REVERSIBLE JUMP MARKOV CHAIN MONTE CARLO: A REVOLUTION IN CLAIMS RESERVES VALUATION?

French Actuary Marion Gremillet unveils here the results of her deep research on a new non-life stochastic reserving valuation method: the Reversible Jump Markov Chain Monte Carlo (RJMCMC) applied to triangles. We asked her about her research.

How did you come to study RJMCMC reserving methods?
'Today, calculating deterministic reserves is no longer sufficient in a world of enhanced Risk Management. Indeed insurers strive to have a complete view of the risk underlying reserves valuation: therefore stochastic projection methods become central to today's actuaries. It is even more the case with the Solvency II European Regulation which requires a VaR99.5% valuation… and consequently a very robust stochastic model to achieve a credible tail valuation.

I had the feeling that the Reversible Jump Markov Chain Monte Carlo method had many advantages over traditional approaches mostly based on Chain Ladder. This is what I wanted to check, basing my initial work on the RJMCMC paper by Verrall and Wüthrich in 2012.'

What is for you the main weakness of current traditional reserving methods?
'Traditional methods like Chain Ladder evaluate, column by column, each element of the lower triangle, according to the upper triangle data. In the case of the Chain Ladder method, this evaluation is based on an estimated development factor which determines one column's data from earlier ones. The paradox is that the estimates for the columns on the left-hand side use a lot of data in order to project just a few points, whereas the right-hand columns contain relatively little data to project a lot of points. All that seems counter-intuitive and leads to a potentially significant estimation error.'

How does RJMCMC remedy these weaknesses?
'On the contrary, the RJMCMC method consists in applying two different models: one for the left part of the triangle, based on a large set of parameters, which allows a better fit to the data, and one for the right part of the triangle, based on only two parameters and on reference statistical curves. This allows a more robust evaluation of the tail, the last columns corresponding mainly to the development of the claims that have already occurred which can more easily fit a simple parametric model.'

What is the main issue you face when applying RJMCMC?
'One of the main issues is to decide in what column we should switch from one methodology to the other. The RJMCMC method answers this question with a solution that is admittedly complex, but pragmatic.

Indeed, the method is a mix of several algorithms which have proved themselves in the fields of biology and computational physics: Bayesian statistical analysis; Markov chains for the iterations; Monte Carlo techniques for the simulation of the models' truncation index; Gibbs sampling for the left-hand side of the triangle; and the Metropolis Hastings algorithm to estimate the parameters for the right-hand side.'

And what about the assumptions behind it?
'The fundamental assumption of the method supposes that the incremental values follow an over-dispersed Poisson distribution with different row and column parameters. The basic aim of RJMCMC is to estimate these parameters using different models.

The row parameters in the run-off triangle are modeled by a gamma distribution.

As for the column parameters γ_j, there are two cases. First: if the column is in the left part of the triangle: the column parameter follows a gamma distribution; and secondly: if the column is in the right part of the triangle: the column parameter is estimated by one of the classical parametric distributions, for example an exponential decay in the Verrall and Wüthrich paper.'

How do you find the best triangle limit? How can you handle it?
'The aim of RJMCMC is to estimate the parameters by testing algorithmically different values for the limit. Indeed the algorithm will go to all possible values and will converge to the most probable distribution, using acceptance probabilities, as shown in the box.'

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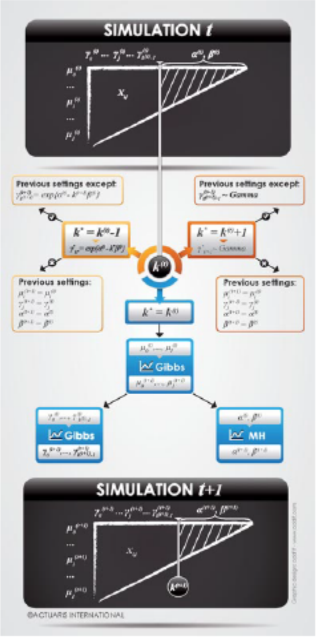


Each step of the algorithm consists of choosing a new truncation index k^* according to the previous step $k^{(t)}$. To achieve this, we use a uniform distribution which allows us to get the $k^{(t-1)}$, $k^{(t)}$, $k^{(t+1)}$ values, each with 1/3 probabilities.

If k^* is different from $k^{(t)}$ the RJMCMC algorithm consists of proposing a new value for the unique column parameter which migrates from one model to another, while the values of the other parameters remain unchanged from the previous state of the Markov chain. This proposed value can then be accepted or rejected; in the latter case, the value used is the same as in the previous state.

If k^* is equal to $k^{(t)}$ the RJMCMC algorithm consists of updating parameters block after block. At first the row parameters are updated by using Gibbs sampling, then the same technique is used for the column parameters. Finally, the parameters of the exponential decay will be updated using the Metropolis Hastings algorithm.

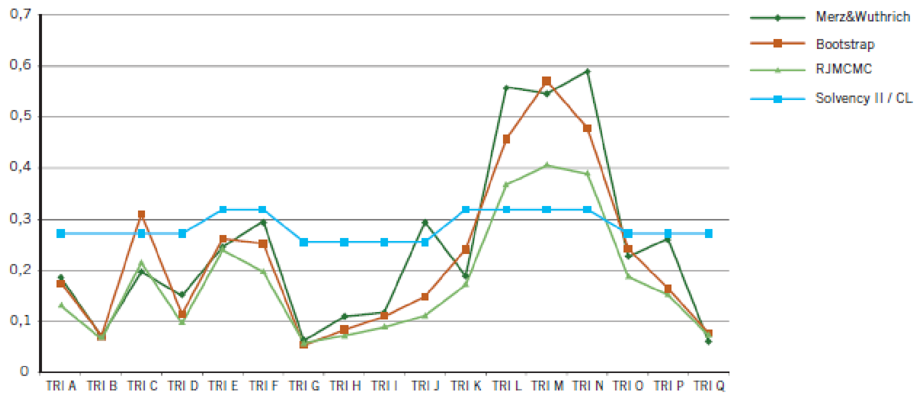
Thus, in each case we obtain a new vector of parameters. The diagram presents, for a given iteration, the RJMCMC methodology.

Through the use of complex algorithms based on Monte-Carlo techniques, the methodology requires a high number of iterations. In general, several iterations are necessary before the algorithm become stable – the so- called "burn-in" stage. Results from the iterations before this stationary distribution is achieved have to be excluded from later calculations.

Solvency II has set the one year volatility as the new valuation standard. How can you deal with it?
'I have simply applied the "Actuary in the box" method to the RJMCMC algorithm as exposed in the paper from D DIERS (2010): Stochastic re-reserving in multi-year models. This is the method also traditionally used for getting Bootstrapping results.'

Have you applied RJMCMC to the "real world"? Does it help save capital for companies?
'I have applied the 1 year RJMCMC to a set of 17 market triangles kindly provided by the Belgium Supervisor, and then compared it to the commonly used methods for the estimate of the reserving risk: Solvency II standard formula, Chain Ladder/ Merz & Wüthrich, and Bootstrap/Actuary in the box.'

The graph below shows the comparison of the capital requirements calculated with these methodologies applied to the seventeen triangles (listed from A to Q):



Graph representing capital as a percentage of the reserves for the different triangles

The table below represents the capital (as percentage of the mean of the reserves) obtained over the seventeen triangles and for each method. On the second row, a comparison is done with the results obtained with Solvency II.

	Mack	Bootstrap	RJMCMC	Solvency II
Capital Mean of reserves	23 %	20 %	16 %	28 %
Differences with Solvency II	– 20 %	– 29 %	– 42 %	–

Table summarizing the mean of capital obtained over the 17 triangles for the different methods

The capital saved with the RJMCMC method is quite significant: 42% capital saved in comparison to the application of the Solvency II standard calibration, or 29% capital saved compared to the Bootstrap/Actuary in the box method, and again 20% capital saved compared to the Chain Ladder/Merz & Wüthrich method.

As a conclusion, would you say RJMCMC will revolutionize the science of reserving?
'It is perhaps too early to state that it will supersede the well-established chain ladder or bootstrap methods. There are different limitations that have to be overcome:
- The high number of iterations which makes it sometimes difficult to interpret;
- Not all data are fitting an over dispersed Poisson;
- The difficulties for non-actuaries to understand part of the method.

But all insurers understand well that applying different methods depending on the amount of data available, namely on the left or right part of the triangle, makes sense and should return better results. However explaining in simple terms such a complex methodology will be key to its adoption in companies. And it will require efforts of actuaries to make the methodology accessible to all concerned parties.'