

Developing Mathematical Models That Admit Unconstrained Moving of Mortality Curves and Their Application to Projections for Japan

Futoshi ISHII

This study aims to propose mathematical models that admit unconstrained moving of mortality curves and their application to projections for Japan in terms of developing new mortality models that are suitable for Japanese mortality trends.

In this study, we showed that the application of tangent vector fields on the log mortality surface is useful for a framework of expression for unconstrained moving of mortality curves. Then, we proposed a new shift-type model, the Linear Difference (LD) model, which is applicable for that type of modeling and able to express old age mortality effectively.

We applied this method to Japanese mortality and evaluated the models. Applying the actual rates to the Lee-Carter (LC) model and the LD model, we found that the LD model exhibits good fitting for old ages even though the LC model fits slightly better for younger ages. We also compared the performances for both models from the statistical viewpoint, and confirmed that the LD model is better than the LC model for old ages whereas the LC is better for younger ages. From the observations, we concluded that the recent mortality improvement in Japan could be better expressed as shifting than declining, and found that it would be effective to use the LC model for younger ages and the LD model for old ages. Then, we defined a vector field that continuously connects between the LC model and the LD model with weighted averages of the vectors belonging to both models with some weights, and proposed the TVF model as a whole age model.

Finally, we described the method of the mortality model in the official population projection in 2012 and its evaluation as an application of the TVF model. We found that the TVF model succeeded in expressing the age shift with a large improvement and its reflection on projected mortality, which could not be achieved with the LC model. We also observed that the TVF model does not exhibit the unnatural mortality patterns that are found in the LC model when we assume an extremely high improvement in mortality, and that the favorable behaviors of the survivor function are compatible with recent trends in Japan. We found that the projections by the TVF model have many advantages compared with those by the LC model.