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Integrating uncertainty in time series population forecasts: An illustration using a simple projection model

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Abstract

Background: Population forecasts are widely used for public policy purposes. Methods to quantify the uncertainty in forecasts tend to ignore model uncertainty and to be based on a single model.

Objective: In this paper, we use Bayesian time series models to obtain future population estimates with associated measures of uncertainty. The models are compared based on Bayesian posterior model probabilities, which are then used to provide model-averaged forecasts.

Methods: The focus is on a simple projection model with the historical data representing population change in England and Wales from 1841 to 2007. Bayesian forecasts to the year 2032 are obtained based on a range of models, including autoregression models, stochastic volatility models and random variance shift models. The computational steps to fit each of these models using the OpenBUGS software via R are illustrated.

Results: We show that the Bayesian approach is adept in capturing multiple sources of uncertainty in population projections, including model uncertainty. The inclusion of non-constant variance improves the fit of the models and provides more realistic predictive uncertainty levels. The forecasting methodology is assessed through fitting the models to various truncated data series.

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