MSC in Actuarial Science

Summer Projects (MSc Dissertations) 2006

Project 2.1

RISK ANALYIS USING COPULAS
Supervisor: Andrew Cairns. Number of students: 1-2

Suppose that we have a problem involving two random variables X and Y (e.g. two investment or economic risks). The value of your investment fund depends on the joint random variable (X,Y). In this project we will investigate a very flexible method that involves decomposing the joint distribution into its marginal distributions and a what is called a "copula" which describes the dependency structure.

In the project we will look at theoretical properties of copulas before setting out to analyse some bivariate datasets involving financial data (e.g. stock market returns and interest rate data).

This project will contain a substantial element of computing and students should have a strong background in statistics.

Background reading:

- See Chapter 5 on the web page: http://www.ma.hw.ac.uk/~andrewc/frm/ or the book
- Alexander J. McNeil, Rudiger Frey, Paul Embrechts (2005) Quantitative Risk Management: Concepts, Techniques and Tools. Princeton University Press.

Project 2.2

STOCHASTIC MORTALITY MODELLING
Supervisor: Andrew Cairns. Number of students: 1-2

It is now an accepted fact that aggregate mortality rates in the UK (a) have been falling over time and (b) future improvements are difficult to predict. The second remark has led to the development of a range of models for future aggregate mortality rates.

In this project we will review the evidence for aggregate mortality rates being stochastic; we will look at some specific stochastic models; and we will look at some applications in reserving and pricing.

This project will contain a substantial element of computing and students should have a strong background in statistics and time series analysis.

Background reading:
Cairns, A.J.G., Blake, D., and Dowd, K., (2005) A two-factor model for stochastic mortality with parameter uncertainty.
See http://www.ma.hw.ac.uk/~andrewc/papers/ajgc47.pdf

Project 2.3

THE LEE-CARTER MODEL OF MORTALITY USING P-SPLINES
Supervisor: Iain Currie. Number of students: 5

This project looks at the Lee-Carter model of mortality. Data can be found on the Human Mortality Database (at www.mortality.org). Each student will choose two countries and extract relevant data from the database. The project will use the computer language R on PC-Caledonia (additionally, a CD will be available for those students who wish it). A program in R will be provided and students will explore the effect of different parameter choices on the fitted models. Students will be expected to use a wide range of graphical and tabular output to summarise and compare the different mortalities. The stages in the project will be:

1) Getting to know R and the supplied program - group work.
2) Describing the datasets - group and individual work.
3) Writing up - individual work.

With 5 students I will hold "classes" (one hour) and "labs" (one hour) for the whole group each week. In addition there will be one office hour per week.

General comments: This is a non-technical project that would suit someone with an interest in computing. There is very little mathematics involved. The program will be used as a "black box".

The supervisor will be away from the University as follows (all dates inclusive):
July 3 - July 7
July 12 - July 17
July 28
August 28 - August 30
Sept 4 - Sept 8

Project 2.4

SIMULATING AGGREGATE CLAIMS PROCESSES
Supervisor: Iain Currie. Number of students: 5

The idea of this project is to produce a suite of R functions for simulating aggregate claims processes. Emphasis will be on flexibility of (a) input ie specification of input distributions and (b) output ie tabular or graphical. The starting point will be the simulation material in the Risk Theory course but the

content should be comprehensive and go beyond what is considered in the Risk Theory course. Certainly, non-parametric modelling of real data sets should be considered. The end result should be suitable for use as a teaching resource for next year's Diploma class! The project is very open ended and I expect a student to follow their own ideas for what is important.

With 5 students I will hold "classes" (one hour) and "labs" (one hour) for the whole group each week. I expect students to work as a group in the initial stages of the project.

General comments: This project will only suit someone with an interest in computing. There is very little mathematics involved.

The supervisor will be away from the University as follows (all dates inclusive):
July 3 - July 7
July 12 - July 17
July 28
August 28 - August 30
Sept 4 - Sept 8

Project 2.5

SEMIPARAMETRIC MODELLING AND FORECASTING ACTUARIAL TIME SERIES
Supervisor: Yuanhua Feng. Number of students: 3

The aim of this project is to apply nonparametric regression, ARMA models as well as other relevant statistical tools for analysing some real insurance time series. Also short or middle term forecasting will be given. The considered data examples are those of the income, outgo, net-income and assets time series of The Social Security Trust Funds in the US. Both yearly and monthly time series till the most current time period will be used.

The project consists of three main parts. In the first part the trend in yearly time series will be modelled using local linear regression. Then an analysis of residuals will be carried out. If it is possible, ARMA models should be fitted to the residuals using optimal orders selected by the BIC. Point and interval forecasts for several years in the future will then be calculated. In the second part of the project monthly time series will be modelled using local linear and local trigonometric functions together with corresponding analysis of residuals and monthly forecasts for these series. In the third part more detailed study will be done, including analysis and forecasts of the components of an income or outgo time series as well as modelling the relationships between the time series considered here and other available series (e.g. the beneficiary series), to obtain detailed structures of the time series and to improve the forecasting.

Each of the candidates will use different data sets and will work on some special topics different to the others. However, the three candidates should

collaborate closely with each other, because the methodology for all three dissertations is quite similar.

Computer component of this project is approximately 25% . The calculation will be done in R. The main packages you need will be provided.
The candidates are welcome to use own (or other) suitable data sets, if applicable.

The supervisor will be away from campus for about two weeks at the end of July but will keep in touch with the students per email.

Selected references:

1. "Actuarial Resources, History, Research & Data" on the web http://www.ssa.gov/data_research.htm
2. Cleveland, R.B., Cleveland, W.S., McRae, I.E., Terpenning, I. (1990). STL: A seasonal-trend decomposition procedure based on LOWESS (with discussion). J. Official Statistics, 6, No. 1, 3-73.
3. Fan, J. and Gijbels, I. (1996). Local Polynomial Modeling and its Applications. Chapman & Hall, London.
4. Feng, Y. (2003). Semiparametric modelling of seasonal time series. Bulletin of the International Statistical Institute, Volume LX, Book 1, pp. 334-335, Berlin.
5. Hart, J.D. (1991). Kernel regression estimation with time series errors. Journal of the Royal Statistical Society, Ser. B, 53, 173-188.
6. Heiler, S. and Feng, Y. (2000). Data-driven decomposition of seasonal time series. Journal of Statistical Planning and Inference}, 91, 351-363.
7. Suitable texts in Regression Analysis and Time Series Analysis.

Project 2.6

ANNUITY DRAWDOWN: A SIMULATION STUDY
Supervisor: Tom Fischer. Number of students: 1-2

Annuity drawdown (also: income or pension drawdown) was introduced in the UK in 1995 to provide annuity holders with higher income flexibility. Instead of paying into a pension fund until retirement and then immediately buying an annuity, the policyholder has the opportunity to start drawing regular benefits from his/her accumulated funds already from an age of 50. At the latest by the age of 75, an annuity has to be purchased from the remaining funds to provide a secure lifetime income. In the UK, the monthly, quarterly or yearly benefit during the drawdown period must be chosen between limits set by the Government Actuary's Department (GAD) each year. Under the new pensions simplification with effect from April 2006 ("A-day") these limits have been further relaxed.

During the project, students will implement a simplified version of the mechanism for the determination of limits by the GAD, using a simple combined stochastic model for stock prices and interest rates. Simulation studies for different drawdown strategies (including the maximal allowed rates) will be carried out to determine the distribution of the rate of the finally purchased annuity. Possible lines of investigation are: - How do outcomes of different strategies compare (riskiness)? - How sensitive are these outcomes to model parameters (e.g. to the correlation of interest rates and stock prices)? - How do worst case outcomes for pre-A-day and after-A-day strategies compare?

The project will involve a summary of the existing literature (mainly available in online documents of the GAD and HM Revenue & Customs) and the outlined simulation part. Matlab, R or any other suitable programming language can be used. The computing component will be up to 50%.

The supervisor will be away from the University from June 30 to July 19, and August 11 – 21.

Project 2.7

MEASURES OF RISK AND THE FAIR ALLOCATION OF RISK CAPITAL
Supervisor: Tom Fischer. Number of students: 1-2

Since the middle of the 1990's, the interest in how to measure "risk" and how to determine adequate amounts of risk capital has grown immensely amongst practitioners and researchers in the financial sector. Two important questions are the following:
(1) What is an appropriate method to determine the amount of capital to be held back by a financial institution to cover possible risks evolving from a certain financial portfolio?
(2) If there are two subgroups within the considered institution, e.g. an investment department and a credit department within a bank (contributing

with stocks/options, respectively credits to the overall portfolio), is there a fair method to split the risk capital between the two?

Students will start this project by learning about the general aspects of defining risk measures. For instance, the concept of "coherent" risk measures will be investigated. Different types of risk measures, including the very popular concepts of Value-at-Risk and Expected Shortfall, will be considered. For simple market models, like binomial trees or geometric Brownian motions (Black-Scholes model), example calculations will be carried out. In a next step, the concept of "fair" risk capital allocation will be investigated. A method to determine the fair risk contribution of a risky position will be numerically implemented for the mentioned simple market models and different types of risk measures.

The project will involve a review of the existing theory/literature and a part with numerical applications as outlined above (for instance using Matlab, R or any other suitable programming language). The computing component's range is 25-33%. One or two introductory lectures will be given by the supervisor.

References:
- Artzner, P., Delbaen, F., Eber, J.-M., Heath, D., 1999. Coherent measures of risk.Mathematical Finance 9 (3), 203-228
- Fischer, T., 2003. Risk capital allocation by coherent risk measures based on one-Sided moments. Insurance: Mathematics and Economics 32 (1), 135-146
- McNeil, A.J., Frey, R., Embrechts, P., 2005. Quantitative Risk Management: Concepts, Techniques, and Tools. Princeton University Press

The supervisor will be away from the University from June 30 to July 19, and August 11 – 21.

Project 2.8

BAYESIAN ESTIMATION OF JOINT SURVIVAL FUNCTIONS IN LIFE INSURANCE

Supervisor: Serguei Foss. Number of students: Up to 3

The insurance industry recently experienced a high demand for life insurance policies issued to married couples, with pay off due at the second spouse’s death. The fair pricing of such policies is an example of insurance problems requiring the construction of two or higher dimensional survival functions.

For a given data and for a parametric class of two-dimensional joint survival functions, we plan to use the Bayesian approach and Markov chain Monte Carlo methods for estimation of unknown parameters.

The project will begin with a number of introductory lectures on Bayesian and MCMC techniques.

Project 2.9

LOSS DISTRIBUTION ANALYSIS

Supervisors: Serguei Foss and David Wilkie. Number of students: Up to 3

Given a sample of insurance claims and assuming that claims are distributed according to a given distribution (like Pareto, Weibull, Gamma, etc) one has to estimate distribution parameters by use of various methods: maximum likelihood, moments, etc.

The project consists of two steps:
In step one, for a given parametric family of distributions, choose somehow parameters and simulate samples from it. Then try to solve the inverse problem: to estimate parameters of a distribution given data, to compare methods for estimation, and to choose an optimal one (in a certain sense). In step two, given real loss data, try to estimate a distribution.

The project will begin with a number of introductory lectures.

Project 2.10

OPTIMALITY PROBLEMS IN REINSURANCE

Supervisors: Serguei Foss and Stan Zachary. Number of students: Up to 3

This project considers a risk process with a number of insurers and with one reinsurer. Simulation will be used to study the problem of how to fairly share the risk between the insurers and the reinsurer so as to minimise the overall probability of ruin. Various probability distributions of claim size will be examined, including so-called light-tailed and heavy-tailed distributions.

Project 2.11

DEMUTUALISATION OF THE STANDARD LIFE ASSURANCE COMPANY

Supervisor: David Forfar. Number of students: 2

The Standard Life is a major UK mutual insurance company (i.e. owned by its policyholders) but it is about to demutualised and become owned by shareholders. It will in future have a U.K. stock-market value and quotation which can be compared with Prudential, Aviva and Legal & General. The Project will involve studying the demutualisation 'pack', determination the nature of, and amount of future cash flow which will give profits to shareholders and therefore give Standard Life its market value. The Project will involve the study of embedded values (i.e. the valuation of shareholder profits from existing business) and how goodwill derives from the flow of profits arising from future new business.

Candidates will learn:-

(1) About shareholder value for a proprietary life company,
(2) Where the flow of profits to shareholders come from,

(3) Analysis of the Realistic Balance Sheet for a with-profits fund, the *Estate* and its future.

*Documents (*copies of these can be downloaded from the Internet http://ukgroup.standardlife.com/sgm/content/index.html

(1) Document 'pack' sent to all with-profit policyholders,
(2) Full Report on demutualisation by the Independent Actuary,
(3) Full Report on demutualisation from the Actuarial Function Holder and With-Profits Actuary.

Computing
Own laptop preferable, EXCEL spreadsheets.

The supervisor anticipates being away from Edinburgh 25 July to 2 August inclusive

Project 2.12:

PROJECTING MORTALITY
Supervisor: David Forfar (with the support of Dr Iain Currie). Number of students: 2

Apply the Singular Value Decomposition (SVD) of a matrix to the 15 ELTM's and 15 ELTF's (the 30 graduated data sets and, where the data is available, the raw un-graduated data) to determine the best fitting k(t) and a(x)'s and b(x)'s to fit the ELT data -the Lee/Carter method where $m(x,t)=\exp\{a(x)+k(t)*b(x)\}$ as opposed to the Gompertz method where $\mu(x,t)=\exp(a(t)+b*x)$. Then applying some suitable method to project k(t) into the future, determine the 'funnel of doubt' and compare with Dr. Currie's splines method.

References (Copies of these will be given out to the candidates)
LEE R. D. and CARTER R. C. (1992), Modelling and Forecasting U.S. Mortality, *Journal of the American Statistical Association*, **87**, 659-671
LEE R. D. (2000), The Lee-Carter Method for Forecasting Mortality with various Extensions and Applications, *North American Actuarial Journal*, **4**, 80-93
GOOD I J (1969), Some Applications of the Singular Value Decomposition of a Matrix, Technometrics, 11, 4.

Computing
Own laptop preferable, EXCEL add-in to do the SVD can be downloaded from internet, maybe some VBA.

The supervisor anticipates being away from Edinburgh 25 July to 2 August inclusive

Project 2.13

APPLICATIONS OF BOOTSTRAP METHODS IN RISK THEORY AND RELATED CONTEXTS

Supervisor: Roger Gray. Number of students 2-3

The bootstrap is an appealing computer-based technique for assessing the precision of a statistical estimate. It is particularly useful in cases where we cannot derive a nice simple formula for the standard error of a particular statistic and/or where it is inappropriate to make distributional assumptions. First proposed by Bradley Efron in 1979, it is one of a number of computer intensive methods made possible by the availability of powerful computing facilities and which gained popularity through the 1980's and 1990's.

The bootstrap method is based on re-sampling from a given set of data (i.e. sampling from the empirical distribution function in place of the unknown theoretical distribution function).

How precise are the mean and median as estimates of the level of a distribution when that distribution is skewed (for example in the case of a Pareto or lognormal claim size model, or in the absence of a suitable model)? How precise is a sample estimate of the 90^{th} percentile of an aggregate claims distribution? How precise are parameter estimates based on other setting principles? How precise are the estimates of parameters in a fitted AR(2) time series model? Hoe precise is the slope estimate in a non-normal regression setting?

In this project students will consider such questions. Starting from simple situations, students will move on to situations which involve more structure, for example comparing the levels of two populations, estimating parameters in simple time series modules, non-parametric regression, parametric regression.

In some situations, you will compare bootstrap results with known theoretical results and in others you will work with simulated data.

The computing will be done using R and help a dn advice will be given. The states in the project will be:

1. Getting to know R and the basic bootstrapping method – taught class work and group work.
2. Bootstrap estimates of standard errors of means, medians, quantiles etc – group work
3. Particular applications – individual work.
4. Writing up – individual work.

The project will suit students with an interst in applying modern statistical techniques in actuarial science. Some computing effort will be required.

References

- Efron B and Tibshirani R (1986): Bootstrap methods for standard errors, confidence intervals, and other measures of statistical accuracy. Statisitcal Science Vol 1 No 1

- Efron B and Tibshirani R (1993) An introduction to the bootstrap. Chapman & Hall

The supervisor will be away from the University from 18 – 28 August.

Project 2.14

THE IMPACT OF MODEL SPECIFICATION ON EXOTIC OPTION PRICES

Supervisor: Torsten Kleinow. Number of students: 1-2

In recent years many new probabilistic models have been proposed to represent the dynamics of financial time series. One class of models consists of so-called Levy Processes, of which Brownian Motion is a special case. These models have been proven to be very useful for the modelling of financial data. The flexibility of Levy models offers the opportunity to calibrate the parameters of a particular model to observed market prices. The calibrated model can be used to price exotic financial derivatives. However, although the parameters of a given parametric model can be calibrated, it is not clear how good the parametric model itself is. It has been shown in the literature that different parametric models, all calibrated to market data, lead to the same prices of plain vanilla options but lead to different prices for exotic options.

The main goal of the project is to compare the prices of plain vanilla and exotic options calculated from different parametric models. This involves a review of the existing literature and the implementation of simulation methods as well as calibration and pricing algorithms.

Reading:

Schoutens, W. (2003) Levy Processes in Finance: Pricing Financial Derivatives. Wiley.
Schoutens, W. (2004) Exotic Options under Levy Models: An Overview. UCS Technical Report 2004-06, K.U.Leuven, Leuven.
Schoutens, W., Simons, E. and Tistaert, J. (2003) A Perfect calibration ! Now what ? UCS Technical Report 2003-03, K.U.Leuven, Leuven.
Cont, R. and Tankov, P.(2004): Financial Modelling with Jump Processes, Chapman & Hall
Carr, P. and Madan, D. (1998): Option valuation using the fast Fourier Transform, Journal of Computational Finance 2, 61-73

Extent of the computing component: 50%

The supervisor will be away from the University as follows (all dates inclusive):

July 3 - July 7
July 17 – August 4
August 15 - August 21

Project 2.15

WHAT DO YOU DO WHEN YOU HAVE A SMALL NUMBER OF CENSORED DATA?

Supervisor: Takis Konstantopoulos. Number of students: Up to 2-3

The Kaplan-Meier estimator is one of the most important methods for the estimation of a lifetime distribution function in presence of censored data, assuming independent and identically distributed observations. However, this works well when you have lots of data. In practice, this is not the case: when you work for a small company you may not have access to huge sets of mortality data. This project aims at exploring a novel method of what to do in precisely this situation.

How can we improve our understanding of constructing such estimators? The students are expected carry out numerical studies. This is a practical but non-boring project based on my idea which the student is expected to analyse by means of experimentation.

Project 2.16

RISK ASSESSMENT USING CONTINUOUS-TIME MODELS AND CALCULUS

Supervisor: Takis Konstantopoulos. Number of students: 2

I noticed that a lot of problems in assessing risk involve optimisation of certain nature. For instance, if, say, a large pension funds company wants to re-insure, it has to do so at minimal risk. These days, people forget that optimisation is a calculus problem. I would like to offer the possibility, through this project, to look at what classical calculus has to offer to such optimisation problems. Indeed, lots of particular situations are being taught and dogmatically applied, without understanding of what goes on. People are too busy to think that all they are doing is to take a derivative and set it equal to zero--essentially.

Using a continuous-time model of a risk process for the free reserves of an insurance company, is one we may try to explore. The interest here is an accurate estimate of the ruin probability, particularly in the case when this happens as a result a single large claim. How can we deal with such an ``unpredictable'' situation? How can the company itself be insured towards such a catastrophe at minimal risk?

The students will discuss, understand, analyse and apply ideas and modelling techniques.

Project 2.17

LIFE ANNUITIES CALCULATIONS IN THE 18TH CENTURY
Supervisor: Takis Konstantopoulos. Number of students: 1

Before the probability era, people had to deal with the payment of life annuities without using stochastic models. How did they do it? An interesting paper by one the most prolific mathematicians, Leonhard Euler, explains us how. Are these calculations relevant today? What can we say about Euler's data on lifetimes using modern statistical techniques? The student will find in this project, both from a historical and mathematical viewpoints, an interesting application of the techniques they learn in survival analysis and life insurance courses. He/she will be expected to understand, apply, and numerically simulate Euler's data.

Project 2.18

BIAS TESTING IN GRADUATION METHODS
Supervisor: Takis Konstantopoulos. Number of students: 1

A problem that appears in graduation (smoothing) of statistical data of lifetimes is that the model may result to bias. The students learn some statistical tests that detect this bias. This project aims at a deeper understanding of these tests, by means of central limit theorems as well as by approximations by stochastic functions (Brownian bridges). The student is expected to use sampling and central limit theorems in order to find correct and accurate tests.Numerical studies will also be performed.

Project 2.19

FORCE OF MORTALITY AND STOCHASTIC INTENSITY
Supervisor: Takis Konstantopoulos. Number of students: 1 - 2

The force of mortality is a function that describes the probability that a life will end in a small neighbourhood of the observed point, given that the life has not ended thus far. This function is used when lifetimes are assumed to (a) have densities and (b) be statistically independent. When these assumptions (especially the latter one) fail, we resort to a more general concept, known as stochastic intensity.

Understanding and using stochastic intensity methods in survival analysis is the goal of this project. The students are expected to read and discuss relevant papers and carry out simulations.

Project 2.20

MULTIVARIATE NORMAL DISTRIBUTION AND OTHER METHODS IN ACTUARIAL RESEARCH

Supervisor: Takis Konstantopoulos. Number of students: 1 - 2

Actuarial research (in particular, solving insurance problems occurring in practice) has made an enormous progress in the last twenty years. Nowadays one encounters many models and techniques that can be considered as being typically actuarial.

In this project papers on recently developed actuarial models and techniques for life- and/or non-life insurance will be studied. Many models are not only attractive from a theoretical point of view, but also effective in solving insurance problems occurring in the insurance practice. A large component of this project is understanding the effective use of multivariate normal distribution and some non-normal counterparts of it.

The project also involves numerical experimentation.

Project 2.21

TITLE – TO BE ADVISED

Supervisor: Angus Macdonald. Number of students: 1 - 2

It is only relatively recently that life insurance mathematics has been securely anchored in the framework of probabilistic models, first based on random variables then stochastic processes. The taught courses presented a fairly complete picture of random-variable models for very simple problems such as the single-decrement life-death model, but also indicated that intractable difficulties would arise if this approach was attempted for more complex problems, such as a disability model. On the other hand, the treatment of Markov models in the course was (necessarily) incomplete: it was based on probabilities of events without the events themselves being defined in the context of a probabilistic model.

The aim of this project is to write a more complete survey of the subject, in the form of a review of a modest number of journal papers. It will require a firm grasp of the basic ideas of life insurance mathematics and an interest in stochastic processes. There will be no computational work beyond simple examples.

Project 2.22

TITLE – TO BE ADVISED

Supervisor: Angus Macdonald. Number of students: 1 - 2

Recent advances in genetics have raised questions about the use of genetic information in insurance underwriting. If insurers are not allowed to use genetic test results, however, they may face adverse selection - people with adverse test results may be more likely to buy insurance. This possible cost can be quantified using simple Markov models that represent the insurance market as well as the insured person's life history.

The aim of this project is to construct such a model and apply it to critical illness insurance, in the context of a given genetic disorder (there are several possibilities). It will not require any mathematical treatment beyond the life insurance mathematics course. It will require programming beyond the level of Excel to solve differential equations; any language such as Visual Basic or C/C++ would be suitable, or a maths package like Matlab or Maple could be used.

Project 2.23

FITTING PROBABILITY DISTRIBUTIONS TO ACTUARIAL AND FINANCIAL DATA

Supervisor: John Phillips. Number of students: 2

The project is designed for two students to work on together for at least the first half of the time; they would then concentrate on different aspects of the work towards the end. Much of the work will be computer-based, so students choosing this project must already possess good computing skills or be prepared to learn them. The software package to be used in this project is R.

The project will begin with an introduction to R followed by an exposure to examples of the types of data set that it may be appropriate to analyse using this statistical package (e.g. Standard and Poor's 500 Index).

Students will be expected to extend the use of R by writing programs that will allow for the calculation of a collection of goodness-of-fit statistics such as the chi-squared and negative log likelihood tests. The theory behind these tests and their effectiveness should also be well covered in the project.

Project 2.24

THE REGULATED SALE OF LIFE AND PENSION PRODUCTS
Supervisor: Michael Sharp. Number of students: 4

This project would examine particularly the three following areas :-

1. The Review of Personal Pension Policies sold after 1988.
2. Endowment Mortgage Policy Complaints.
(1. and 2. together have already proved massively expensive for many insurance companies)
3. The new National Savings Pension Scheme, proposed in the Turner Report.

For each of these it is suggested that, inter alia, the roles of the government, the FSA, the insurance companies, the financial advisers and of the consumer could be examined. Similarities or differences noticed would be highlighted, together with any lessons to be learned for the future.

This project could serve as a useful introduction into the world of regulation and consumer protection.

Project 2.25

RISK MEASURES UNDER MODERN VOLATILITY MODELS
Supervisor: Ken Siu. Number of students: 3

In recent years, there has been a considerable amount of interest in the development some quantitative tools for financial risk measurement and management due to the demand of these important tools from market practitioners and regulators.

Various tools for risk measurement and management have been introduced and investigated. Value at Risk (VaR) has emerged as a popular tool for risk measures and become the workhorse of risk management practice. In practice, VaR can be computed based on some modern financial time series models for volatility modelling, such as the ARCH/GARCH models and their variants. Risk-Metrics group has developed Risk-Metrics system for implementing VaR models based on some modern econometric models for volatility.

In this project, we will investigate the behaviors of different risk measures, such as VaR and Expected Shortfall (ES), under different specifications of asset price dynamics based on some asymmetric volatility models, such as the GJR-GARCH model, the exponential GARCH (EGARCH) model, and others. We will study these behaviors based on simulation results from different specifications of asset price dynamics. In particular, we will document the consequences for the behaviors of risk measures of various specifications of time-varying volatility models.

Over 75% of this project will involve computing work – students will be required to numerically implement VaR and ES by simulating financial time series models.

The supervisor will be on leave from July 17 to 21, and from the middle of August until the beginning of September.

Project 2.26

HOW SECURE ARE DEFINED BENEFIT PENSIONS?
Supervisor: Andrea Sneddon. Number of students: 2

Every day we see stories in the press about failing pension schemes and lost benefits. This project will consider the plethora of regulation in place to ensure that promised pension benefits are actually received by individuals once they retire. To what extent do the Pensions Acts, Pensions Regulator, Pension Protection Fund, Financial Assistance Scheme etc ensure that workers will receive their occupational pensions? How does the actuary ensure scheme benefits are funded and protected in accordance with their professional responsibilities?

This project will begin with some lectures on defined benefit pension schemes and actuarial funding.

The supervisor will be away from the University from 21 – 29 August.

Project 2.27

STATE PENSIONS FOR AN AGEING POPULATION
Supervisor: Andrea Sneddon. Number of students: Up to 3

Financing the pensions of an ageing population is a problem faced by governments of most developed countries. While the UK Government commissioned the Turner Report in attempt to develop a solution, other countries have their own approach to dealing with the 'pensions time bomb'. This project will compare the pension systems in a number of countries, looking at both structure and financing arrangements, and consider just how robust these systems are in the face of further predicted mortality improvements.

The supervisor will be away from the University from 21 – 29 August.

Project 2.28

DEVELOPING TOMORROW'S ACTUARIES – A GLOBAL PERSPECTIVE

Supervisor: Andrea Sneddon. Number of students: 1

The actuarial profession is going through a time of change as it responds to changing needs from its clients, new legislation and new market pressures. How should these changes influence actuarial education strategy to ensure that we are developing the right type of actuary for the future? To what extent are we seeing a new global emphasis on the development of our profession?

This project will consider the global influences on the actuarial profession, and will involve researching the ways in which the major actuarial bodies are choosing to educate actuaries. We will consider whether alternative paths to qualification impact on the time taken to qualify, the core skills and key strengths of an actuary.

The supervisor will be away from the University from 21 – 29 August

Project 2.29

FINDING ASSETS TO MATCH WITH-PROFITS GUARANTEES

Supervisor: Mark Willder. Number of students: Up to 6

In this project we consider how to find assets which match the guarantees given under with-profits policies. The initial results for this project will be calculated by the whole group. Then each student will individually extend these results to their own application. For example, some students will consider applications of a simple option pricing formula, while students with more experience of Financial Economics 2 will use a binomial tree model.

This project will make considerable use of the spreadsheet package Excel and students should expect to spend around 70% of their time working with Excel.

The project will begin with a number of lectures and Excel training sessions.

As this project will be given for a group it will start with a small number of lectures and labs, so it is important that all students are available from 26 June to start the project.

The supervisor will be away from the University from 17 to 20 July. In addition, the supervisor will be taking some holidays over the summer, but is unlikely to be away for more than a week at a time.

Project 2.30

ANALYSIS OF EXTREMES OF INSURANCE LOSS DATA

Supervisor: Stan Zachary. Number of students: Up to 3

Analysis of extreme value data is challenging because the ultimate aim is to make predictions for regions in which there are relatively few observations. Nevertheless prediction of the distribution of very large claims is of the utmost importance for insurance and re-insurance companies.
(a) Insurers have to be aware of the worst possible outcomes that might happen in a given year.
(b) Reinsurers typically take on e.g. the excess claims over the 95% quantile, so are only interested in the tail of the distribution of claim size.

Traditional methods that fit a complete distribution to the whole of a dataset don't typically do a good job in the tails, and so statistical extreme value theory is used instead. Methodology for i.i.d. univariate observations is fairly well established, but there is considerable interest in how to proceed when these assumptions are perhaps not satisfied, and also in the analysis of multivariate data. This project will explore the analysis of some major insurance loss datasets.

An interest in statistics and computing (via R) is required.