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– Longevity 5, New York –

Mortality Regimes and Pricing

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Discussion

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Content

Modeling Issues

Technical Issues

"My Conclusion"

Content

- **Basic idea:** Use regime-shifting (RS) models for building stochastic mortality models
- Consideration of different models:
  - 2-state RS model for combined mortality index ($\rightarrow$ *index model*)
  - 2-state RS extension of Lee-Carter model ($\rightarrow$ *LC model*)
- Calibration via recursive Bayesian estimation
- Focus on pricing applications
- **Conclusions:**
  - RS models perform better than well-known models proposed in literature
  - Model choice has economic significance: Prices differ considerably

Modeling Issues

- Index model shows structural break around 1950. Has been documented *structurally* in other publications:[1]
  - **Until 1950:** infectious diseases, respiratory diseases
  - **Since 1950:** Improvements primarily due to improvements in health care, cardiovascular diseases

  → Evidence that it will ever jump back?
- Choice of **two** states for the index model
  - no "catastrophic" states – possibly not suitable for modeling CAT bonds
  - sole considerations of likelihoods may not be sufficient

  → Addition of 3rd state? Would that depict CAT states? Significant improvement? Impact on results?
- Lee-Carter extension:
  - Observe only positive spikes, no negative ones. Positive jumps do not mean-revert, but stay up – biases the results since it implies increased volatility → Show simulated paths of model. Do they seem like "reasonable" mortality paths?

  → Not sure of whether it's apt for **longevity** risk modeling

[1] Cf. e.g. `http://www.richardsuen.net/files/Tech_HCS3.pdf`

Technical Issues

- Model comparison: need to penalize for extra parameters, theoretical justification for comparison of non-nested models based on likelihood-ratio test? (Arg. for RS > Jumps)
- Figure 3: Shouldn't the physical loss distribution also depend on the model? Isn't the Wang-transform related to the model in view – are simple comparisons reasonable?
- How are starting values chosen for calibration?
- Esscher transform:
  - Isn't $\xi = 1,000$? Not 5.3 bn?
  - Mistake in Equation (5.5)? Shouldn't it be:

$$\xi = -\frac{1}{c}\log\left\{E\left[\exp\left\{-B\sum\ldots\right\}\right]\right\} \neq \frac{1}{c}\log\left\{E\left[\exp\left\{B\sum\ldots\right\}\right]\right\}$$

  $\rightarrow$ Impact on c / prices?
- **I don't know** if it is alright to rely on SVD to derive κ_t's in Lee-Carter model and then calibrate model with non-Gaussian improvements

  $\rightarrow$ Formal justification for Lee-Carter approach is Maximum-Likelihood – does that depend on all m's being jointly normal? ($\rightarrow$ would require κ_t's to be normal). Already wondered in Chen & Cox (2009,JRI).

"My Conclusion"

- I **really like** the idea of using regime-switching models, and I think basic approach & estimation are nice and rigorous

→ I think it's a nice paper...

- Problems with modeling approaches, in particular what models are applied for what purpose
- Technical issues may have significant impact on quantitative results (?)

→ ...but I believe it requires some work.

- **Suggestions:**
  - Address technical issues
  - For index model, consider adding a 3rd state to model CAT component
  - For Lee-Carter, maybe jump component + RS-baseline would be worthwhile
  - I think more care is required in the model comparison. Consideration of purpose of the model when judging its appropriateness

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Thank you!