Stochastic Projections of the Financial Experience of Social Security Programs

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Session Number: TBR8

Joint IACA, IAAHS and PBSS Colloquium in Hong Kong
www.actuaries.org/HongKong2012/

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Issues, Limitations and Alternatives

Deterministic versus Stochastic models

Deterministic models

- Apply a set of “best-estimate” assumptions to a known initial state.
- Produce as many years of future experience as are necessary and appropriate.
- Discount future cash flows to produce summary measures.
- This methodology has been used for more than a century in the social security context.

Stochastic models

- Became feasible only recently with increasing computer power.
- Recognize that all important (and interesting) variables are probabilistic in nature.
- Future experience is therefore random, not determined.
- Projections can be run again and again to produce a distribution of future experience.

All models are uncertain

- Past experience may not be a good predictor of future experience.
- How much past experience is relevant?
- Does the length of the projection period dictate the number of years of relevant past experience?
- How does one distinguish a blip from a trend?
- Will new policies influence the future?

IAA book on stochastic modeling

- Issued in 2010: *Stochastic Modeling: Theory and Reality from an Actuarial Perspective*
- Explains advantages and disadvantages of stochastic (versus deterministic) modeling.
- Explains when stochastic modeling may be helpful and appropriate – and vice versa.
- Stochastic models are especially useful when analyzing extreme outcomes or “tail risks” that are not well understood.

Tail risk in social insurance

- Social insurance programs are generally *not* subject to significant tail risk.
- Financial projections for such programs focus more on the means of variables' probability distributions than on the extremes (or tails).
- Programs can be changed in response to extreme circumstances, mitigating the effects.
- This is often not true in the private sector.

Stochastic models may be inappropriate

- When it is difficult or impossible to determine the appropriate probability distribution (or variables are not really probabilistic).
- When it is difficult or impossible to calibrate the model (because the past is inapplicable).
- When it is difficult or impossible to validate the model (because its output cannot be compared to expectations).

Central assumptions versus distributions

- Deterministic models require single, “best-estimate” assumptions for most variables.
- Stochastic models require distributions of future experience around the mean.
- This adds another dimension of much greater complexity and therefore more uncertainty.
- More than determining a *range* of future values, each value must have a probability.

Uncertainty increases with duration

- A variable may not change very much over a short period of time (although some do).
- Over a long period of time, enormous changes can occur.
- Social security programs rely on some of the longest projections ever made by actuaries:
  - Multiple-decade projections are common-place.
  - The United States has gone to infinity!

Covariances

- Important economic and demographic variables may interact with each other.
- Their probability distributions are therefore not independent.
- Their covariances may be unknown, unrecognized or poorly understood.
- Ignoring covariances is equivalent to assuming that they are zero – also an assumption!

Alternatives

- Deterministic models with sensitivity or stress testing can illuminate tail risks.
- Multiple deterministic runs can show high-cost and low-cost outcomes.
- Stochastic models can be helpful in calibrating those outcomes.
- The two types of models should be used to supplement rather than supplant each other.

Conclusion

- Actuaries must determine which type of model will produce the most useful results.
- Do newer, more powerful models produce better information or just *more* information?
- Policymakers often demand point estimates, not ranges and probabilities.
- Actuaries must have the judgment to evaluate models' output and inform users of inherent uncertainty.