

## **Scienze attuariali**

### **HIGH AGE MORTALITY, FRAILTY AND RISK CLASSIFICATION FOR A LIFE ANNUITY PORTFOLIO**

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Prof.ssa Annamaria Olivieri (Università di Parma, Dipartimento di Economia).

#### **Abstract:**

The age-pattern of mortality rates at very old ages shows, in many populations, a slowed increase. Causes of this deceleration have been explained in different ways. An analytical justification is, in particular, provided by the (likely) heterogeneity of the population with respect to mortality, which can be formally described with a frailty model. The presence of mortality heterogeneity can have an impact on the risk profile of a life annuity portfolio (or a pension fund). While the adoption of frailty models for the representation of mortality is well-known, their application for risk management purposes is not common. In this research we focus on a potential application of the frailty model, which can be helpful to design a rating structure for life annuities. Voluntary life annuities are mainly underwritten by healthy people. In order to expand their business, in recent years some insurers have started offering special annuity rates to those whose health conditions are critical. As a result of such a strategy, risk classes can be identified within the portfolio, showing different levels of mortality. In general, the level of mortality in life annuity portfolios is lower than for the general population. Mortality rates for annuitants are usually obtained by applying reduction coefficients to the population mortality rates. According to common actuarial practice, such coefficients are chosen empirically, calibrated on the average ratio (possibly measured for age-groups) between the annuitants' and the population mortality rates; conversely, a model formally justifying such a difference is not adopted. Within a frailty model, lower mortality rates can be justified by lower frailty levels. Thus, we identify risk groups (or classes) within the population by assigning specific ranges of values to the frailty within each group. Conditional probability distributions for the frailty are obtained for each risk class, which allow us to describe the different levels of mortality of the various groups. This way we design a rating system, as different values for the annuity rate derive from the different assumptions about the frailty level of the specific risk class. We also investigate the following issue. When dealing with several risk classes, the insurer may increase its portfolio size, but also the heterogeneity of the portfolio. While a larger size implies an improved pooling effect, a higher risk profile follows from the increased heterogeneity. We investigate the result of this trade-off. The risk profile of the portfolio is examined in terms of the dispersion of the probability distribution of the present value of future benefits. Portfolios without and with risk classification are compared, so to measure the trade-off between size and heterogeneity.

#### **Info:**

[susanna.levantesi@uniroma1.it](mailto:susanna.levantesi@uniroma1.it)