Institution: University of Southampton

Unit of Assessment: 19 Business and Management Studies

Title of case study: 19-06 Improving the way consumer credit risk is assessed

1. Summary of the impact

Credit scoring, the process of estimating the risk of lending to consumers, has traditionally estimated the likelihood of default over a fixed period, usually 12 months. Research carried out at Southampton's School of Management has led to a gradual shift by many financial institutions in the UK and elsewhere towards an alternative method that estimates default over any period. This approach provides accurate risk estimates over any time period. It also allows for the inclusion in the "scorecard" of economic conditions and the lending rates charged – features whose absence from previous scorecards was identified as contributing to the sub-prime mortgage crisis.

2. Underpinning research

Sir David Cox developed the proportional hazards approach to survival analysis in the mid-1970s to model problems of mortality. It estimates when an event will occur and how much more likely it is to occur as a function of an individual's characteristics. Apart from one non-academic paper, the concept's potential benefits in the context of consumer credit remained overlooked for more than two decades.

In 1999 Professor Lyn Thomas, then at the University of Edinburgh, suggested a proportional hazards model could be as effective as the standard approaches – principally logistic regression – in modelling credit defaults. Thomas continued his research in this field after moving to Southampton in 2000 (Professor of Management Science, Centre for Risk Research, Southampton Management School, 2000-present) and produced a series of papers, the most important being Survival Analysis Methods for Personal Loan Data (2002) [3.2] and PHAB Scores: Proportional Hazards Analysis Behavioural Scores (2001) [3.1]. The former solved various technical issues and identified the appropriate statistical tests, allowing scorecard builders to know their scorecard was robust and valid. The latter extended the idea to behavioural scoring – the way of assessing the risk of existing borrowers rather than just new borrowers. This work was enhanced by the arrival at Southampton in 2004 of Dr Christophe Mues (Senior Lecturer, Centre for Risk Research, Southampton Management School, 2004-present), who would go on to apply the same approach to collection scoring – when and how likely events occur that determine how much of a defaulted debt will subsequently be recovered [3.5]. Dr Bart Baesens (Lecturer, Centre for Risk Research, Southampton Management School, 2004-present) extended the approach by incorporating non-linear data-mining techniques [3.6].

In 2006 an ESRC grant [3.7] to develop the Quantitative Financial Risk Management Centre allowed the Southampton research team to show how the survival analysis approach to credit scoring enabled changes in both the economic environment and the interest rate on the loan to be incorporated into the scorecard. Banks were anxious to incorporate such changes, as the failure to do so had been one of the weaknesses highlighted by the sub-prime mortgage crisis that began in 2007.

Having economic conditions in individual loans' risk assessments made it possible to build models of the default risk of portfolios of consumer loans by allowing the correlations between the default risks of different loans to come from the common economic conditions. In addition, in work beginning in 2007, the competing risk approach in survival analysis enabled the modelling of portfolios of loans with both default and churn [3.3] [3.4].

The work has led to important advances in modelling credit defaults. Firstly, all the data can be used in building scorecards, thus eliminating the time-consuming process of filtering out information that would offer insufficient history to construct a fixed-period scorecard. Secondly, competing risk ideas can be used to build scorecards not just for default but also for attrition and

early repayment – the other occurrences that might affect a bank's profits. Thirdly, expanding the survival analysis method to incorporate economic conditions facilitates building default risk models for portfolios of consumer loans.

3. References to the research

Publications

3.1 Thomas LC, Stepanova, M (2001): PHAB Scores: Proportional Hazards Analysis Behavioural scores, *Journal of the Operational Research Society*, 52, 1007-1016

3.2 Thomas, LC, and Stepanova, M (2002): Survival Analysis Methods for Personal Loan Data, *Operations Research*, 50, 277-289

3.3 Malik, M, and Thomas, LC (2010): Modelling Credit Risk of Portfolios of Consumer Loans, *Journal of the Operational Research Society*, 61, 411-420

3.4 McDonald, R, Matuszyk, A, and Thomas, LC (2010): Application of Survival Analysis to Cash Flow Modelling for Mortgage Products, *OR Insight*, 23(1), 1-14

3.5 Tong, ENC, Mues, C, and Thomas LC (2012): Mixture Cure Models in Credit Scoring: If and When Borrowers Default, *European Journal of Operational Research*, 218, 132-139 (doi:10.106/j.ejor.2011.10.007)

3.6 Baesens, B, Van Gestel, T, Stepanova, M, Van den Poel, D, and Vanthienen, J (2005): Neural Network Survival Analysis for Personal Loan Data, *Journal of the Operational Research Society*, 59(9), 1089-1098

Grants

3.7 EPSRC grant (2006-2010): Quantitative Financial Risk Management Centre, to Hand (Imperial), Thomas (Southampton) and Crook (Edinburgh) – £560,000 (£170,000 to Southampton)

4. Details of the impact

Recent economic events have underlined the enormous importance of risk management. Logistic regression, involving estimating the likelihood of a customer defaulting within a set period, was long the dominant method of building credit scorecards. In what has been described as a "sea-change" in modelling, Southampton's research has been fundamental in driving the development and adoption of a more flexible approach.

The broad impact of this work can be split into two phases. The first saw recognition among lenders that survival analysis can lead to a scorecard that is as good as – if not better than – logistic regression in terms of identifying loans that are more likely to default. The second phase heightened awareness that this approach allowed scorecards to include factors such as economic conditions and loan interest rates – the absence of which was a critical weakness of scorecards used in the run-up to the sub-prime mortgage crisis. The approach also allowed estimation of the default risk of portfolios of consumer loans.

Workshops and conferences have been key to disseminating the advantages of these new methods. Since 2008 Thomas, Mues and Baesens have presented their research at an average of 30 events a year. Held both in the UK and abroad, these have included the University of Edinburgh's Credit Scoring and Credit Control Conferences, - the 2013 one, attracted more than 450 practitioners [5.1]; conferences organised by industry specialists such as SAS, the OR Society and Infoline; and workshops for individual institutions such as GE Capital, Lloyds, RBS and the Coventry Building Society.

Banks, industry experts and other practitioners are now acknowledging the major advantages of the survival analysis approach. For example, referring to Thomas's presentation at a March 2008 "master class" for risk modellers at HBOS [5.2], Alan Forrest, who at the time was HBOS's Manager of Group Credit Analytics, described the "experience and insight" provided by Southampton's work as "crucial to the training of the HBOS modellers". Forrest, now Manager of

Model Review and Research for RBS Risk Management, said: “At the time survival analysis was a growing technique in HBOS. [Southampton’s] academic papers were fundamental texts and motivators… and the 2008 Master Class cemented HBOS’s acceptance of survival analysis as a modelling and retail risk management technique.” [5.3] Similarly Richard Norgate, Director of Customer Analytics and Decisions at the Lloyds Banking Group acknowledged the Southampton group “played an instrumental part in changing the industry in the use of survival analysis to model credit risk” [5.4]

The ability to expand the survival analysis method to incorporate economic conditions and loan interest rates allows the building of default risk models which can be stress tested. This is fundamental to the Basel Accord regulations introduced in 2008. This aspect of the research, together with the School’s work on estimating Loss Given Default, has become the basis for a new series of conference appearances and workshops, held in more than 30 countries and including presentations to regulators such as the Financial Services Authority and the Department for Business, Innovation and Skills.

One such event led to the research team using survival analysis to build a pricing model for the Coventry Building Society’s mortgage portfolio. The Coventry is among Britain’s top-10 mortgage lenders. In 2008 Southampton’s model was applied to a portfolio of 115,000 mortgages with a total value of £12bn, and the concepts it introduced are still used in the Coventry’s modelling today [5.5].

Other financial organisations have introduced these ideas as a result of summer projects undertaken by Southampton MSc students in Management Science and Finance under the supervision of the research team. Each year around 10 of these projects are in the credit-scoring area, with several involving the development of models based on the proportional hazard approach. Lloyds and HSBC have been among the organisations to implement related methods with Lloyds saying “they helped them make real steps forward in new project ideas which we would struggle to make otherwise”.

There have also been numerous email enquiries and several visits from financial analysts concerning the technical details of building scorecards in this way. During 2012-13 these included organisations in the USA (Toyota Financial Services, WW Grainger, Citi and JPMorgan), Canada, Brazil, Chile, Ecuador, Hong Kong, China, Australia, South Korea, South Africa, Germany, Spain, Hungary and Lithuania [5.6]. These demonstrate the research’s ongoing impact on financial organisations worldwide.

Dr Joseph L Breeden, CEO of leading industry specialist Prescient Models LLC, has remarked that the work of Thomas, Mues and Baesens has been pivotal to “a sea-change in modelling”, observing: “Loan-level forecasting techniques… are a great advance over standard logistic regression. The research being conducted by the Southampton team is critical to exploring the applicability and limitations of these methods so that we can educate lenders about where they work best and where further advances are required for success” [5.7].

5. Sources to corroborate the impact

5.1 Presentation to Credit Scoring and Credit Control Conference, University of Edinburgh, March 2011 http://www.business-school.ed.ac.uk/crc/conferences/conference-archive?a=46022

5.2 Survival Analysis Master Class for HBOS, Halifax, March 2008

5.3 Statement from Manager, Model Review and Research, RBS Risk Management

5.4 Statement from Group Analytics and Modelling Director, Lloyds Banking Group

5.5 Statement from Head of Risk Models, Coventry Building Society

5.6 Email correspondence from financial institutions in countries mentioned above

5.7 Statement from CEO, Prescient Models LLC