - Resource intensive – team, time, programming
- Technical
  - Randomness
  - Validation (solution: external validation, sensitivity analysis)
- Political
  - Not well experimented and established, esp. population projection – so aligned to external projections

# Conclusion

- MSMs yet to be widely used for demographic modelling
- Baseline scenarios are created by replicating external projections
- Require considerable time and effort – but dropping
- MSMs can widen scope of demographic models
- MSMs have the potential to become standard tool for demographic modellings : projection and spatial modelling
- Optimal benefit/flexibility by linking macro and mirco models



Thank you

Contact:

Binod Nepal

Tel: 02 6201 5922

Email: [Binod.nepal@natsem.canberra.edu.au](mailto:Binod.nepal@natsem.canberra.edu.au)

[www.natsem.canberra.edu.au](http://www.natsem.canberra.edu.au)