

FORECASTING SCHOOL ENROLMENTS IN THE AUSTRALIAN CAPITAL TERRITORY (ACT)

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Joint work with the ACT Education Directorate



Australian
National
University

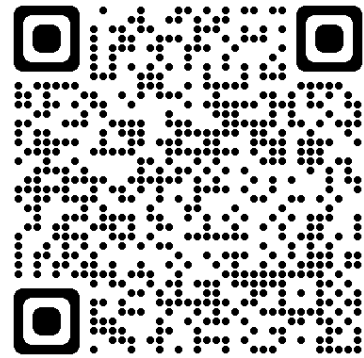


Education

New Zealand Population Conference
Auckland, 29-30 August 2023

BACKGROUND

- A five-year project between ACT Education Directorate and ANU school of demography to annually produce 10-year forecasts of school enrolments for all ACT schools
- Demographic growth and compositional shifts in the ACT
 - Urban intensification and greenfield housing developments
 - High turnover through internal and international migration
- Complex pressures on public school systems
- School Transition Estimation and Projection (**STEP**) model was developed in first 3 years
 - Has proven to be robust and reliable



Xiang, Raymer
& Gray (2023)
*Population
Space and
Place*

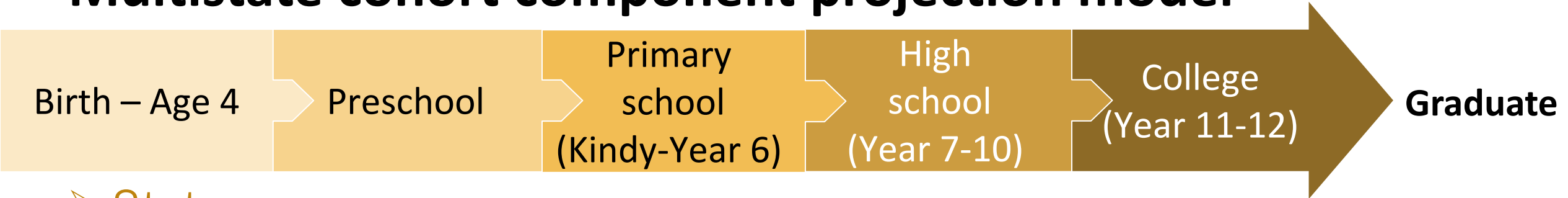


AIM

- STEP model projects student enrolments (point estimates) by school and academic level
 - Cost of over/under projection could be high
 - Errors could undermine the trust in the projection and the planning policies ensued
- An extension on the STEP model to incorporate uncertainty into the projection
 - Further evidence on accuracy and expected range of school enrolment projections
 - Assist with planning and prioritisation of school resources

STEP MODEL DESIGN

Multistate cohort component projection model



➤ States

- More than 130 schools (65 % Public, 35% Private)
- 14 Academic levels (Preschool to Year 12)

➤ Transitions

- Progression: ‘ageing’ from one academic level to the next
- Movements: transfer, leave ACT system (out-migrate), graduate

➤ Inputs

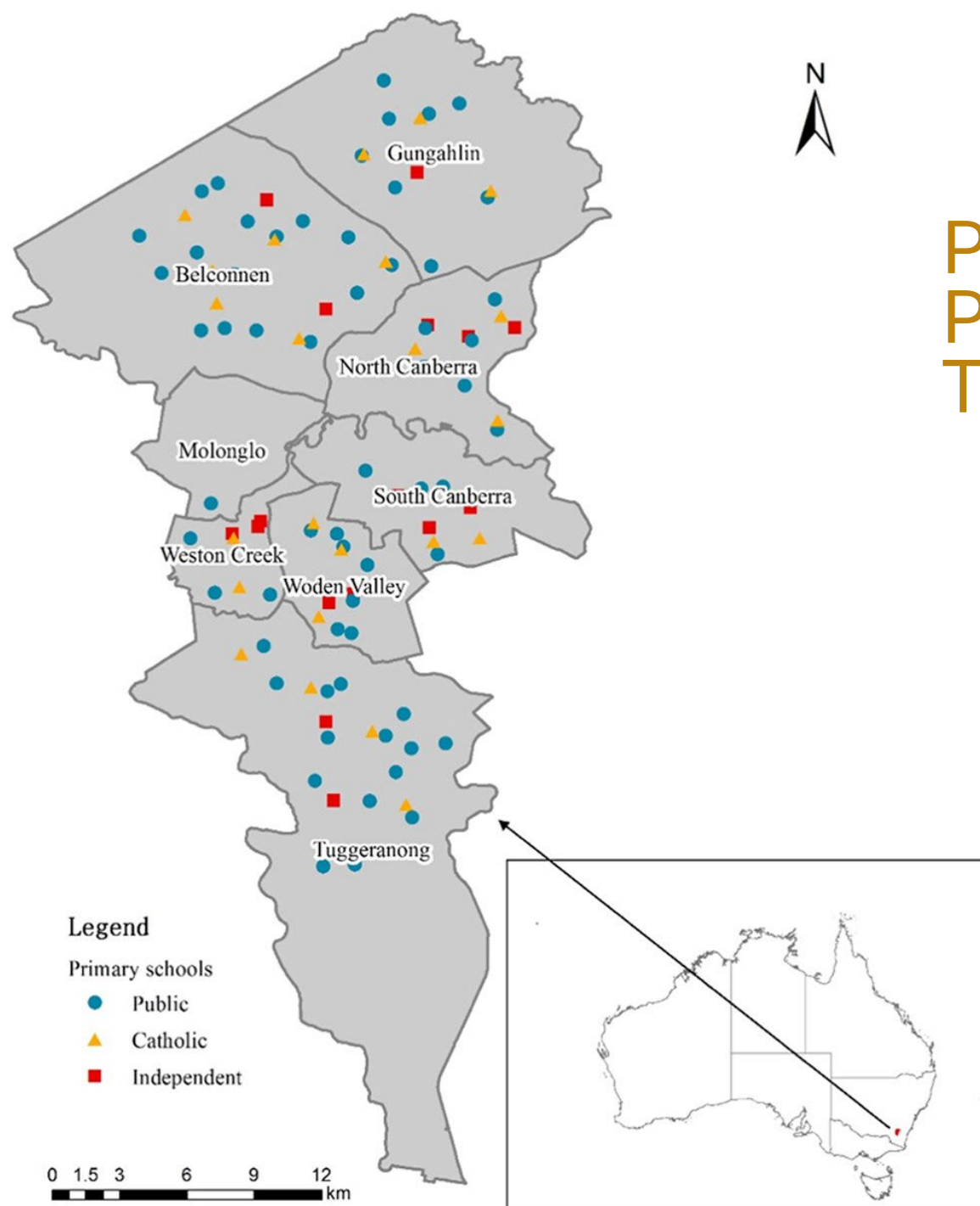
- Preschool entries and in-migration

➤ Unit of projection

- Each school and academic level (about 1,000 combinations)

STEP MODEL INPUTS

- School enrolment census (2009-2023)
 - Administrative data collected at the individual record level
 - Student locations and movements are trackable over time
- ACT population projections (2010-2060)
 - 4 years old (projected from birth with migration)
 - By suburb (50-200 age 4 residents)
- New public schools' development plan



PUBLIC AND PRIVATE PRIMARY SCHOOLS IN THE ACT

Source: Xiang, Raymer & Gray (2023)

ADDING UNCERTAINTY

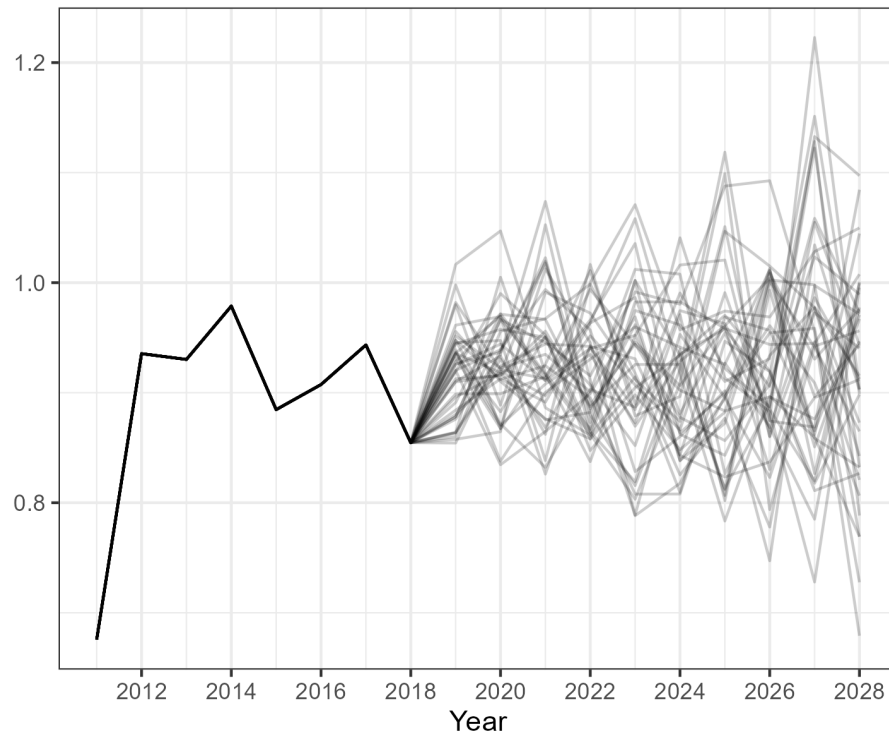
- Generate probability distributions for each source of enrolment change based on the observed data from the past 7 years
 - Preschool entries
 - In-migration to school system
 - Transition probabilities: grade progression, school transfer, leaving ACT school system (out-migration), graduation

- MONTE CARLO SIMULATIONS
 - Draw randomly from specified distributions and project forward 2,000 times

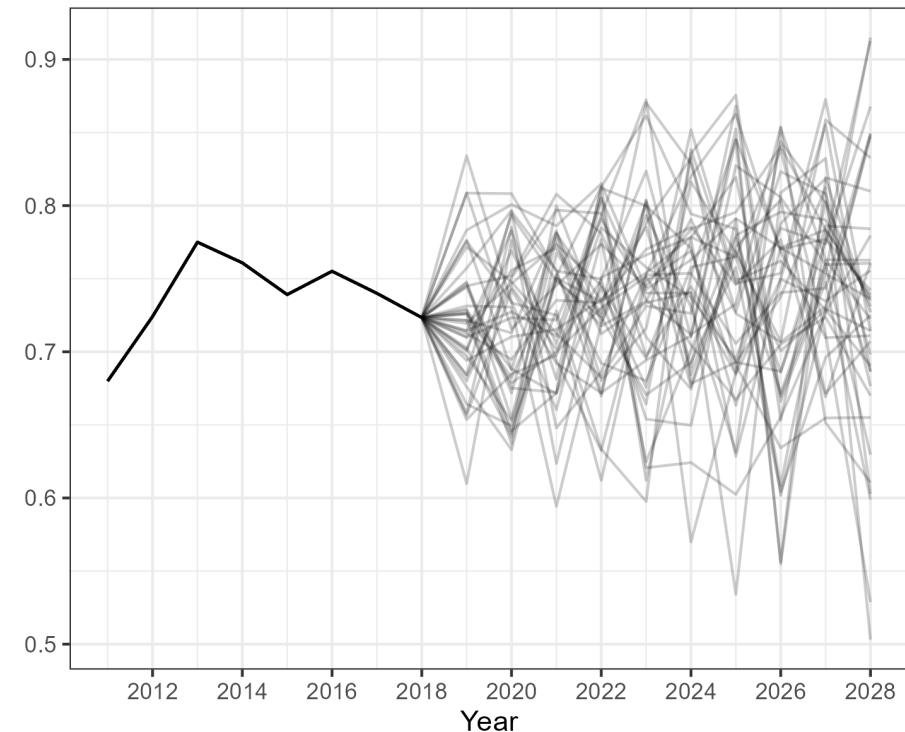
MONTE CARLO SIMULATIONS

- Preschool entries (Gamma and Beta Distributions)
 - One school and one suburb as an example

Ratio of age 4 residents to preschool student in a suburb



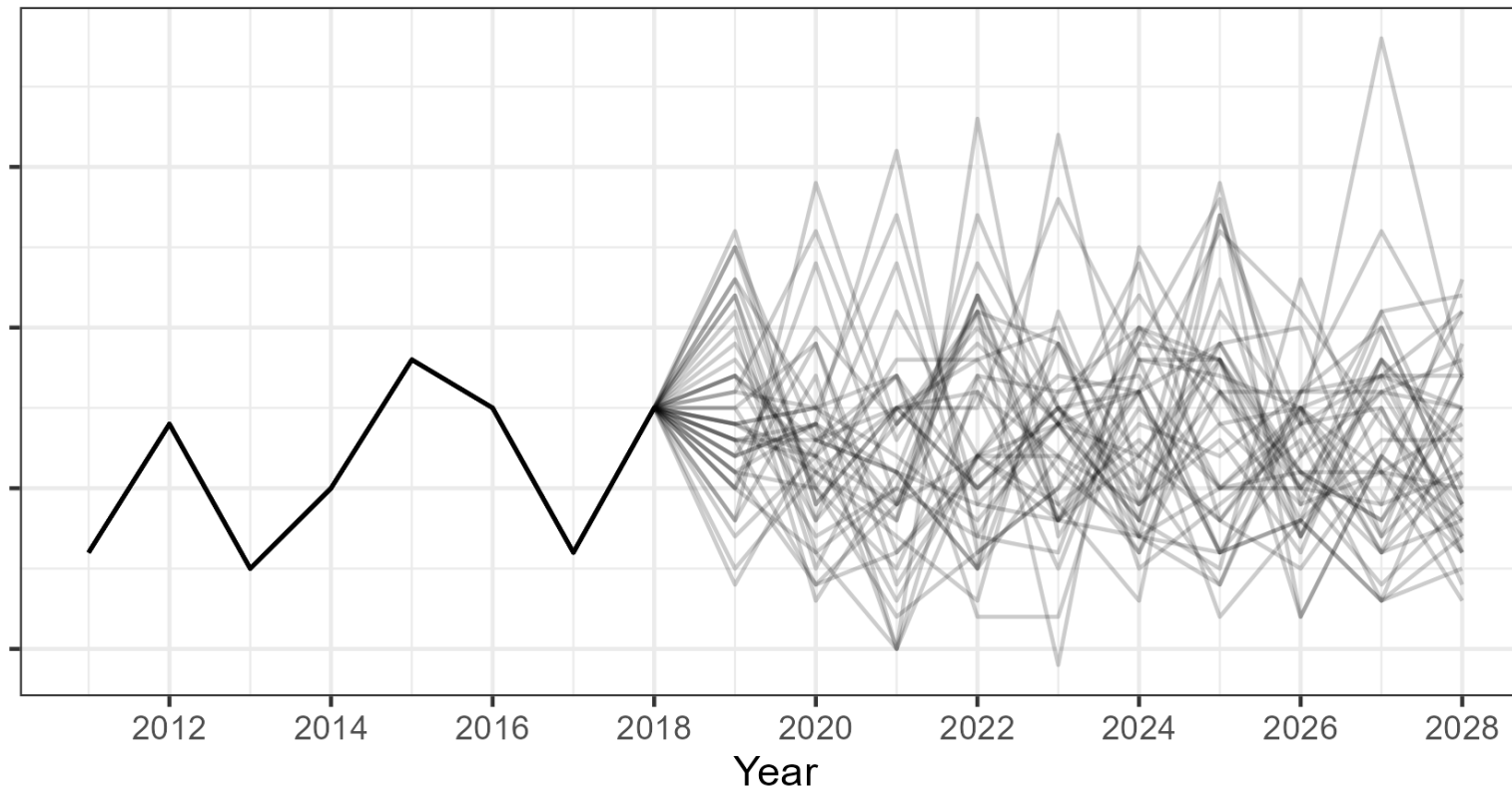
Proportion of student in this suburb to a school



MONTE CARLO SIMULATIONS

➤ In-migration to school system

- Example of one school and one academic level
- Poisson distribution with the forecasted value

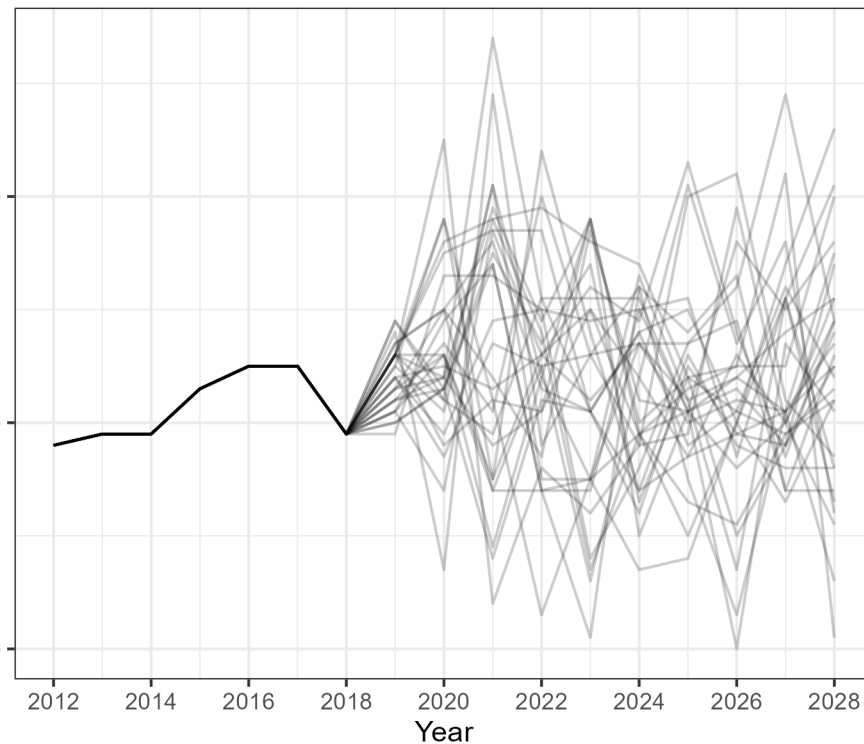


MONTE CARLO SIMULATIONS

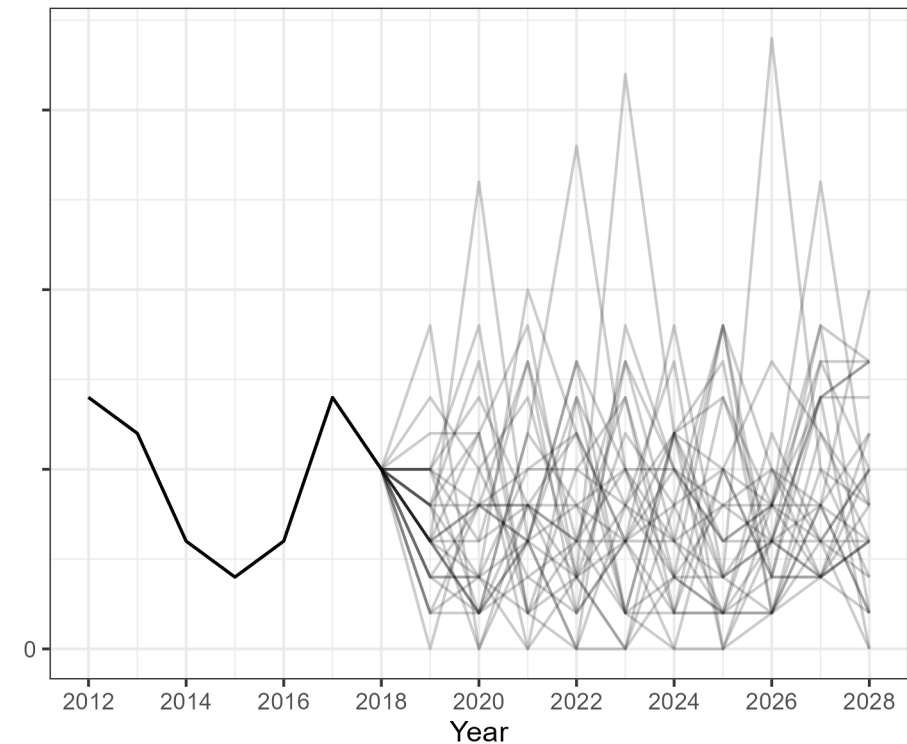
➤ Transitions (Beta and Multinomial Distributions)

- Kindergarten of one school as an example

Grade progression (same school)

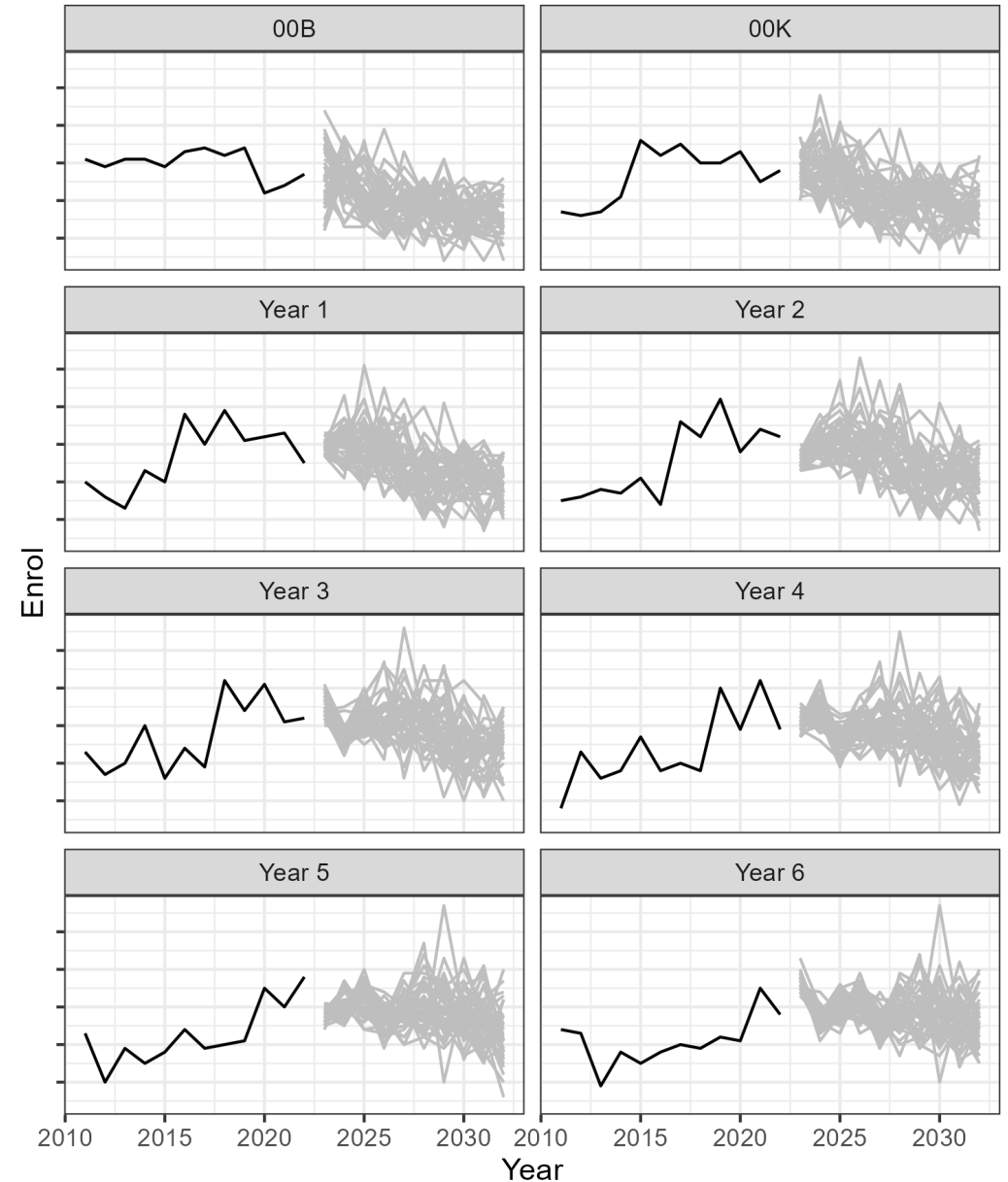


Leaving ACT school system (out-migration)



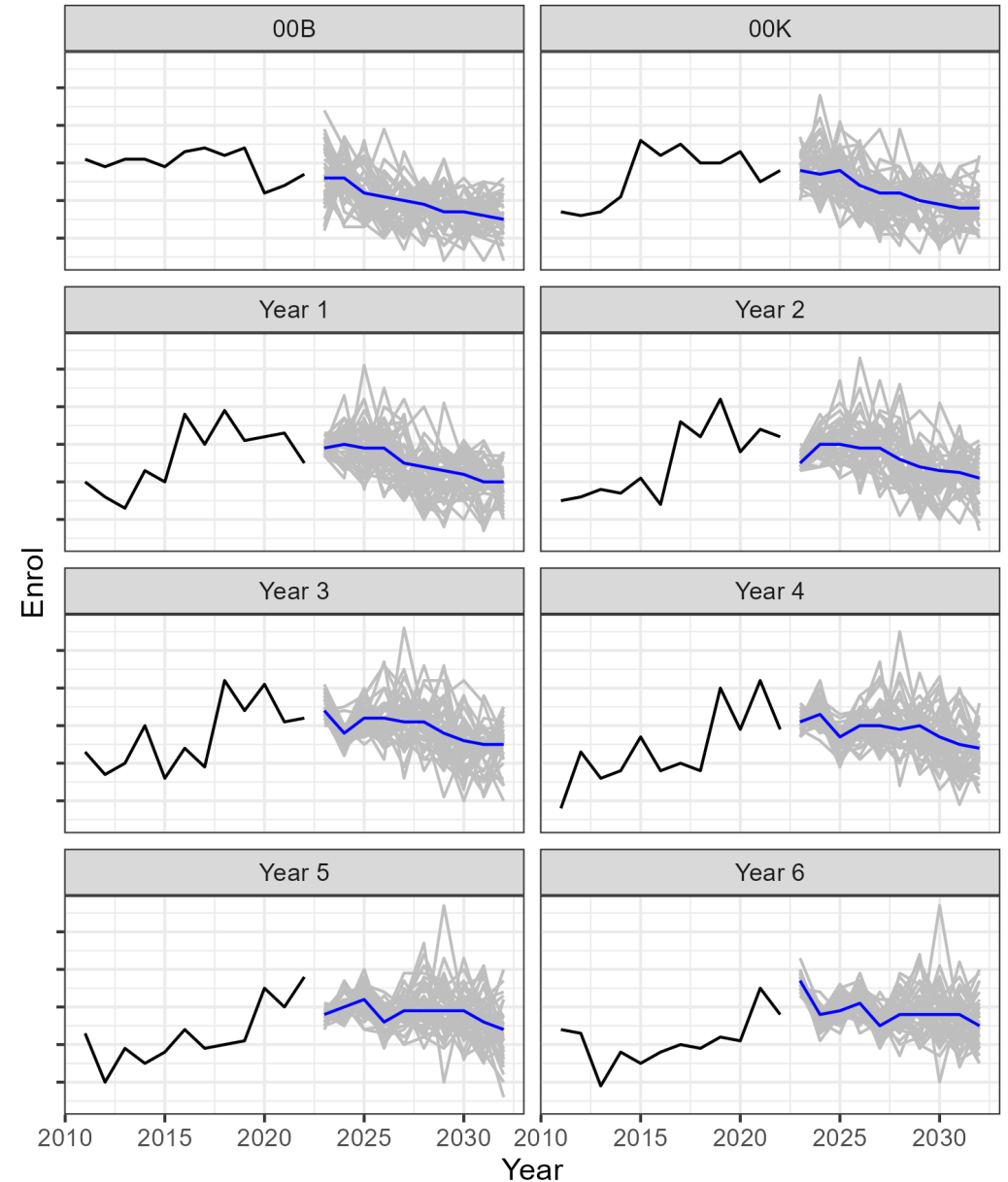
MONTE CARLO SIMULATIONS

- Draw randomly from specified distributions and project forward 2,000 times
- From the 2000 simulations, calculate lower and higher bounds at the school, region, and sector level
- Use 'in-sample' predictions to assess uncertainty intervals

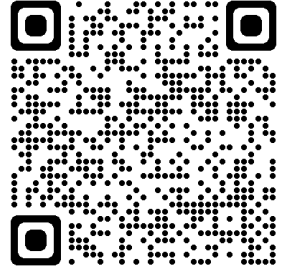


MONTE CARLO SIMULATIONS

- Draw randomly from specified distributions and project forward 2,000 times
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MODEL PERFORMANCE: MEAN ERROR



Projected	2016	2017	2018	2019	2020	2021	2022	Average
1 Year	-0.7%	-0.7%	-0.1%	-0.1%	0.1%	1.1%	1.7%	0.2%
2 Year	-1.4%	-0.9%	-0.2%	0.0%	1.1%	2.9%	-	0.3%
3 Year	-1.8%	-1.2%	-0.3%	0.8%	2.7%	-	-	0.0%
4 Year	-2.1%	-1.6%	0.3%	2.1%	-	-	-	-0.3%
5 Year	-2.6%	-1.1%	1.5%	-	-	-	-	-0.7%
Overall	-1.7%	-1.1%	0.2%	0.7%	1.3%	2.0%	1.7%	-0.1%

MODEL PERFORMANCE: PREDICTION INTERVAL

80% PI

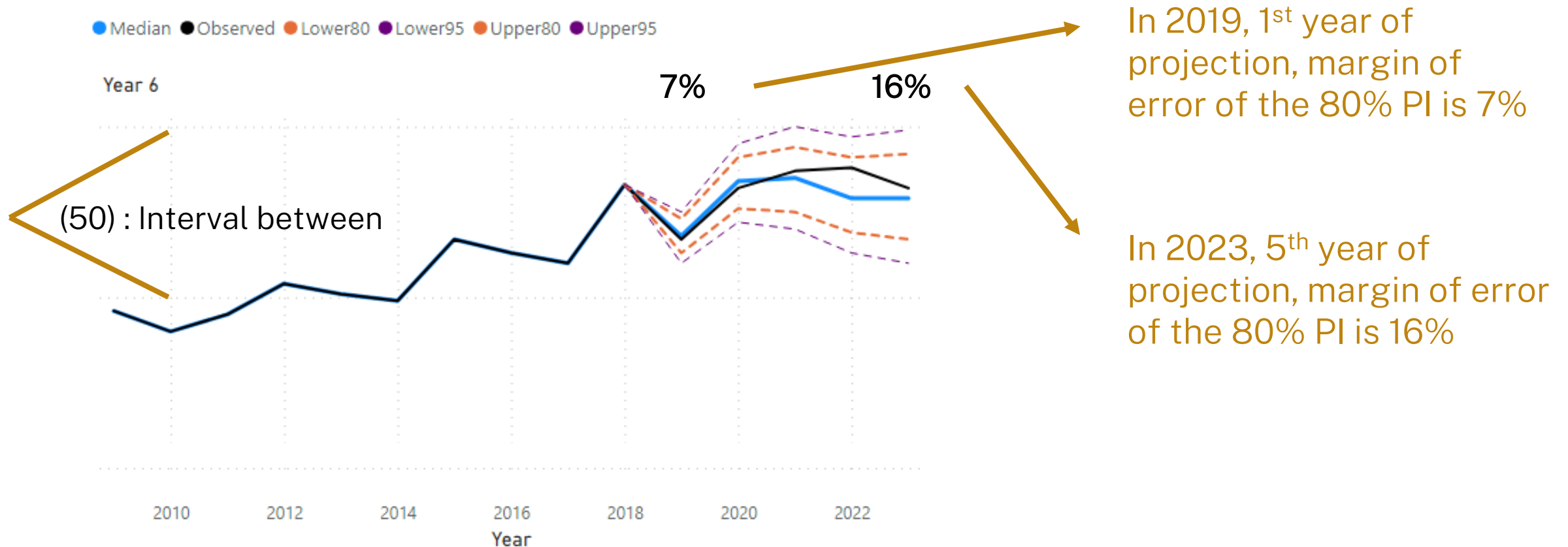
Projected	2016	2017	2018	2019	2020	2021	2022	Average
1 Year	84%	83%	85%	85%	90%	88%	84%	86%
2 Year	81%	80%	81%	86%	86%	82%	-	83%
3 Year	76%	78%	82%	83%	84%	-	-	81%
4 Year	74%	78%	82%	82%	-	-	-	79%
5 Year	74%	78%	80%	-	-	-	-	77%
Overall	78%	79%	82%	84%	87%	85%	84%	81%

95% PI

Projected	2016	2017	2018	2019	2020	2021	2022	Average
1 Year	96%	95%	97%	96%	98%	97%	95%	96%
2 Year	92%	93%	95%	96%	97%	94%	-	95%
3 Year	92%	92%	95%	96%	94%	-	-	94%
4 Year	91%	92%	95%	93%	-	-	-	93%
5 Year	91%	93%	94%	-	-	-	-	93%
Overall	92%	93%	95%	95%	96%	96%	95%	94%

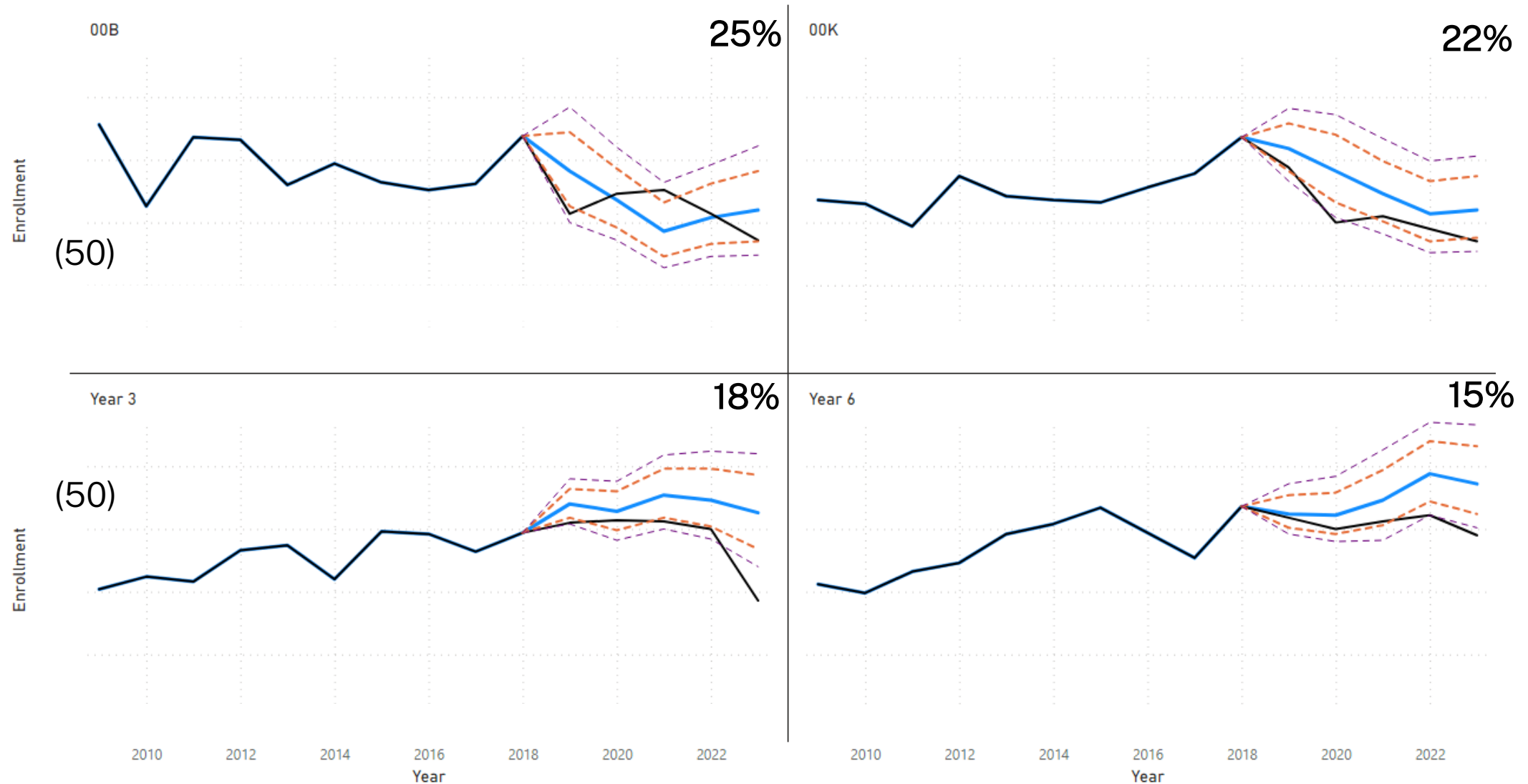
MODEL PERFORMANCE: Margin of error (%)

$$\text{Margin of error percentage (80\%)} = \frac{\text{Upper80} - \text{Lower80}}{\text{Median}} \times \frac{1}{2}$$

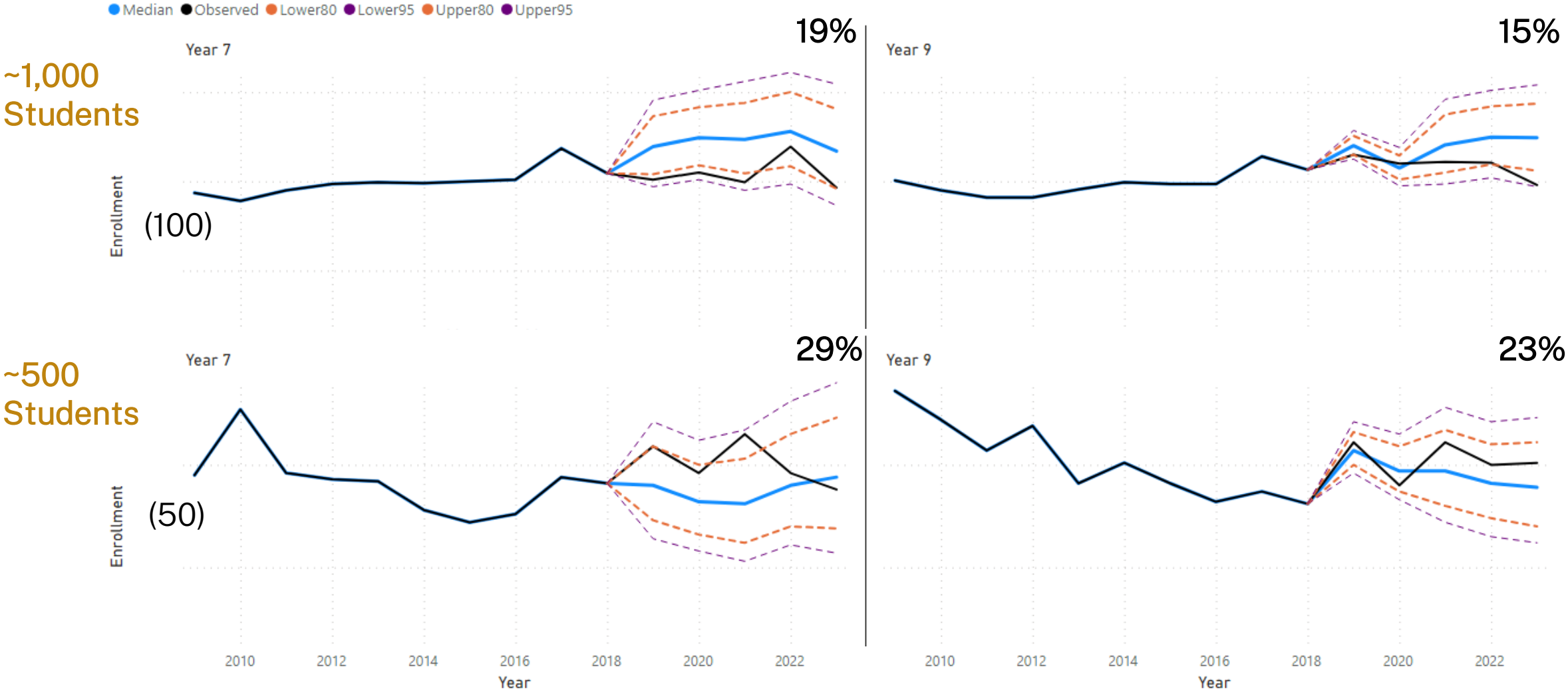


Predictions at academic level: Large preschool & primary school example (~1,000 students)

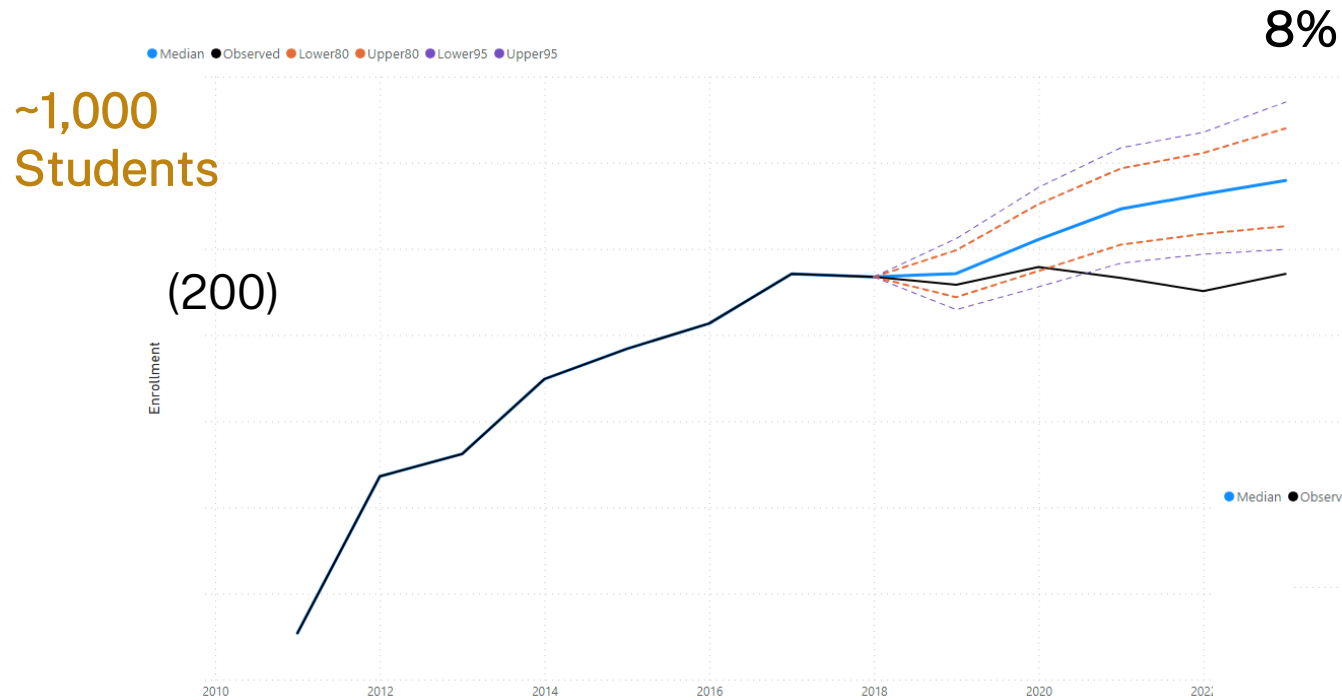
● Median ● Observed ● Lower80 ● Lower95 ● Upper80 ● Upper95



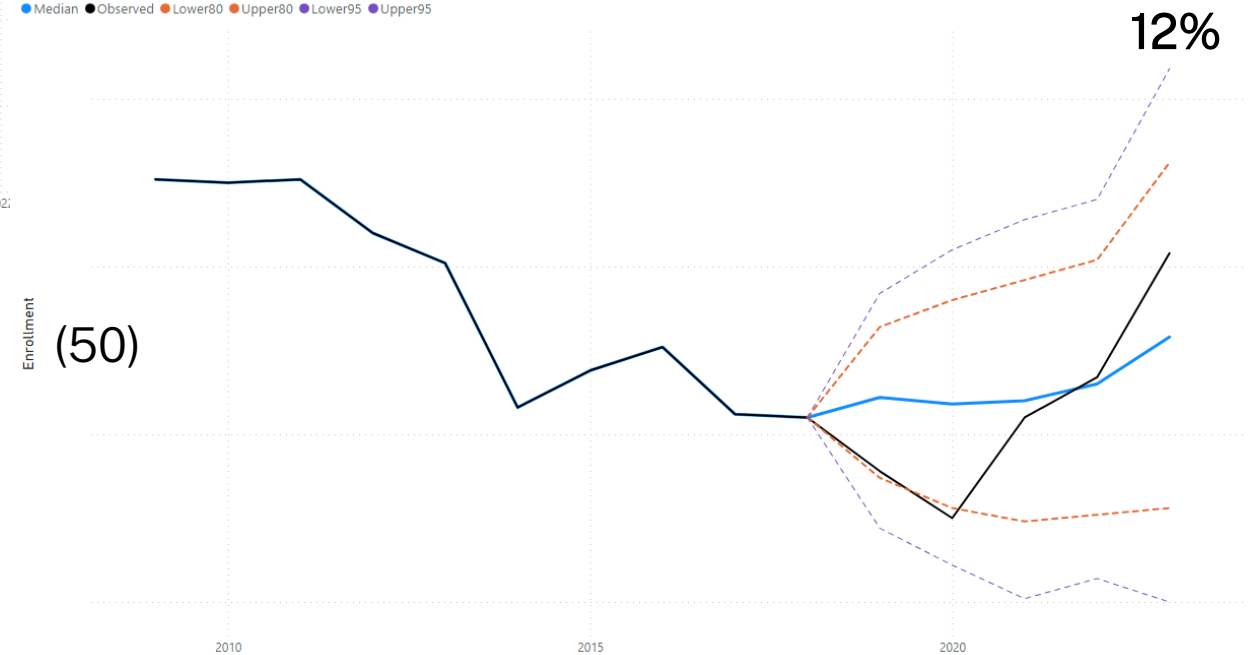
Predictions at academic level: Large and medium high school examples



Large and medium college examples (all levels)

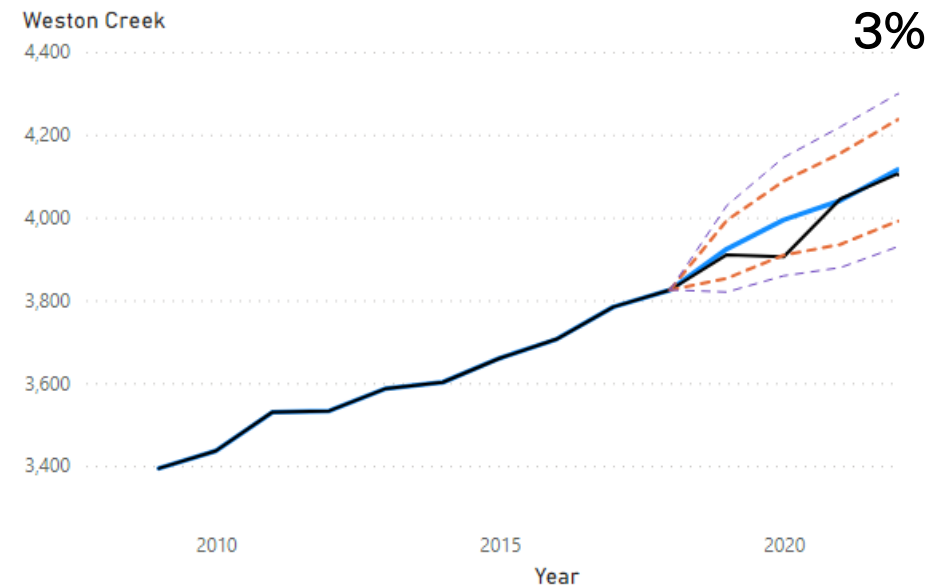
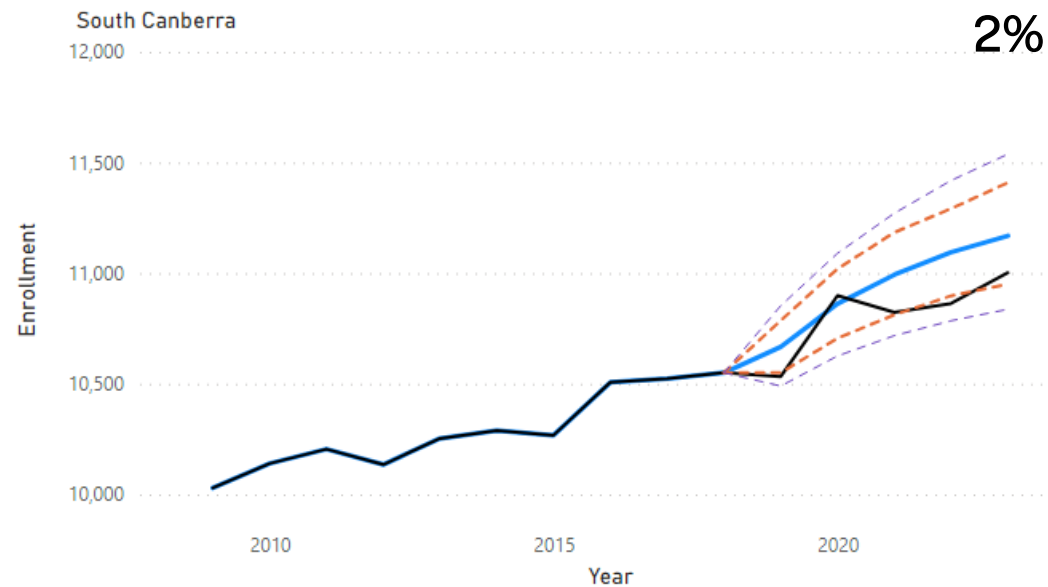
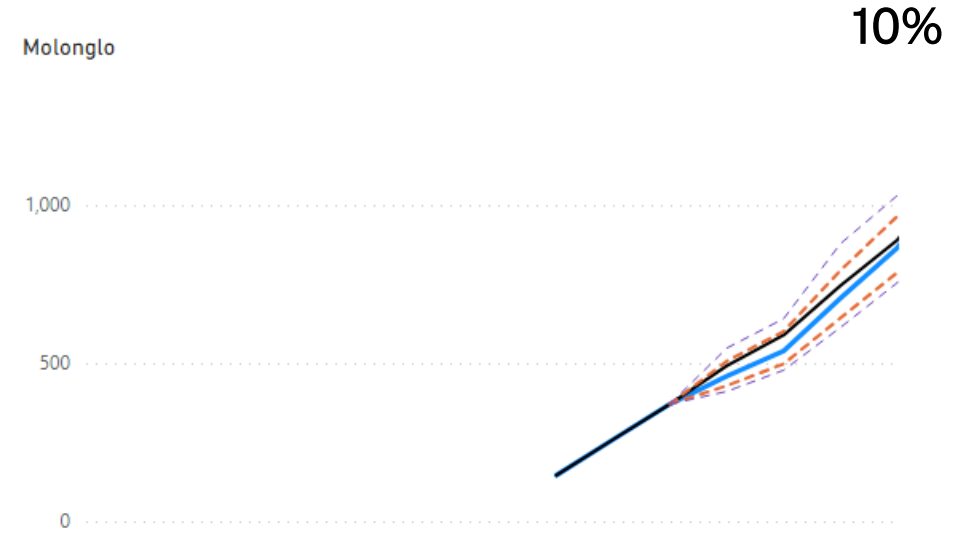
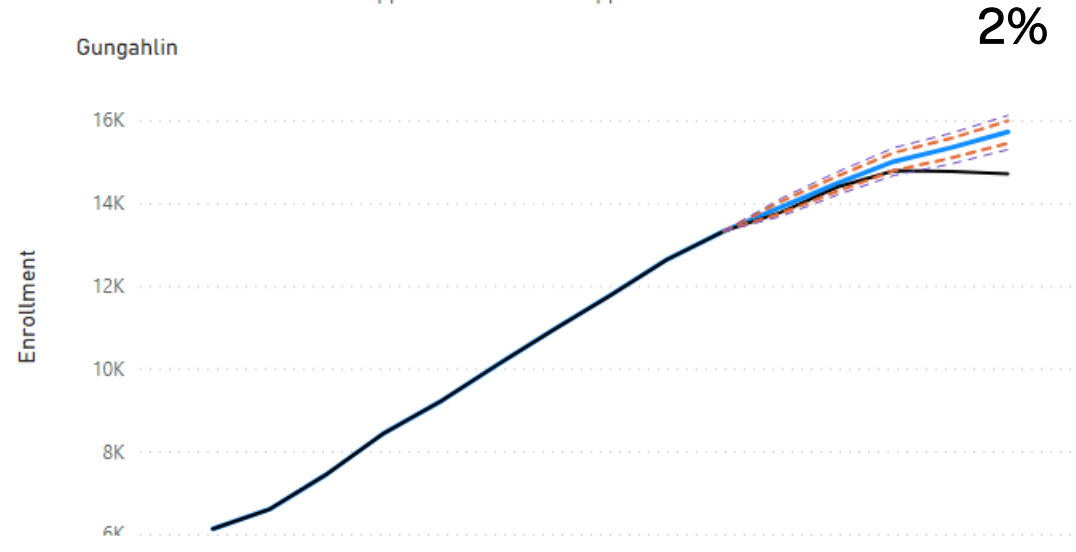


~500 Students

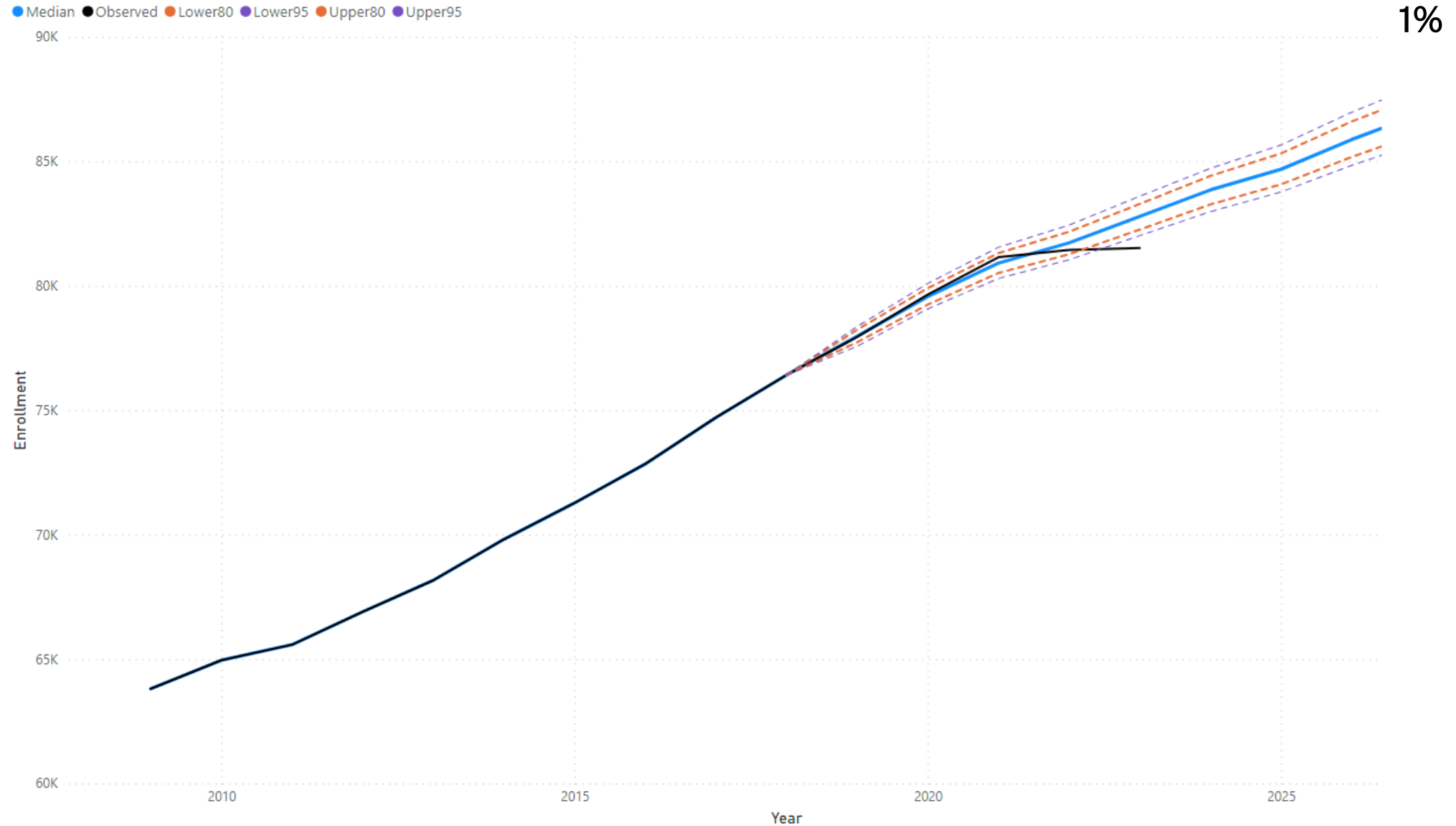


Region forecasts, 2019-2023

● Median ● Observed ● Lower80 ● Upper80 ● Lower95 ● Upper95



ACT total forecast, 2019-2028



MODEL PERFORMANCE

➤ Strengths:

- Uncertainty modelled for every source of enrolment change
- Prediction intervals consistent with observed data
- Reasonable uncertainty predicted for larger schools, higher academic levels, established suburbs and schools

➤ Weaknesses:

- Uncertainty slightly understated at aggregated levels
- First 2-3 years of predicted enrolment uncertainty more practical
- New schools and areas require additional assumptions
- Abrupt changes in school policies difficult to predict
- Relies on accurate population projections of 4-year-olds

ACHIEVEMENTS

- New framework for projecting school enrolments is more efficient than previous model
- Better representation of the future with measure of certainty
- Capacity for detailed analyses and scenario building for specific sources of change
- Flexible and reproducible framework provided the local administration has record level data

ACKNOWLEDGEMENTS

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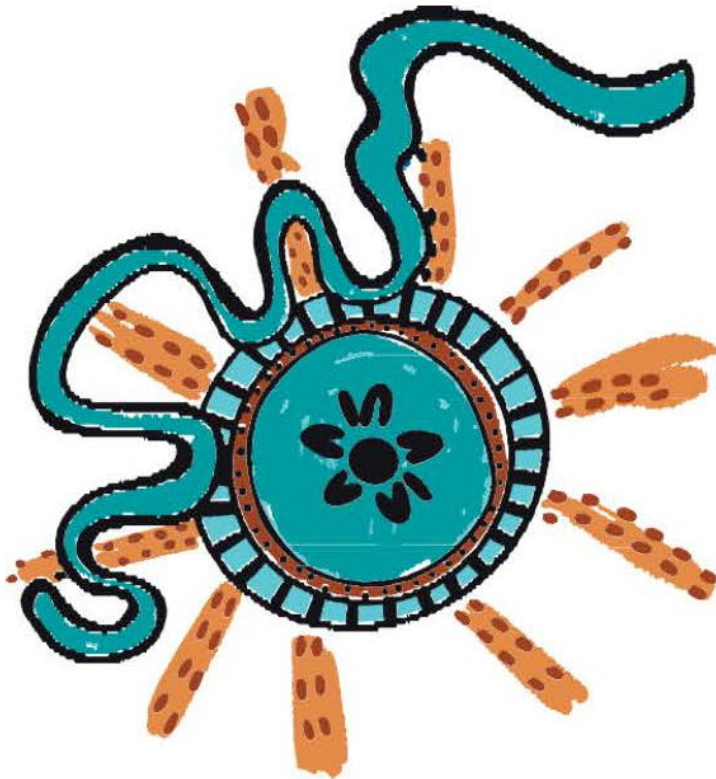


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