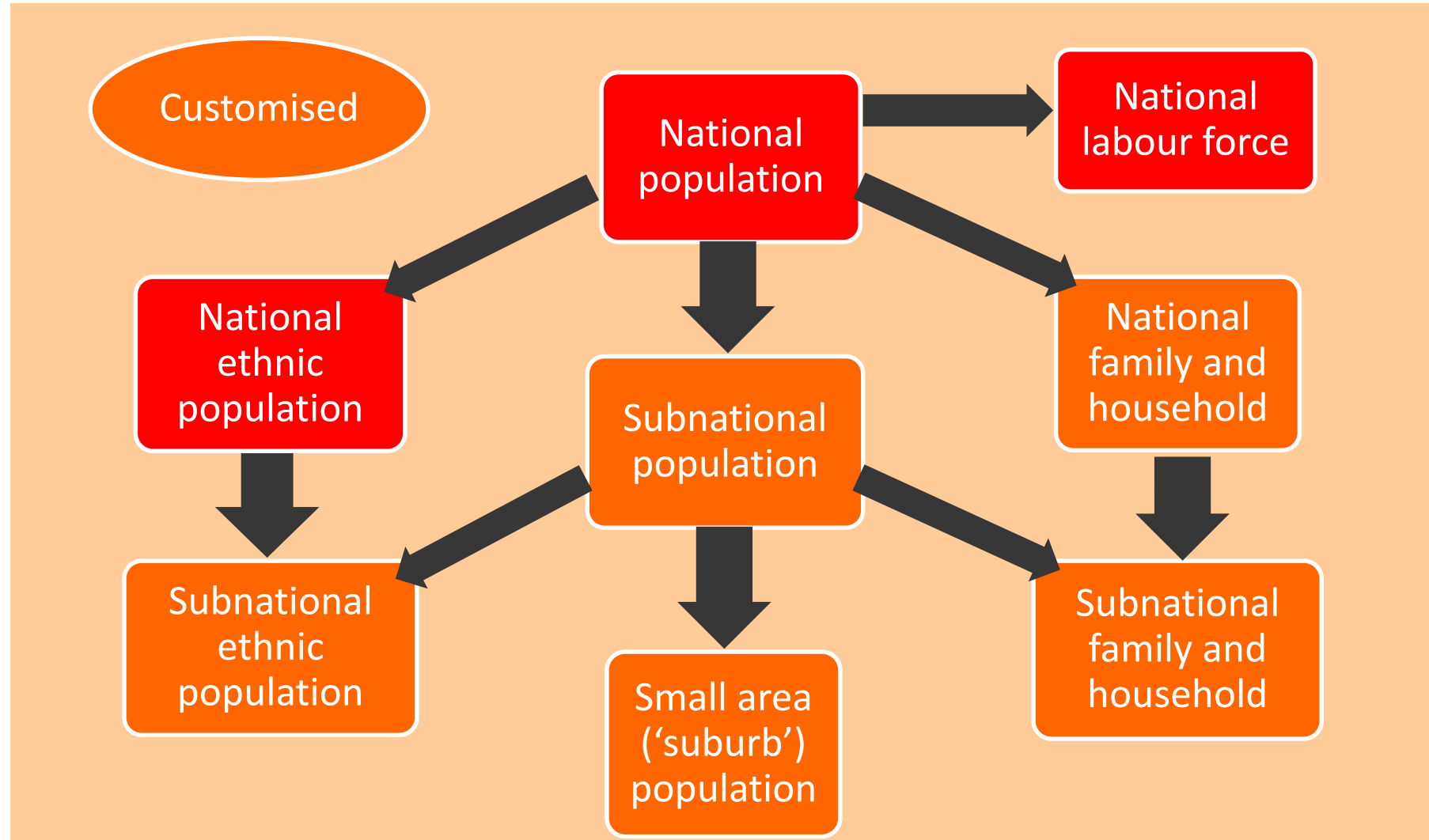


Developing stochastic projections: Suggestions from the New Zealand experience

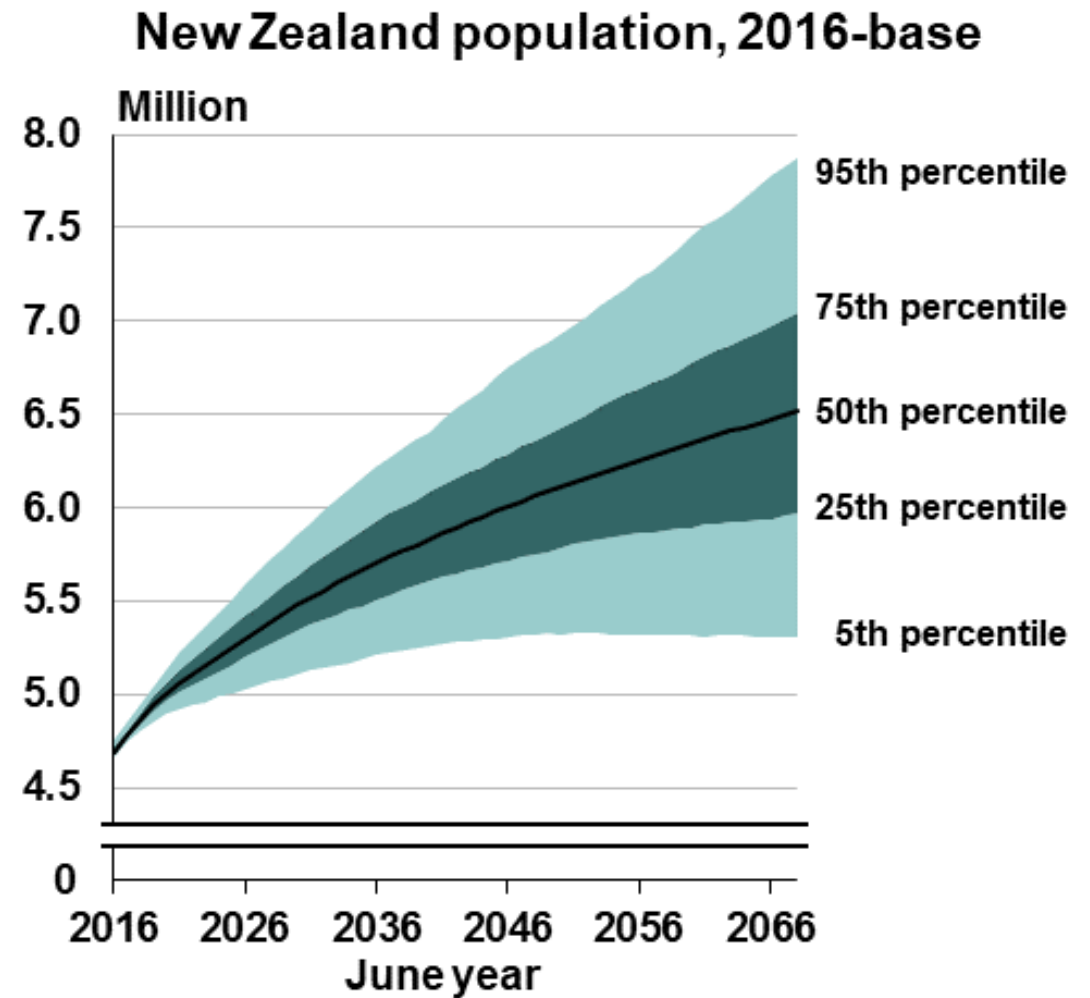
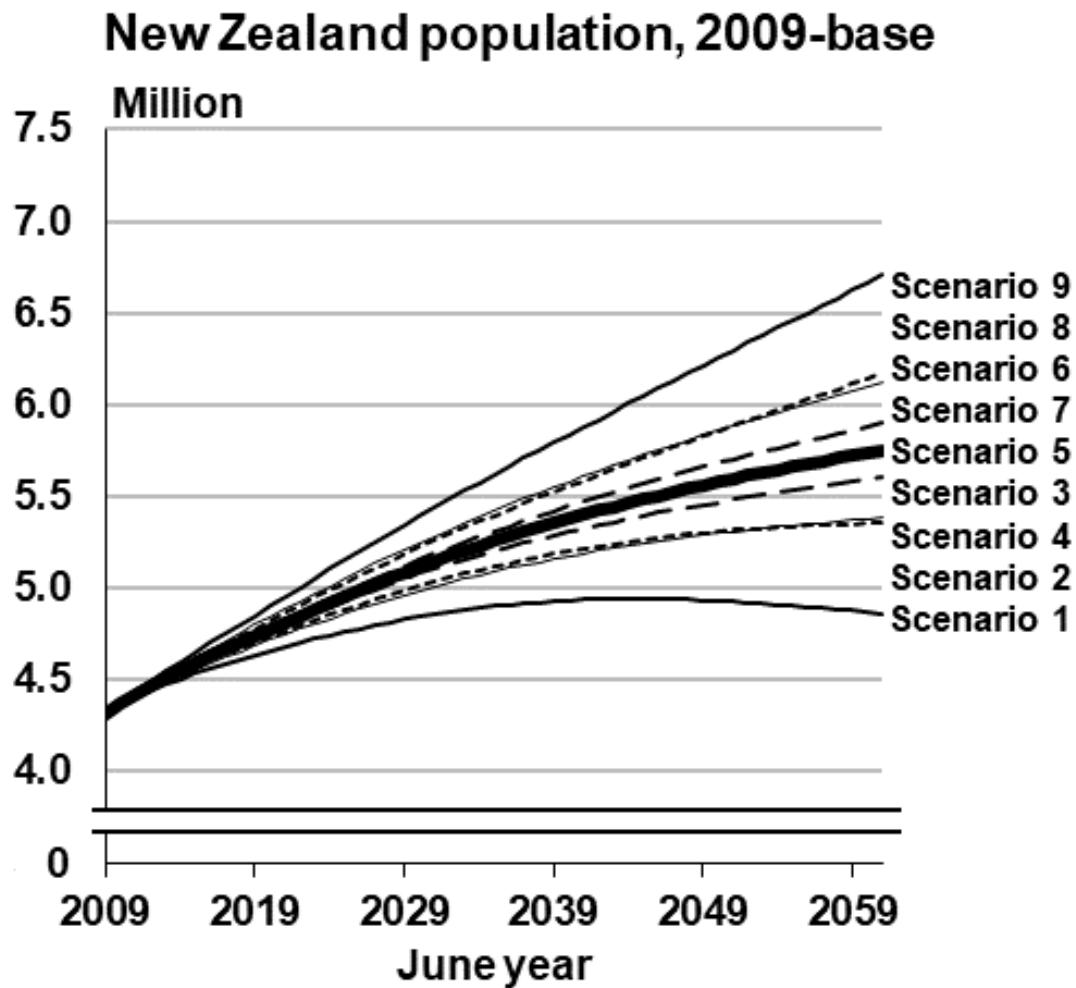
Kim Dunstan



Stats NZ's demographic projections

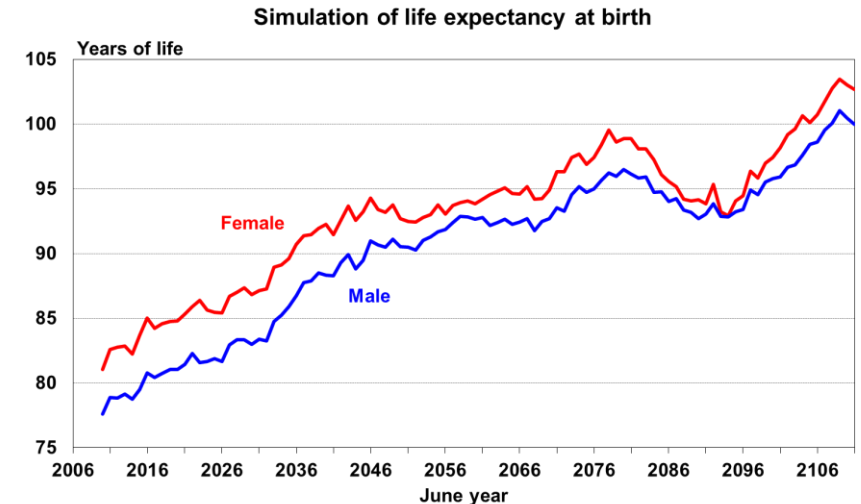


Deterministic v stochastic projections



Stochastic method summary

- Projections, not forecasts
- Uncertainty modelled for all assumptions
- Repeated simulations (eg 2,000)
- Cohort component method
- Simulations summarised probabilistically (percentiles)
- Selected percentiles disseminated
 - Tables
 - Graphically



Method of assumption formulation

National (total NZ) population projections, 2016-base

Assumption	Median (50 th percentile)	Variance/distribution of values
Base population	Empirical model: official population estimates based on census and post-enumeration survey	Expectation (judgement): variance varies by age-sex
Fertility	Expectation (judgement)	Empirical model: ARIMA (0,1,0) model fitted to 'total fertility rate' for 1977–2016 June years
Mortality	Empirical model: coherent functional demographic model fitted to age-specific death rates for 1977–2015 June years	
Migration	Expectation (judgement)	Empirical model: ARIMA (1,0,1) model fitted to net migration for 1988–2016 June years
Sex ratio at birth	Empirical model: median and variance from sex ratio at birth for 1900–2015 December years	

Why stochastic projections?

- Assists interpretation
- Quantification (estimation) of uncertainty
- Projections are inherently uncertain
- Avoids tyranny of implausibly precise projections (‘medium’)
- Uncertainty is not necessarily symmetrical
- Illustrates what is certain and what is uncertain
 - Input components
 - Age groups
 - Ethnic groups
 - Characteristics (eg dependency ratios, median age)

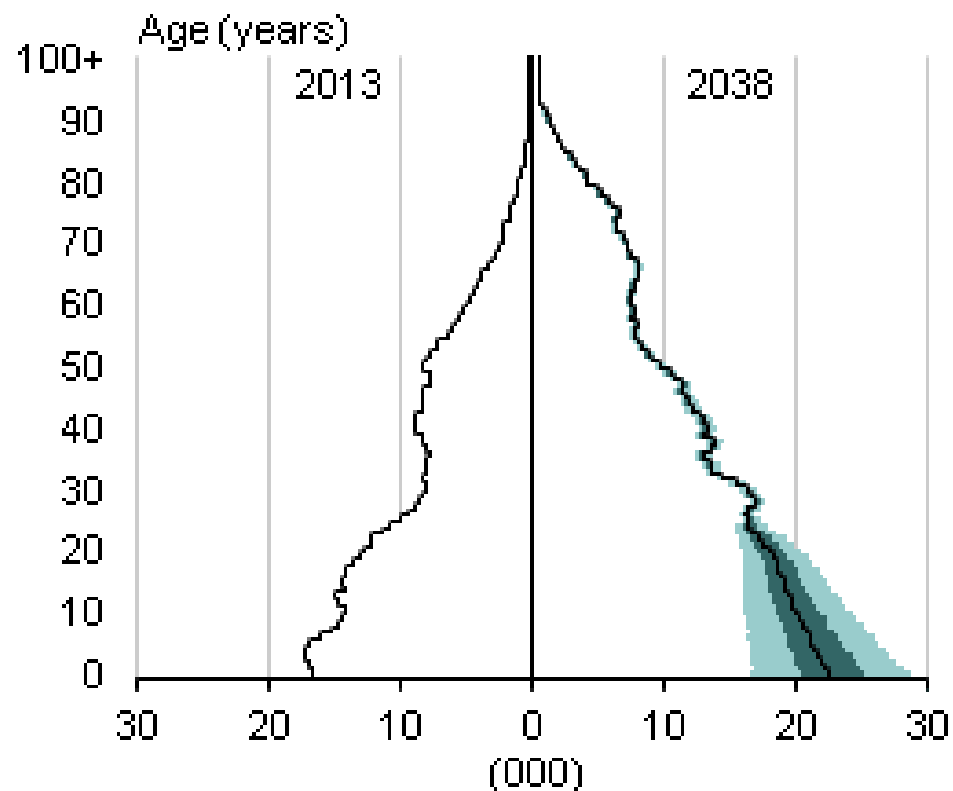
Māori and 'European or Other' age structure

Percentiles 5th, 25th, 50th, 75th, 95th

Māori population

By age

2013 and 2038

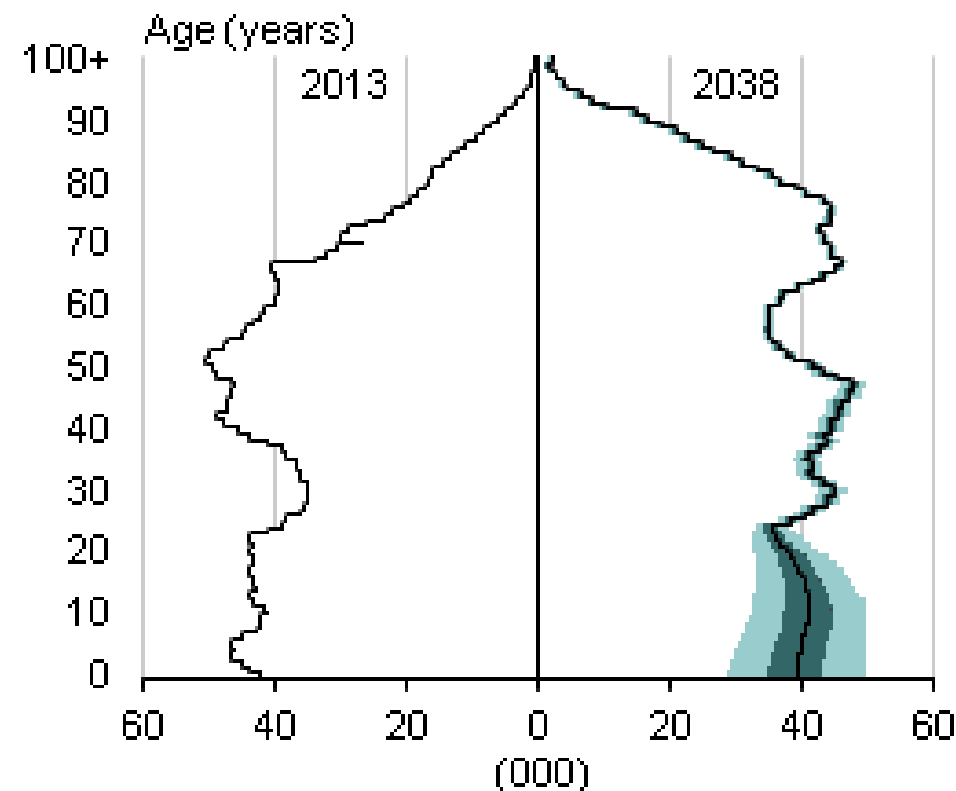


Source: Statistics New Zealand

'European or Other' population

By age

2013 and 2038



Source: Statistics New Zealand

Challenges

- Computing capacity
- Customer need
- Customer expectations
- Customer understanding
- Spurious precision
- Impact on other projections
- Cost

Suggestions

1. Engage with customers
 - Do they understand and use alternative variants (eg low, high)?
 - Would they benefit from more informative measures of uncertainty?
2. Identify institutional barriers
3. Collaborate with others
4. Utilise existing open source software
5. Utilise published examples (data, metadata)

Suggestions

6. Interpretability not accuracy
 - More emphasis on understanding variance
7. Don't ignore uncertainty in base populations
8. Uncertainty can be estimated using models or judgement
9. Complementary 'what if?' scenarios
10. Consider progressive development
11. Visual communication – fan charts

Summary

- Stochastic projections help interpretation
- Customers intuitively understand fan charts
- Uncertainty can be estimated using models or judgement
- No-one is worse off with stochastic projections
- Projections for multiple sub-populations (eg subnational) remains greatest challenge
- Stochastic projections consistent with:
 - How producers want their projections to be interpreted
 - How users should be interpreting projections

More information

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Method of assumption formulation

National **ethnic** population projections, 2013-base update
(published 2017)

Assumption	Median (50 th percentile)	Variance/distribution of values
Base population	Empirical model: official population estimates based on census and post-enumeration survey	Expectation (judgement): variance varies by age-sex
Fertility & paternity	Expectation (judgement): based on estimates for total NZ population	
Mortality	Expectation (judgement): based on estimates for total NZ population	
Migration	Expectation (judgement): based on estimates for total NZ population	
Inter-ethnic mobility	Expectation (judgement): based on New Zealand Longitudinal Census	
Sex ratio at birth	Empirical model: median and variance from sex ratio at birth for 1997–2016 June years	

Method of assumption formulation

National labour force projections, 2017-base (published 2017)

Assumption	Median (50 th percentile)	Variance/distribution of values
Labour force participation rates	Expectation (judgement)	Empirical model: ARIMA (0,1,0) model fitted to 'average working life' by sex for 1986–2017 June years
Average hours worked	Expectation (judgement)	Empirical model: ARIMA (0,1,0) model fitted to 'total hours worked' by sex for 1987–2017 June years