Impact case study (REF3b)

Institution:
University of Oxford
Unit of Assessment:
18 – Economics and Econometrics
Title of case study:
Improving the reserving decisions of general insurers
1. Summary of the impact
General insurers are required to have a capital reserve to cover outstanding liabilities, i.e. liabilities that have been incurred but not settled, or perhaps not even reported. Under the new Solvency II regulation, adopted by the EU Council in 2009, general insurers now face complex new capital requirements. These new regulations must be fully implemented by 2016. The development of new statistical methods led by Dr Bent Nielsen and his co-researchers, in collaboration with the general insurer RSA, extends traditional forecasting methods, and provides tools by which insurers are able to meet these new statutory requirements.
2. Underpinning research
Research team
Dr **Bent Nielsen** has been Lecturer/Reader in Econometrics at the University of Oxford since 1999. **Di Kuang** was a DPhil student at Oxford under the supervision of Dr Bent Nielsen from 2005 to 2008. Dr Kuang has since left academia to work in the industry. Prof **Jens Nielsen** is former research director at RSA, co-owner of the Copenhagen-based knowledge-transfer firm Festinalente, and professor of Actuarial science at Cass Business School since 2012. Dr **Maria Dolores Martínez Miranda** lecturer in Statistics at the University of Granada, Spain, and, from 2013, a Marie Curie Fellow at the Cass Business School.
An insurance policy provides, in return for the payment of a premium, acceptance of the liability to make payments to the insured person on the occurrence of one or more specified events (insurance claims) over a specific time period. General insurers are faced with delays from insured events happening to the final settlement of the claim. Typical reasons are (i) delays between event and reporting to the insurer; and (ii) delays from reporting to settlement of the claim. The delays can run into years for employers' liability or auto third party liability or even decades in the case of mesothelioma caused by employment related exposure to asbestos. General insurers are required to hold large capital reserves to cover outstanding liabilities.
Many of the problems encountered in reserve forecasting are closely related to those found in time-series econometrics. Dr Bent Nielsen, a leading researcher in the field of time-series econometrics, led the research to develop new statistical methods for reserve forecasting, which can be broken down into the following areas
1) Research on calendar effects
The traditional approach to forecasting the capital reserve, needed to cover outstanding liabilities, is the Chain Ladder method. It is a two-way Poisson regression allowing for policy year and delay year effects. In practice, it is often necessary to include a third component for the calendar year. The calendar effect introduces problems with respect to identification and extrapolation of the model. The identification problem is the same as that found in the so-called "age-period-cohort" models used in economics, epidemiology, biostatistics, sociology. In those literatures, the problem has been extensively discussed but only partially solved, whereas the extrapolation problem has gone unnoticed.
The identification problem is that the three effects cannot be fully separated from each other. In a Poisson regression, this shows up as perfect collinearity among the regressors. It was found that the problem is related to those encountered in time-series econometrics. Dr Bent Nielsen and his co-researchers solved the identification problem by establishing a representation theorem that characterises exactly what can and what cannot be estimated by the models **[R1]**. The extrapolation problem arises from the need to extrapolate the estimated calendar effect in order to forecast the reserves. If the identification problem is handled incorrectly then the forecast has undesired, but avoidable, arbitrary components. The research identifies a necessary and sufficient condition for avoiding such arbitrary components **[R2]**.

> ## 2) Research on forecasting in the presence of structural breaks
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> Insurers are occasionally faced with structural breaks in the underlying economy which can have a big impact on the reserves. The problem of forecasting in the presence of structural breaks has been studied in time series econometrics, and research led by Dr Nielsen demonstrates how these results may be translated across to the reserving problem **[R3].**
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> *3)* *[text removed for publication]*

3. References to the research

[R1] * Kuang, D., Nielsen, B. and Nielsen, J.P. (2008) Identification of the age-period-cohort model and the extended chain ladder model. *Biometrika* 95, 979-986.

[R2] * Kuang, D., Nielsen, B. and Nielsen, J.P. (2008) Forecasting with the age-period-cohort model and the extended chain-ladder model. *Biometrika* 95, 987-991.

[R3] Kuang, D., Nielsen B. and Nielsen, J.P. (2011) Forecasting in an extended chain-ladder-type model. *Journal of Risk and Insurance* 78, 345-359.

[R4] *[text removed for publication]*

Research quality
Biometrika is a top-ranked peer-reviewed statistics journal.
Journal of Risk and Insurance is a top-ranked peer-reviewed actuarial journal, and a middle-ranked economics journal.
[text removed for publication]

*Denotes publication returned as part of REF2014.

Research Funding
Marie Curie Action FP7-302600. Title: "Stochastic reserving based upon mathematical statistics". 278807€. Sep 2012-Sep 2014. Held at Cass Business School. The grant allows MD Martínez Miranda to relocate from Spain to the UK. Bent Nielsen is one of the designated supervisors.

4. Details of the impact Background

RSA is one of the world's leading multinational insurance groups, focusing on general insurance. It employs 23,000 people and serves 17 million customers in over 140 countries. RSA has annual premiums of £9 billion and a £4.5 billion market capitalization, and they hold reserves of £15 billion, The European Commission established the Solvency II project in the early 2000s, to review and reform the rules governing direct life and non-life insurance undertakings and reinsurance undertakings operating in the European Union (EU). The Solvency II Directive,adopted by the EU in the European Council in 2009, significantly change how the capital requirement of general insurers is set and assessed. To ensure compliance with the new regulations, RSA set up a research programme into reserving which has fed through to impact on RSA policies and practise. To facilitate the research and its impact, Jens Nielsen, then research director at RSA, set up a "knowledge loop" in 2004, which continues today, whereby practical problems confronting RSA are fed through as research questions for academic research, the research is then tested on RSA data through an internship programme. The outcome of this process is then evaluated by RSA with a view to implementation or to stimulate further research. Dr Bent Nielsen was contacted initially by Jens Nielsen, in 2004, to lead the research into problems of calendar effects in the chain ladder model. Bent Nielsen then became associated with RSA as an academic consultant from 2004 to 2012. As part of this "knowledge loop" with RSA, Bent Nielsen also organised a number of workshops in Oxford between 2006 and 2008 as a part of RSAs corporate development programme. These discussed the emerging research with participation from academics and about 20 actuaries from RSA helping to continue this co-productive research dialogue.

Internship programme
An annual internship programme has been running since 2004 for 2-3 Oxford undergraduate mathematics students. It involves a period spent absorbing recently researched methods and associated computer programs, followed by a period of testing the methods on RSA data. In the initial period the students are supervised by academics. Subsequently they are supervised by RSA actuaries. The students then write their findings up in a confidential internal research report and make an oral presentation to RSA management. The topic of the internship has changed from year to year. In 2009 the main topic was calendar effects with Dr Bent Nielsen leading the initial academic supervision and guidance.

Impact 1: Research on calendar effects
To date the research by Dr Bent Nielsen and others has impacted on the operations of RSA in two main ways. First, the research into calendar effects **[R1, R2]** influenced RSA. *[text removed for publication]*

Impact 2: Research on forecasting in the presence of structural breaks
Second, the research on forecasting in the presence of structural breaks was important in determining the company's response to the global financial crisis. In 2009, the possible effects of the financial crisis on their reserves was a key issue for RSA and the research on forecasting in the presence of structural breaks **[R3]** was the focus of the 2009 internship. Bent Nielsen presented the theory and related computer routines in R to the interns, and to the then Head of UK Reserving at RSA. The interns then tested the methods on a number of internal RSA data sets. *[text removed for publication]*

Impact 3: *[text removed for publication]*

5. Sources to corroborate the impact

[C1] Copeland, J., Howell, T. and Ramsay, R. (2009) Applying the extended chain-ladder model. (*RSA internal research report - strictly confidential.) [text removed for publication]*

[C2] *[text removed for publication]*