

# Pricing Extreme Mortality Risk amid the COVID-19 Pandemic

Han Li <sup>\*1</sup>, Haibo Liu <sup>†2</sup>, Qihe Tang <sup>‡3</sup>, and Zhongyi Yuan <sup>§4</sup>

<sup>1</sup>Department of Economics, The University of Melbourne

<sup>2</sup>Department of Statistics and Department of Mathematics, Purdue University

<sup>3</sup>School of Risk and Actuarial Studies, UNSW Sydney

<sup>4</sup>Department of Risk Management, The Pennsylvania State University

## Abstract

In pricing extreme mortality risk, it is commonly assumed that the interest rate and mortality rate are independent. However, the recent COVID-19 outbreak calls this assumption into question. We propose a bivariate affine jump-diffusion structure to jointly model the interest rate and excess mortality, allowing for both correlated diffusions and joint jumps. Utilizing the latest US mortality and interest rate data, we find a strong negative correlation between the jump sizes of interest rate and excess mortality, and a much higher jump intensity when the pandemic data is included. Moreover, we construct a risk-neutral pricing measure that accounts for both a diffusion risk premium and a jump risk premium. We then solve for the market prices of risk based on mortality bond prices. Our results show that the pandemic experience can drastically change investors' perception of the mortality risk market in the post-pandemic era.

**Keywords:** affine jump-diffusion model; implied market price of risk; mortality-linked security

---

\*E-mail address: [han.li@unimelb.edu.au](mailto:han.li@unimelb.edu.au)

†E-mail address: [haiboliu@purdue.edu](mailto:haiboliu@purdue.edu)

‡E-mail address: [qihe.tang@unsw.edu.au](mailto:qihe.tang@unsw.edu.au)

§E-mail address: [zhongyi-yuan@psu.edu](mailto:zhongyi-yuan@psu.edu)