



## Mortality Improvement Rates: Modeling and Parameter Uncertainty

Andrew Hunt

Pacific Life Re, London, United Kingdom

Andrés M. Villegas

School of Risk and Actuarial Studies and

ARC Centre of Excellence in Population Ageing Research (CEPAR)

UNSW Sydney, Australia

Presented at the Living to 100 Symposium

Orlando, Fla.

January 4–6, 2017

Copyright © 2017 by the Society of Actuaries.

All rights reserved by the Society of Actuaries. Permission is granted to make brief excerpts for a published review. Permission is also granted to make limited numbers of copies of items in this monograph for personal, internal, classroom or other instructional use, on condition that the foregoing copyright notice is used so as to give reasonable notice of the Society's copyright. This consent for free limited copying without prior consent of the Society does not extend to making copies for general distribution, for advertising or promotional purposes, for inclusion in new collective works or for resale.

# Mortality Improvement Rates: Modeling and Parameter Uncertainty

Andrew Hunt<sup>a</sup>, Andrés M. Villegas<sup>b</sup>

<sup>a</sup>*Pacific Life Re, London, United Kingdom*

<sup>b</sup>*School of Risk and Actuarial Studies and*

*ARC Centre of Excellence in Population Ageing Research (CEPAR)  
UNSW Sydney, Australia*

## Abstract

Rather than looking at mortality rates directly, a number of recent academic studies have looked at modeling rates of improvement in mortality when making mortality projections. Although relatively new in the academic literature, the use of mortality improvement rates has a long-standing tradition in actuarial practice when allowing for improvements in mortality from standard mortality tables. However, mortality improvement rates are difficult to estimate robustly, and models of them are subject to high levels of parameter uncertainty, since they are derived by dividing one uncertain quantity by another. Despite this, the studies of mortality improvement rates to date have not investigated parameter uncertainty due to the ad hoc methods used to fit the models to historical data. In this study, we adapt the Poisson model for the numbers of deaths at each age and year, proposed in Brouhns et al. (2002), to model mortality improvement rates. This enables models of improvement rates to be fitted using standard maximum likelihood techniques and allows parameter uncertainty to be investigated using a standard bootstrapping approach. We illustrate the proposed modeling approach using data for the U.S. population and the England and Wales population.

*Keywords:* Mortality improvements; Mortality forecasting; Parameter uncertainty

---

*Email addresses:* [a.o.d.hunt.00@cantab.net](mailto:a.o.d.hunt.00@cantab.net) (Andrew Hunt), [a.villegas@unsw.edu.au](mailto:a.villegas@unsw.edu.au) (Andrés M. Villegas)

This project has received funding from the ARC Center of Excellence in Population Ageing Research (grant CE110001029). The work in this study was started before Dr. Hunt commenced work at Pacific Life Re, and any opinions expressed in this paper are held in a personal capacity and should not be construed as the views of Pacific Life Re or related companies.