INDUSTRY DISCUSSION ARTICLE

AN INDUSTRY QUESTION: THE ULTIMATE AND ONE-YEAR RESERVING UNCERTAINTY FOR DIFFERENT NON-LIFE RESERVING METHODOLOGIES

BY

ERIC DAL MORO AND JOSEPH LO

ABSTRACT

In the industry, generally, reserving actuaries use a mix of reserving methods to derive their best estimates. On the basis of the best estimate, Solvency 2 requires the use of a one-year volatility of the reserves. When internal models are used, such one-year volatility has to be provided by the reserving actuaries. Due to the lack of closed-form formulas for the one-year volatility of Bornhuetter-Ferguson, Cape-Cod and Benktander-Hovinen, reserving actuaries have limited possibilities to estimate such volatility apart from scaling from tractable models, which are based on other reserving methods. However, such scaling is technically difficult to justify cleanly and awkward to interact with. The challenge described in this editorial is therefore to come up with similar models like those of Mack or Merz-Wüthrich for the chain ladder, but applicable to Bornhuetter-Ferguson, mix Chain-Ladder and Bornhuetter-Ferguson, potentially Cape-Cod and Benktander-Hovinen — and their mixtures.

KEYWORDS

One-year volatility, bootstrapping methods, Mack model, Chain-Ladder, Bornhuetter-Ferguson, Cape-Cod, Benktander-Hovinen.

The purpose of the ASTIN Bulletin is to gather scientific articles which aims are to provide solutions to given problems. It is also its purpose to describe issues which the (re)insurance industry is facing and for which solutions are (desperately) needed. In this framework, this article is a call for paper on the general subject of the one-year reserving uncertainty.

1. INTRODUCTION

If one performed a straw poll among present-day industry practitioners as to which ASTIN Bulletin paper has contributed most direct to their work,

Astin Bulletin 44(3), 495-499. doi: 10.1017/asb.2014.16

Mack (1993) must surely be in a top slot. The Mack model distinguishes itself by its link with a popular reserving method and its practicality. The well-established and simple chain ladder reserving method was endowed with a stochastic model that was similarly transparent for estimating the standard error of ultimate reserves. In the same spreadsheet, the actuary can quite easily implement the Mack method to estimate the standard error, alongside estimating of the ultimate reserves.

Understanding and communicating uncertainty of actuarial outputs are central: The Mack method gives the actuary a practical tool of quantifying the uncertainty underlying their ultimate reserve projections. On top of this professional requirement, two developments in the nonlife industry have helped to drive — and, at the same time, have been helped by - advances in stochastic reserving methods.

From around the turn of the millennium, management increasingly commissioned in-house "Dynamic Financial Analysis" stochastic models in search of better quantitative inputs to help manage their companies. Such models typically require simulation from full distributions of Balance Sheet and Income Statement items. Being able to simulate from distributions of the ultimate reserves was therefore important. The bootstrapping and Bayesian methods advocated by England and Verrall papers (2002 and 2006) in the U.K. contributed immensely in this area. Their methods provide Mack's model and other Generalized Linear Models whose means match the chain ladder projections with a way of simulating full distributions based on these models. As the tradition of the non-life industry is to manage risk on an ultimate basis for policyholder protection, being able to obtain the distribution of the ultimate reserves was enough for most applications. However, there were already signs that insurance companies were seeking ways to simulate distributions of Balance Sheets at annual intervals: They were also trying to understand at what point in time adverse reserving risk might materialise. After a year's worth of claim developments were simulated, the method of actuary in a box was sometimes used to perform mechanical projections at the end of year.

The second development was regulatory interest in stochastic modelling. The U.K.'s ICA regime was possibly the first of its kind: requiring companies to assess capital requirements at the 1 in 200 year level with one year's worth of new business, allowing for full run-off. A little later, Solvency II demanded a similar metric with an important twist: Capital requirements would be based on one-year movements of the Balance Sheet. The ability to estimate annual movements of the Balance Sheet in companies' internal models was no longer optional: It became a requirement.

In light of the above discussion, we suspect that the internal model documentation or model validation reports for most non-life firms would not only reference the England-Verrall bootstrapping papers (2002 and 2006), but also Wüthrich and Merz (2008). The latter paper opened the way for actuaries to estimate the standard error of the one-year movement of the prior-year outstanding claims reserves. The concepts in the paper are influential in the industry because they are based on a well-known model — that of the Mack model, which in turn is linked with the simple chain ladder method. Just as with the Mack model, the Merz-Wüthrich calculations could be performed using a spreadsheet, alongside the Mack calculations as well as the usual chain ladder projections. An industry practice of scaling the ultimate distributions for the one-year using ratios, derived from Merz-Wüthrich and Mack standard errors, is emerging as a practical approach to adjust an internal model to be Solvency II compliant (see White and Margetts 2010; England *et al.*, 2012).

On the reserving side, even when the actuary finally selects otherwise, development factor based triangular methods such as the Chain-Ladder, Bornhuetter-Ferguson, Cape-Cod, Benktander-Hovinen, etc., are important tools for projecting claims. Often, the Cape-Cod or BF is considered for the most recent years, and the Chain Ladder for the earlier years. Sometimes, weighted averages of the different projections are selected. Ultimate standard errors for all combinations would be immensely helpful in such cases for comparison and selections of ultimates. One-year standard errors would be helpful for more scientific back-testing of selections. Both would be useful for internal model calibration and validation.

2. The challenge

After looking at the current scientific situation and its historical developments, in this section, we would like to go through a description of the challenges that the (re)insurance industry is facing in providing estimates of the one-year volatility for different commonly used non-life reserving methodologies. These methodologies include:

- Chain-ladder: For this method, almost all the questions have been solved. In Mack (1993), the overall variance estimator of the ultimate reserves is given. In addition, in Merz-Wüthrich (2008 — hereinafter “MW”), the one-year volatility is provided through the standard deviation of the Claim Development Result (hereinafter “CDR”). Alternatively, bootstrapping methods (see England and Verall, 2002) can be applied to estimate both the volatility of the ultimate reserves and the one-year volatility of the reserves.
- Bornhuetter-Ferguson (hereinafter “BF”): For this method, the question of the volatility of the ultimate reserves was solved in Mack (2008)[1]. It is not uncommon to use this method to estimate the ultimate reserves for the most recent underwriting (or accident) years and to mix it with the chain-ladder for the older underwriting (or accident years). In this case, the volatility of the overall ultimate reserves can be estimated with the Hybrid Chain-Ladder method (see Arbenz and Salzmann, 2010). However, the one-year volatility of the reserves for the BF method is still an open question. Of course, it is always possible to use ad-hoc methods to get some estimates of the BF one-year volatility (An example may be to use actuary in the box with some BF

https://doi.org/10.1017/asb.2014.16 Published online by Cambridge University Press

methodology for the closing reserves, after scaled stochastic developments from known stochastic models of a diagonal). But the "industrialization" of such simulations poses significant challenges to the practitioner who has to deal with many different lines of business in different jurisdictions.

- Cape-Cod (see Buehlmann, 1983) and Benktander-Hovinen (see Benktander, 1976): For these methods, neither the ultimate volatility nor the "one-year" volatility is known in terms of closed-form formulas. Like for the BF method, the only alternative to estimate volatilities is to use simulation and scaling methods, as discussed in Koslover and Lo (2012) and Möhr and Ogut (2013).

In the industry, generally, reserving actuaries use a mix of the above discussed methods to derive their best estimates. On the basis of the best estimate, Solvency 2 requires the use of a one-year volatility of the reserves. When internal models are used, such volatility has to be provided by the reserving actuaries. However, due to the lack of closed-form formulas for the one-year volatility of BF, Cape-Cod and Benktander-Hovinen, reserving actuaries have limited possibilities to estimate such volatility apart from scaling from tractable models, which are based on other reserving methods. However, such scaling cannot be justified cleanly towards the different stakeholders such as rating agencies and regulators/supervisors.

The challenge is therefore to come up with a similar model like Mack and MW but applicable to BF, mix Chain-Ladder (for older years) BF (for recent years), potentially Cape-Cod and Benktander-Hovinen — and their mixtures.

If such models could be made available, it would really be a break-through in the implementation of Solvency 2 by (re)insurance companies and by regulators. It must be however noted that the one-year volatility models for each methodology (BF, Cape-Cod, Benktander-Hovinen) will almost certainly involve very different techniques. In addition, the one-year volatility models for methodology blending (e.g. mix chain-ladder/BF) may also involve additional questions to be solved. The response to this industry question could open new areas of statistical developments.

3. Conclusion

In this paper, we have listed out one key issue relating to the actual implementation of Solvency 2 which is the estimation of the one-year reserve volatility when different reserving methods are used. In the past few years, it must be recognized that significant steps towards the estimation of this key element for the implementation of Solvency 2 were done. On the other hand, for traditional actuarial claim projections, one-year volatility estimation would help more rigorous back-testing, and ultimate volatility estimation could contribute to better selection of projections as well as communication of uncertainty to stakeholders. However, the limits of the scientific and practical knowledge related to the one-year reserve volatility are now starting to be felt by practitioners. At this point, it is not uncommon to find some stakeholders, e.g. regulators, questioning the way in which the calibration of the one-year reserve volatility is done. It is therefore our wish that the scientific community tackles this issue in a view to develop practical and easy-to-use models, if possible with closed-form formulas. We would like to thank any person who would work on such issue in advance.

NOTE

1. Although we should note that Mack's BF model suffers from coming up with a different development pattern - as does Saluz, Gisler & Wüthrich (2011).

REFERENCES

ARBENZ, P. and SALZMANN, R. (2010) A robust distribution-free loss reserving method with weighted data- and expert-reliance. http://www.risklab.ch/hclmethod.

BENKTANDER, G. (1976) An approach to credibility in calculating IBNR for casualty excess reinsurance. The actuarial review, April 1976, p. 7.

BUEHLMANN, H. (1983): Estimation of IBNR Reserves by the Methods Chain Ladder, Cape Cod, and Complimentary Loss Ratio, unpublished, 1983.

ENGLAND, P.D., CAIRNS, M. and SCARTH, R. (2012) *The 1 year view of reserving risk: The "actuary-in-the-box" vs emergence patterns*. GIRO Conference 2012.

ENGLAND, P.D. and VERRALL, R.J. (2002) Stochastic claims reserving in general insurance. *British Actuarial Journal*, **8**(III), 443–544.

ENGLAND, P.D. and VERRALL, R.J. (2006) Predictive distributions of outstanding claims in general insurance. *Annals of Actuarial Science*, **1**(II), 221–270.

KOSLOVER, P. and LO, J. (2012) *Reserve Uncertainty in the London Market*. London Market Actuaries Group, 30 March 2012.

MACK, T. (1993) Distribution-free calculation of the standard error of chain-ladder reserve estimates. *ASTIN Bulletin*, **23**(2), 213–225.

MACK, T. (2008) The prediction error of Bornhuetter/Ferguson. *ASTIN Bulletin* 38(1) 87–103.

MÖHR, C. and OGUT, M. (2013) One-year insurance risk for non-life business. Schweizerische Aktuarvereinigung Assembly 2013.

SALUZ, A., GISLER, A. and WÜTHRICH, M. V. (2011) Development pattern and prediction error for the stochastic Bornhuetter-Ferguson claims reserving method. *ASTIN Bulletin* **41**(2), 297–313.

WHITE, S. and MARGETTS, S. (2010) *A link between the one-year and ultimate perspective on insurance risk*. GIRO Conference 2010.

WÜTHRICH, M. V. and MERZ, M. (2008) *Stochastic Claims Reserving Methods in Insurance*. Chichester: Wiley.

ERIC DAL MORO (Corresponding author)
Chief Reserving Actuary SCOR Switzerland
E-Mail: eric_dal_moro@yahoo.com

JOSEPH LO
Head of Actuarial Research and Development, Aspen, London, UK
E-Mail: Jo.Lo@aspen.co