

Probabilistic demography developed with Bayesian dynamic linear models: testing and projections for Puerto Rico



Angélica M. Rosario Santos,
angelica.rosario2@upr.edu
Department of Mathematics, UPR-RP.

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Abstract

In this work, we propose a set of methodological and practical innovations in Demography with Dynamic Linear Models to strengthen projections for Puerto Rico. As our first methodological innovation, a dynamic linear representation of ARMA models to model net migration rates for Puerto Rico was used. Migration is greatly influenced by climatic, economic and environmental factors. Because of this behavior, the nature and structure of dynamic linear models could provide a better way to capture drastic changes in this demographic indicator. We develop an approximation of the empirical Bayes factor to perform tests between ARMA(1,1) and ARMA(1,0) dynamic linear models based on Rodriguez and Pericchi's work. The main advantage of this innovation is the calculation of the probability of each model. However, due to the small annual amount of data available for Puerto Rico, we developed a hierarchical AR(1) dynamic linear model (HDLM) to project net migration rates for seven US states that have reported negative net migration during 15 years. In this model, we also incorporate a Scaled Beta2 distribution for the scaling parameters instead of the criticized Inverse Gamma distribution. For fertility, we also introduce another way to project the Total Fertility Rate (TFR) for Puerto Rico. We propose a TFR model only for 17 countries with TFR less than 1.5, based on Raftery's work. This change is adopted due to the dramatic descending behavior of the TFR of Puerto Rico in recent years. In fact, some researchers have expressed that the assumption that all countries will once again reach the replacement level $TFR = 2.1$ seems unlikely. Subsequently, using our projections for the TFR and the mean trajectory projection for net migration rates, we generate our own probabilistic population projections for Puerto Rico by 2050. The median population for 2050 is expected to be 2,283,400 people with (2,110,000; 2,488,500) a 95% interval. These projections are of crucial importance for Puerto Rico's current demographic crisis.