ACTUARIAL RESEARCH CLEARING HOUSE
1995 VOL. 1

Uncertainty in the Modelling Process [1]

Andrew J.G. Cairns[2]
Department of Actuarial Mathematics and Statistics,
Heriot-Watt University,
Riccarton, Edinburgh, EH14 4AS, United Kingdom

We consider the process of modelling uncertainty. In particular we are concerned with making inferences about some quantity of interest which, at present, has been unobserved. Examples of such a quantity include the probability of ruin of a surplus process, the accumulation of an investment and the future volume of new business in an insurance company.

Uncertainty in such a quantity can arise from three sources:

- within model variance;
- uncertainty in the estimated parameter values;
- uncertainty in the choice of model.

In insurance work only the first of these is routinely assessed. Parametric uncertainty is also often analysed for its effect, although this is often in the form of a sensitivity analysis rather than a rigorous statistical analysis. Model selection is treated in a rather different way. It is well known that there is a trade off between realism and model simplicity but once a model has been selected it is common practice to ignore all other alternatives.

It is discussed how, in the presence of parameter and model uncertainty, a prediction interval for a quantity of interest can only be given if we are working in a Bayesian framework. (Prediction intervals only exist in the classical framework when the model and its parameter values are known with certainty.)

Here we consider a Bayesian approach recently described by Draper (1994) which allows us to quantify the effects of both parameter and model uncertainty. This approach is then applied to two simple problems in actuarial science: one from ruin theory; and one from stochastic interest theory using simple time series models. In each case, the results of uncertainty analyses are compared with those which focus on a best estimate model and a best estimate parameter set.

First, it is found that parameter uncertainty should form an integral part of any uncertainty analysis. In the stochastic interest example, in particular, it was found that the incorporation of parameter uncertainty could have a significant impact on a posterior distribution. In this case parameter uncertainty

[1] 29th Actuarial Research Conference, Corvallis, Oregon, 25-27 August, 1994
[2] e-mail: andrewc@cara.ma.hw.ac.uk

caused the posterior mean and variance of the accumulation function to become infinite. This reflected a relative fattening of the tails of the distribution but it was found that parameter uncertainty had just as much impact on the posterior distribution function.

Second, it is found that conclusions must be checked for sensitivity to the choice of model used. If they are found to be sensitive then a full analysis incorporating model uncertainty seems to be the only sensible course of action.

Reference

Cairns, A.J.G. (1995) Uncertainty in the modelling process. *submitted* , .

Draper, D. (1994) Assessment and propagation of model uncertainty. *to appear in Journal of the Royal Statistical Society, Series B* **56**, .