

KILLING THE LAW OF LARGE NUMBERS: MORTALITY RISK PREMIUMS AND THE SHARPE RATIO

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ABSTRACT

We provide an overview of how the law of large numbers breaks down when pricing life-contingent claims under stochastic as opposed to deterministic mortality (probability, hazard) rates. In a stylized situation, we derive the limiting per-policy risk and show that it goes to a non-zero constant. This is in contrast to the classical situation when the underlying mortality decrements are known with certainty, per policy risk goes to zero. We decompose the standard deviation per policy into systematic and non-systematic components, akin to the analysis of individual stock (equity) risk in a Markowitz portfolio framework. Finally, we draw upon the financial analogy of the Sharpe Ratio to develop a premium pricing methodology under aggregate mortality risk.

REFERENCES

Ballotta, L., and S. Haberman, 2003, Valuation of Guaranteed Annuity Conversion Options, *Insurance: Mathematics and Economics*, 33: 87-108.

[Web of Science®](#) | [Google Scholar](#)

Blake, D., and W. Burrows, 2001, Survivor Bonds: Helping to Hedge Mortality Risk, *Journal of Risk and Insurance*, 68: 339-348.

[Web of Science®](#) | [Google Scholar](#)

Biffis, E., and P. Millosovich, 2004, The Fair Value of Guaranteed Annuity Options, Working Paper, Università degli Studi di Trieste .

[Google Scholar](#)

Boyle, P. P., and M. Hardy, 2003, Guaranteed Annuity Options, *ASTIN Bulletin*, 33: 125-152.

[Google Scholar](#)

Cairns, A. J. G., D. Blake, and K. Dowd, 2006, A Two-Factor Model for Stochastic Mortality with Parameter Uncertainty, *Journal of Risk and Insurance*, 73(4): 687-718.

[Web of Science®](#) | [Google Scholar](#) |

Cox, S. H., Y. Lin, and S. Wang, 2006, Multivariate Exponential Tilting and Pricing Implications for Mortality Securitization, *Journal of Risk and Insurance*, 73(4): 719-736.

[Web of Science®](#) | [Google Scholar](#) |

Dahl, M., 2004, Stochastic Mortality in Life Insurance: Market Reserves and Mortality-linked Insurance Contracts, *Insurance: Mathematics and Economics*, 35: 113-136.

[Web of Science®](#) | [Google Scholar](#) |

Denuit, M., and J. Dhaene, 2006, Comonotonic Bounds on the Survival Probabilities in the Lee-Carter Model for Mortality Projection, Working Paper.

[Google Scholar](#) |

DiLorenzo, E., and M. Sibillo, 2003, Longevity Risk: Measurement and Application Perspectives, Working Paper, Università degli Studi di Napoli .

[Google Scholar](#) |

Hull, J. C., 2002, *Futures, Options and Other Derivative Securities*, 5th edition (New Jersey : John Wiley).

[Google Scholar](#) |

Lee, R. D., and L. R. Carter, 1992, Modeling and Forecasting U.S. Mortality, *Journal of the American Statistical Association*, 87(419): 659-671.

[Web of Science®](#) | [Google Scholar](#) |

Milevsky, M. A., and S. D. Promislow, 2001, Mortality Derivatives and the Option to Annuitize, *Insurance: Mathematics and Economics*, 29: 299-318.

[Web of Science®](#) | [Google Scholar](#) |

Milevsky, M. A., S. D. Promislow, and V. Young, 2005, Financial Valuation of Mortality Risk via the Instantaneous Sharpe Ratio, Toronto, Canada, available at <<http://www.ifid.ca>> Working Paper, IFID Center.

[Google Scholar](#) |

Olivieri, A., 2001, Uncertainty in Mortality Projections: An Actuarial Perspective, *Insurance: Mathematics and Economics*, 29: 231-245.

[Web of Science®](#) | [Google Scholar](#)

Promislow, S. D., and V. R. Young, 2004, Indifference Pricing via the Probability of Ruin, Working Paper, University of Michigan .

[Google Scholar](#)

Schrager, D., 2006, Affine Stochastic Mortality, *Insurance: Mathematics and Economics*, 2006.

[Web of Science®](#) | [Google Scholar](#)

Smith, A., I. Moran, and D. Walczak, 2003, Why Can Financial Firms Charge for Diversifiable Risk? Working Paper, Deloitte Touche Tohmatsu.

[Google Scholar](#)

Soininen, P., 1995, Stochastic Variation of Interest and Mortality, *Proceedings of the 5th AFIR International Colloquium*, 871-904.

[Google Scholar](#)

Stallard, E., 2006, Demographic Issues in Longevity Risk Analysis, *Journal of Risk and Insurance*, 73(4): 575-609.

[Web of Science®](#) | [Google Scholar](#)

Webb, T., and L. Friedberg, 2006, Life Is Cheap: Using Mortality Bonds to Hedge Aggregate Mortality Risk, Working Paper, Centre for Retirement Research, Boston College .

[Google Scholar](#)

Yashin, A. I., K. G. Manton, and E. Stallard, 1989, The Propagation of Uncertainty in Human Mortality Processes Operating in Stochastic Environments, *Theoretical Population Biology*, 35: 1119-1141.

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