ABSTRACTS

Contents

Stream 1

Industrial Statistics
Organizers : Jeff Wu, William Li

A New Method for Marketing Research and Product Development Based on Choice Modeling and Weighted Regression

Stefano Barone
Chalmers University of Technology and University of Palermo

Abstract

Conjoint analysis and kansei engineering are two areas of marketing research and product development where the methods of industrial statistics are predominant. The former, dating back to the 70's, is essentially the extension of Design of Experiments methodology to cases where the response is given by a human subject. The latter is a newer area where the aim is to develop new products and services with an affective/emotional impact on the potential customer. Here the use of statistical methods is also massive. In both cases (conjoint analysis and kansei engineering) the researcher should pay attention to the psychological and psychometric dimension of the study, being them thoroughly involved.

The motivation of this research lies on the fact that when a respondent is asked to evaluate profiles (scenarios) the response can be affected by special kind of noise factors due to the presence of complex interactions between factors (attributes) and unavoidable multicollinearity. This is especially true when it is not possible to build profiles from a common basis, but it is necessary to rely on profiles already existing on the market. In this case it is necessary for the experimenter to empower the estimation (of significant effects) capability by using a double stage procedure.

The first stage procedure, specifically thought for addressing such problem, is aimed at estimating the attribute relative importance by mathematically modeling the time taken by the respondent in a ranking task. The second stage is a more traditional conjoint survey where the respondent rates the profiles. Finally the relative importance weights estimated in the first stage are utilized to strengthen the predictive capabilities of the regression model adopted to estimate the significant effects (main and interactions) of the experimented attributes.

This methodology has already been successfully tested in several applications from the design of a cell phone to the development of a tourist service. The paper will present the methodology and some of the main application results.

Compliance Testing for Random Effects Models with Joint Acceptance Criteria

Derek Bingham
Simon Fraser University

Abstract

For consumer protection, many governments perform random inspections on goods sold by weight or volume to ensure consistency between actual and labeled net contents. To pass inspection, samples must jointly comply with restrictions placed on the individual sampled items and on average. In this talk the current US National Institute of Standards and Technology joint acceptance criteria is used. Motivated by a problem from a real manufacturing process, an approximation for the probability of sample acceptance is proposed that is applicable for processes with one or more known sources of variation. This approach also allows the assessment of the importance of the sampling scheme of the items.

New Chaotic-Based Statistical Method Applied in Hydrological Data Prediction

Eisa Bozorgzadeh
Iran Water and Power Resources Development Co.

Abstract

Chaotic statistics tries to find order in disordered environments through statistical data analyzing. In this paper chaotic statistics which have been developing by author is explained. A few attributes of chaos theory will be reviewed and common patterns are introduced to represent how data varies. The chaotic statistics is developed based on chaos theory attributes such as universality, self similarity, self organization, and strange attractors. In this regard, some new indexes such as value of statistical series (VSS), value of intervals (VI), cellular average (CA), ranked cellular averages (RCAs) are defined to establish a new platform to analyze statistical series. In chaotic statistics the initial statistical series is supported by a virtual statistical series which has interesting properties. These two series have identical VSS and the virtual statistical series re-discrete the initial one to a number of intervals with the same VSS by using RCAs. In chaotic statistics types of parallelism, symmetry, harmony, and self-similarity enter at statistics series and all unrelated data are related together by VSS and RCAs. Many relationships can be developed between RCAs, VSS, and data either at a statistical series A^n or between two series which belong to common system at different periods including A^n and A^{n+r}. This new concept gives statistician powerful tools to analyze statistical series.

The historical series of hydrological data are selected at karoun3 project which is 2000 MW hydro power station and new data are generated by applying chaotic statistics.

Keywords : chaos theory, chaotic statistics, statistical series, dynamical system, karoun3

Copula Goodness-of-Fit Testing Using Ranks and Subsampling

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Abstract

Modeling dependence is an important issue, specially for risk management: copulas are now a tool of choice for this. So, it is compulsory to check their goodness-of-fit. To address this issue, one can cite for example [1,2]. Nevertheless, these methods suffer some limitations : lack of power for non-positive dependences (for example $Y=X^2+\varepsilon$) for [1], curse of dimensionality for [2].

We propose here a new copula goodness-of-fit testing method, using ranks and subsampling. Let $(\boldsymbol{X}_i)_{i \in \{1, \ldots, N\}}$ be a N-sample of a d-dimensional continuous random variable. We draw m subsamples of size n, without replacement. For the sth subsample, one denotes $\boldsymbol{R}_{(i,n)}^{(s)}$ the d-uple of the ranks of the ith observation among the n observations. We compute, for each $\boldsymbol{r} \in \{1,\ldots,n\}^d$:

$$\hat{\mathcal{P}}_N(r) = \frac{1}{mn} \sum_{s=1}^{n} \sum_{i=1}^{n} 1\left(R(i,n)^{(s)} = r\right)$$

Once we have computed $\hat{\mathcal{P}}_N(r)$, it remains to compute the Kullback-Leibler divergence between this probability distribution and the one we would obtain with the null hypothesis (for example the constant value n-d in the independent case).

A simulation study shows that this method is much more robust with respect to non-positive dependences than the ones studied in [1]. Furthermore, it is much more robust with respect to dimensionality than the methods studied in [2].

Regarding the impact of dimensionality, we provide theoretical study to prove it, using large deviations theory: we state that the test-statistic tail exponent is upper-bounded independently of the dimension. A by-product of this proof is a global bound on the Frechet derivative of P: this result could be useful for the study of finite distance properties of this estimation.

This method was used to test independence of projections on Principal Components in [3].

References

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Pricing Weather Derivatives : An Example from China

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Abstract

Weather has significant effects on many industries and on the whole economy. Weather derivatives provide an important tool for better risk management in many industries affected by weather. This paper is the first study to price temperature based weather derivatives based on the daily temperatures of Chinese cities namely Beijing, Shanghai and Shenzhen. We use a mean reverting Ornstein-Uhlenbeck (OU) process with piecewise constant volatility to model the daily temperatures. Temperature based heating degree days (HDD) and cooling degree days (CDD) options for these cities are priced using the analytical approximation and Monte Carlo simulation methods. A historical burn analysis is also demonstrated to price HDD/CDD call options for Beijing, Shanghai and Shenzhen.

Keywords : Weather Derivatives, Historical Burn Analysis, Monte Carlo Simulation
JEL Codes : G13, C63

Three-Dimensional Quantile Plots and Animated Quantile Plots of the Prediction Variance for Response Surface Designs

Dae-Heung Jang
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Abstract

The traditional methods for evaluating response surface designs are alphabetic optimality criteria. These single-number criteria such as D-, A-, G- and V-optimality do not completely reflect the prediction variance characteristics of the design in question. Alternatives to single-numbers summaries include graphical displays of the prediction variance across the design regions. We suppose Three-dimensional quantile plots and animated quantile plots as graphical displays for evaluating response surface designs.

Giovannitti-Jensen and Myers (1989) proposed variance dispersion graphs to evaluate the overall prediction capacity of response surface designs. This variance dispersion graph uses the maximum, the average, and the minimum prediction variances on concentric spheres inside region of the interest. Khuri et al. (1996) suggested quantile plots of the prediction variance for response surface designs. This quantile plot uses the quantiles instead of the maximum, the average, and the minimum prediction variances on concentric spheres inside region of the interest. We must select several values of radii inside region of the interest and draw several corresponding quantile plots for evaluating the overall prediction capacity of response surface designs. Simply we can the same task using three-dimensional quantile plot as a plot. Robinson and Khuri (2003) proposed the quantile dispersion graphs. We can extend the idea of the three-dimensional quantile plots to the quantile dispersion graphs. As an another extension of quantile plots, we can suggest animated quantile plots. Through animated quantile plots with dynamic sequantial change of radii inside region of the interest, we can evaluate and compare the overall prediction capacity of response surface designs.

Graphical Method for Evaluating Supersaturated Design

Youngil Kim
ChungAng University

Abstract

Orthogonality is an important concept in experimental design. When the number of factors is larger than the number of experimental units, supersaturated design is used sometimes. But this supersaturated design often fails to satisfy the condition of orthogonality, therefore a numerical measure has been used to evaluate the performance how the orthogonality was observed. In this paper we propose various graphical methods for evaluating the degree of orthogonality of the supersaturated design.

[This is a joint work with Daeheung Jang of PuKyung University of Korea.]

Optimal Designs for Discrete Choice Experiments under Model Uncertainty

William Li
University of Minnesota

Abstract

We introduce a class of designs for discrete choice experiments for quality improvement. Optimal designs have been proposed and widely used in discrete choice experiments. As the optimality of such designs is dependent on knowing the specific model form at the design stage, they may not perform well when model-misspecification occurs. We provide several examples, in which an optimal design based on the main-effects only model has limited capability to estimate some two-factor interactions. In practice it is not uncommon when practitioners are uncertain about the form of the true model. Thus, it is important to use discrete choice designs that perform well over a class of possible models. We construct a class of optimal model robust designs for discrete choice experiments in terms of a new criterion called Bayesian Information Capacity. The performance of the proposed designs is assessed in terms of the D_B criterion and relative efficiencies. We show the efficacy of the designs from the standpoint of their level overlap. We conclude the article by showing several applications of discrete choice experiments in the quality area.

Recent Advances in Computer Experiments

Dennis Lin
The Pennsylvania State University

Abstract

This talk attempts to address the fundamental question of "what is a (proper) computer simulation?" Various simulation issues will be discussed, including, bootstrapping (re-sampling), Markov Chain Monte Carlo (MCMC), Statistical Distribution, random number generation, and computer models. Their basic concepts and usefulness will be discussed, no specific algorithm will be given, however.

Second portion of the talk will be focused on design of running computer simulation models. Computer models can describe complicated physical phenomena. However, to use these models for scientific investigation, their generally running times and mostly deterministic nature require a special designed experiments. Recent advances on Latin Hypercube Design, Uniform Design and (First- and Second-Order) Orthogonal Latin Hypercube will be discussed. Slides of his talk can be downloaded at the website http://www.personal.psu.edu/users/j/x/jxz203/lin/Lin_pub/

Perceptions of Government-Linked Companies and Entrepreneurship in Singapore : A Probit Model Analysis of Occupational Choice

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Abstract

Existing empirical studies on self-employed persons examine the factors behind their choice to be an entrepreneur. Other survey work on Singaporeans as a whole capture Singaporeans' perceptions of Government-Linked Companies (GLCs). This paper combines the above-mentioned approaches by analysing both entrepreneurs and non-entrepreneurs and the effect of perceptions of GLCs on individuals' occupational choice in three main areas : competition, entrepreneur profit and access to credit. Applying probability theory through a probit model, it is found that although many Singaporeans have strong perceptions of GLCs, these perceptions of GLCs are not statistically significant in terms of influencing their choice to be an entrepreneur or a salaried worker. Instead, the statistically significant factors are educational background, number of dependents and risk-taking inclination.

Keywords : Probit Model, Government-Linked Companies, Entrepreneurship, Occupational Choice

A Class of Three-Level Designs for Definitive Screening in the Presence of Second-Order Effects

Christopher Nachtsheim
University of Minnesota

Abstract

Screening designs are attractive tools for assessing the relative impact of a large number of factors on a response of interest. Engineers prefer quantitative factors with three levels over two-level factors because having three levels allows for some assessment of curvature in the factor-response relationship. Yet, the most familiar screening designs limit each factor to only two levels. We propose a new class of designs that have three levels, provide estimates of main effects that are unbiased by any second-order effect, require only one more than twice as many runs as there are factors and avoid confounding of any pair of second order effects. Moreover, for designs having six factors or more, our designs allow for the efficient estimation of the full quadratic model in any three factors. We also provide an algorithm for design construction.

[This is a joint work with Ke Wang of Fudan University of China.]

Some Recent Advances on Quaternary-Code Designs

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Abstract

In the recent past, there was a realization that nonregular designs could be utilized in conducting efficient experiments with flexibility, run size economy, and ability to exploit interactions. This led to a growing research on developing a general construction methodology of nonregular designs with good properties. Recent research indicates that designs constructed from quaternary codes (QC) are very promising. The first part of this talk provides a brief introduction on the methodology and supplementary techniques on how quaternary codes can be used from constructing designs. Optimal QC designs under maximum resolution, minimum aberration and maximum projectivity criteria are compared to the comparable minimum aberration regular designs. The second part of this talk provides some recent refinements on the theory and optimization of quaternary-code designs, which leads to some cost-efficient optimal designs with better design properties.

Posterior Exploration for Computationally Intensive Forward Models

Shane Reese
Brigham Young University

Abstract

While standard single-site Metropolis updating proves effective in a variety of applications, it has the drawback of requiring many calls to the simulation model. Here we compare multiple MCMC schemes simulation. We use highly multivariate updates to sample from the posterior: the multivariate random walk Metropolis algorithm and the distributed evolution-MCMC sampler. Such schemes are alluring for computationally demanding inverse problems since they have the potential to update many components at once, while requiring only a single evaluation of the simulator. We consider new formulations based on faster, approximate simulators created by altering the multi-grid solver used in the simulator. Additionally, we explore MCMC approaches for sampling from the posterior based on coarse approximations to the expensive computational forward model. We illustrate the methodology on an Electrical Impedance Tomography application.

Multiobjective Optimization of Expensive Black-Box Functions via Expected Maximin Improvement

Thomas Santner
Ohio State University

Abstract

Many practical engineering design optimization problems contain multiple objective functions that are time-consuming to evaluate. One approach to optimize such a system is to model the expensive functions as draws from a Gaussian process (GP) and then maximize an expected improvement function in an iterative fashion to generate the Pareto front. This talk introduces two advances within the GP framework. First, we propose a new improvement function based on a modification of the maximin fitness function. For this improvement function, an analytic expression of the expected improvement function is derived in the biobjective case. Second, we use a nonseparable dependence structure for the interpolating Gaussian process that treats the responses as possibly dependent and uses the data to estimate the strength of dependence; this is meant to improve the accuracy of the prediction. Several examples will be presented to compare the proposed methodology with previously proposed statistical improvement criteria for multiobjective optimization problems.

[This is a joint work with Josh Svenson.]

Corporate Social Performance : A Burden or a Bonus for the Shareholder?

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Bouchra M'Zali
University of Quebec in Montreal

Abstract

The relation between corporate social performance (CSP) and corporate financial performance (CFP) has often been a popular field of study over the past two decades. The results, while broadly conclusive of a positive relation, are not entirely consistent. On one hand, a substantial number of studies such as Frooman, (1997) and Ruf and al. (2001) find a positive relation between corporate social performance and financial performance. On the other hand, several studies such as Vance, (1975) and Moore, (2001) find a negative relation. Nevertheless, researchers agree on the fact that a better comprehension of this relation would be a valuable tool to managers and shareholders in their process of decision making.

As pointed out by Griffin and Mahon (1999), the inconsistency of the results seems to be caused not only by the different financial performance measures used in prior studies but also by the methodological problems.

The objective of this study is to analyze whether corporate social performance is related to financial performance. This paper consists of a portfolio study in which we tend to overcome some of these issues by using Kinder, Lydenberg and Domini (KLD) database and our analysis through different industries. Considering multiple dimensions of corporate social responsibility, KLD provides social ratings for a relatively large number of U.S. corporations in various industries. Based on these ratings, our study focuses on the existence of a relation between CSP and CFP. If the relation exists, we verify whether it consists of a positive relation (long-run premium) or negative (penalty) for holding socially responsible companies. Therefore, our first contribution in this paper is the fact that considering CSP as a multi-dimensional concept as suggested by Stanwick and Stanwick (1998), we suppose that investors consider and grant the same level of importance to each and all of these dimensions in their decision concerning their investments.

Our second contribution consists of our analysis of social-financial relation through different industries. Griffon and Mahon (1999) suggest that industry is a particularly important factor which deserves more consideration in the studies on the relation between CSP and CFP. This suggestion is confirmed by Dewall and al. (2005) who showed that the relation between CSP and CFP seems to be industry-sensitive.

The results show that socially high-ranked portfolios provide, in most cases, higher average returns than their low-ranked counterparts over the 1995-2006 period. This difference of performances can not be explained by investment style.

The results also show that the relation social-financial performance depends also on the economic cycle and consequently, the market performance. Socially responsible investments seem to be more popular during bearish market periods and less popular during bullish market periods. Finally, our results suggest that in some industries, the differences of performances are more significant than the others. In other words, the relation social-financial performance seems to be considerably affected by the nature of firms' activities. Therefore, this paper argues that industry is an important factor that should be taken in consideration in studies on the relation between social and financial performance.

Estimation in High-Dimensional Linear Models with Deterministic Designs

Jun Shao
University of Wisconsin

Abstract

Because of the advance in technologies, modern statistical studies often encounter linear models with the number of explanatory variables much larger than the sample size. Estimation in these high-dimension problems with deterministic explanatory variables or design matrices is very different from those in the case of random explanatory variables, due to the identifiability of the high-dimensional regression parameter. We show that a reasonable approach is to carry out estimation using the projection of the regression parameter into the linear space generated by the design matrix. We consider a thresholded ridge regression estimators for estimation. The proposed procedure has an explicit form and is easy to apply. Asymptotic properties such as consistency and rate of convergence of the mean squared error are established under some sparsity conditions for high-dimensional regression parameter. A simulation is also conducted to examine the performance of the proposed method.

Recent Research on Healthcare and Public Health Surveillance

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Georgia Institute of Technology
Department of Manufacturing Engineering and Engineering Management
City University of Hong Kong

Abstract

Due to recent pandemic outbreaks and continuing bioterrorism threat, research efforts on healthcare and public health surveillance have become very important worldwide. In this talk we will explain and classify the various types of health surveillance problems. We review the latest research in surveillance systems, monitoring methods, and performance measures. We also discuss the research challenges and illustrate them with various problems and examples. In particular, we will compare the performance of scan methods and CUSUM charts for temporal and spatiotemporal surveillance.

Statistical Quality Techniques Applied to Service Industry

Fugee Tsung
The Hong Kong University of Science and Technology

Abstract

Driven by a new business environment including globalized economy, business automation, and business and technology innovations, the service sector keeps growing and now accounts for more than 50 percent of the labor force in the developed economies. It reaches as high as 80 percent in the United States and the United Kingdom. With the shift in economic focus from manufacturing to service, industrial and academic research facilities may need to apply more scientific rigor to the practices of service, such as discovering better methods to use statistics and mathematical optimization to increase quality, productivity, and efficiency to meet the challenges. This talk will focus on the development of statistical quality techniques, and discuss several technical challenges and recent extensions to the service engineering research area.

A Study on the Effects of Skewed Distributions on the Performances of the Max-EWMA and Max-GWMA Charts

Teh Sin Yin and Michael Khoo Boon Chong
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Universiti Sains Malaysia

Abstract

The Max-GWMA (called the Maximum Generally Weighted Moving Average) chart is superior to the Max-EWMA (called the Maximum Exponentially Weighted Moving Average) chart for simultaneously monitoring the process mean and/or variability. These charts require fulfilling the usual assumption in Statistical Process Control (SPC), i.e., the distribution of the process is normal or approximately normal. The main objective of this study is to conduct a comparative study of the performances of the single Max-GWMA and Max-EWMA charts, for skewed populations. A Monte Carlo simulation is conducted using the Statistical Analysis Software (SAS) to study and compare the Average Run Length (ARL) performances of various magnitudes of mean and/or variance shifts for different levels of skewnesses. The skewed distributions considered are the lognormal and gamma distributions. The results showed that the Max-GWMA chart requires less time to detect shifts in the process mean and/or variance than the Max-EWMA chart, for all levels of skewnesses.

Keywords : ARL, EWMA chart, GWMA chart, single control chart, skewed distributions.

A General Minimum Confounding Theory for Factorial Designs

Runchu Zhang
Nankai University and Northeast Normal University

Abstract

In this talk, a general minimum confounding (GMC) theory for fractional factorial designs and its recent developments will be introduced. For regular 2^{n-m} designs, Zhang, Li, Zhao and Ai (2008) introduced an aliased effect-number pattern (AENP) and based on the AENP proposed a general minimum lower order confounding (denoted by GMC for short) criterion. It was indicated that under the situations that experimenters have a prior about importance ordering of factors in experiments the GMC designs are the best choice. The theory based on the AENP is called a general minimum confounding (GMC) theory. This theory holds the promise of the development of a united theory encapsulating the existing criteria, since all the existing criteria, including minimum aberration (MA), clear effects (CE), maximum estimation capacity and GMC itself, are determined by some specific function of AENP. Also, the GMC theory is flexible enough to allow appropriate strategies for finding optimal designs in specific contents depending on the needs of the experimenter. For example, suppose an experimenter requires an optimal design with minimum middle-order confounding, say 4th order, in some chemical experiment.

In the recent three years, the new theory has been quickly developed. Zhang and Mukerjer (2009a) studied the GMC criterion with general s-level. Zhang and Mukerjer (2009b), Zhang, Wei and Li (2009) and Zhang, Li and Wei (2010) established GMC blocking theories for regular factorial designs with different blocking situations respectively. Zhang and Cheng (2010) revealed that the MA design has an averagely not individually minimum lower-order confounding property, which indicates that the MA designs should be better for the case that experimenter has no a prior on importance ordering of factors.

A most recent finished work is on the construction of GMC 2^{n-m} designs. The three papers Li, Zao and Zhang (2010), Zhang and Cheng (2010) and Cheng and Zhang (2010) mathematically constructed all the GMC 2^{n-m} designs with $N/4 + 1 \leq n \leq N - 1$, where N is run number and n is factor number, and the results are simple and easy for use. Hu and Zhang (2009) proved that GMC designs must minimize A3 in the wordlengh pattern and found out the uniquely best confounding structure between main effects and 2fi's. Wei, Yang, Li and Zhang (2010) established a two-level GMC-FFSP criterion for ranking split-plot designs. All the optimal 32-run split-plot designs up to 14 factors were given.

Joint Estimation of Multiple Graphical Models

Ji Zhu
University of Michigan

Abstract

Gaussian graphical models explore dependence relationships between random variables, through estimation of the corresponding inverse covariance matrices. In this paper we develop an estimator for such models appropriate for data from several graphical models that share the same variables and some of the dependence structure. In this setting, estimating a single graphical model would mask the underlying heterogeneity, while estimating separate models for each category does not take advantage of the common structure. We propose a method which jointly estimates the graphical models corresponding to the different categories present in the data, aiming to preserve the common structure, while allowing for differences between the categories. This is achieved through a hierarchical penalty that targets the removal of common zeros in the inverse covariance matrices across categories. We establish the asymptotic consistency and sparsity of the proposed estimator in the high-dimensional case, and illustrate its superior performance on a number of simulated networks. An application to learning semantic connections between terms from webpages collected from computer science departments is also included.

[This is a joint work with Jian Guo, Elizaveta Levina, and George Michailidis.]

Stream 2

Biostatistics
Organizers : Jianguo Sun, Xingqiu Zhao

A Random-Sum Wilcoxon Statistic and Its Application to Analysis of ROC and LROC Data

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Abstract

The Wilcoxon-Mann-Whitney statistic is commonly used for a distribution-free comparison of two groups. One requirement for its use is that the sample sizes of the two groups are fixed. This is violated in some of the applications such as medical imaging studies and diagnostic marker studies; in the former, the violation occurs since the number of correctly localized abnormal images is random, while in the latter the violation is due to some subjects not having observable measurements. For this reason, we propose here a random-sum Wilcoxon statistic for comparing two groups in the presence of ties, and derive its variance as well as its asymptotic distribution for large sample sizes. The proposed statistic includes the regular Wilcoxon statistic. Finally, we apply the proposed statistic for summarizing location response operating characteristic data from a liver computed tomography study, and also for summarizing diagnostic accuracy of biomarker data.

Area under ROC Curve Type Measures without Binary Gold Standard

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Abstract

The receiver operating characteristic (ROC) curve is a very useful tool in analyzing diagnostic/classification power of instruments/classification schemes as long as a binary-scale gold standard is available. The importance of ROC curve has been intensively studied by many authors, which can be easily found in the literatures and textbooks such as Pepe (2003) and Krzanowski and hand (2009). However, if the gold standard is continuous and there is no confirmative threshold for it is available, then the traditional ROC curve analysis cannot be applied. Hence, we propose a new measure, which extends the ROC curve based index, for identifying variables with good potential to be used in a diagnostic scheme. The estimate of the proposed index and its asymptotic property is studied. In addition, we propose a threshold gradient descend based algorithm for finding the best linear combination of variables that maximizes this new measure, which is applicable even when the number of variables is huge. Under the joint multivariate normality assumption, the algorithm for the linear combination can be relied on the LARS method. When this joint normality assumption is violated, we propose a threshold gradient descend based method (TGDM) to find the optimal linear combination. Thus, our algorithms also inherit the nice properties of LARS and TGDM when dealing with the high dimensional and variable selection problems. The performance of the proposed method is illustrated using both synthesized and real data sets.

Frailties Share and Correlate, Copulas Divide and Unite

Luc Duchateau
Ghent University

Abstract

Correlated survival data occur in diverse disciplines such as medicine (human and veterinary), economics, agronomy and social sciences. Appropriate survival analysis techniques need to take into account the correlation structure in the data. Different proposals have been formulated, e.g., marginal models, fixed effects models, stratified models, frailty models, copula models (for a detailed overview, see Duchateau and Janssen (2008), Chapter 3). Frailty models and copula models share the property that they provide estimates of the correlation. The correlation parameter contains essential information, especially in heritability studies, where it leads to an estimate of the heritability coefficient. In this paper, we focus on the frailty model and the copula model. Different types of frailty models are available: the shared fraity model, the univariate frailty model and the correlated frailty model. The links between these different models are unclear, and the techniques used to estimate model parameters differ between the different models often for no obvious reasons. Furthermore, it is often stated in literature that for a specific frailty model there exists a corresponding copula, e.g., the gamma frailty model is often associated with the Clayton copula. To get a better insight in the modeling of correlated survival data we propose a general and unified framework in which the different models can be compared. We show that

- Identifiability problems exist both in correlated and shared frailty models
- In a correlated frailty model, overdispersion must be present in order to accommodate correlated data
- Only under very specific circumstances, i.e., gamma frailty model with Weibull baseline hazard, the (Clayton) copula leads to exactly the same results (Goethals et al., 2008)

We further investigate the properties and sensitivity of the different models through simulations. All these models heavily depend on the assumed baseline hazard assumptions. In the case of incorrect specification, the estimated correlation and overdispersion parameters do not make sense. It is therefore essential in analysing clustered survival data to compare different alternative models and investigate through diagnostic tools and AIC which one describes the data best.

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Uncovering Symptom Progression History from Large Disease Registries, with Application to Young Cystic Fibrosis Patients

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Abstract

The growing availability of population based disease registry data has brought precious opportunities for epidemiologists to understand the natural history of chronic diseases. It also presents challenges to the traditional data analysis techniques due to the multistate nature of the data, including complicated censoring/truncation schemes and the temporal dynamics of covariate influences. In a case study of the Cystic Fibrosis Foundation Patient Registry, we propose analyses of progressive symptoms using temporal process regressions, as an alternative to the commonly employed proportional hazards models. Such regression enables flexible nonparametric analyses of key prognostic factors. Two endpoints are considered: the prevalence of ever positive and curently positive for Pseudomonas Aeruginios (PA) infection. The analysis of ever PA positive via a time-varying coefficient model demonstrates the lack of fit as well as the potential loss of information in a standard proportional hazards analysis. The analysis of currently PA positive is novel and yields clinical insights not directly available from proportional hazards models. Key findings include that the benefits of neonatal screening on patient outcomes attenuate over time and that cohorts may demonstrate different patterns of PA, which may be explained in part by changes in patient management. The simplicity of the proposed time-varying inferences reduces the computational burden considerably over alternative time-varying regression strategies, which may be prohibitive in large datasets.

Information in Adaptive Optimal Design with Emphasis on the Two Stage Case

Nancy Flournoy
University of Missouri-Columbia

Abstract

In 1963, Box and Hunter, followed by many others, recommended selecting sequential treatments to maximize the increment of some information measure (e.g., the determinant of the Fisher information matrix). To explore the accrual of information in adaptive designs, we study a basic one parameter nonlinear regression model with additive independent normal errors. The stage 1 treatment is taken to be fixed, the treatment allocation rule for stage 2 is taken to be a unique function of maximum likelihood estimates derived from stage 1 data. Although conditioning on the design is common in data analyses, we show in this scenario, that conditioning on the stage 2 treatment is equivalent to conditioning on the stage 1 data. This raises questions about the role of conditioning in the analysis of adaptive designs. We also explore the efficiency conducting studies in stages and the effect of allocating different proportions of subjects to stage 1 versus stage 2.

A Joint Model for Analysing Longitudinal Count Data and Event History Data with Application in Clinical Trials

Ali Reza Fotouhi
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University of the Fraser Valle

Abstract

In some applications, such as clinical trials, data include information on four processes : recurrent events, duration between recurrences, number of recurrences, and follow-up time. Generally, recurrent events and duration between recurrences are related and number of recurrences and follow-up time are correlated. Many studies have been done to analyze these processes separately. A few studies have referred to the case that these processes may be dependent. In this article, we introduce and propose the use of joint modeling instead of separate modeling to account for possible correlation. We model the correlation between the recurrent events and the duration between recurrences through a random component. Also the correlation between the number of recurrences and follow-up time is modeled through a random component. The proposed models are applied to bladder cancer data.

Both separate and joint models indicate that there is a significant reduction in the incidence of bladder cancer associated with the use of thiotepa whereas the effectiveness of pyridoxine is not supported by anyone of these models. In addition, patients with a larger number of tumours when bladder cancer was first diagnosed suffer from significantly more tumour recurrences.

Separate modeling of the number of tumours per interval shows that both treatments are significant in reducing the number of tumours at early recurrences. However, the joint modeling of the number of tumours per interval and the durations between the tumour recurrences shows that only thiotepa is significant at early recurrences in reducing the number of tumours. The results from both separate and joint models indicate that patients receiving thiotepa treatment have larger mean time between recurrences at early recurrences. In both models the effect of the logarithm of the lagged count is estimated significantly positive. This indicates that patients with a larger number of tumours removed in each visit suffer from significantly more number of tumours in the next visit. Particularly, patients with a larger number of tumours when bladder cancer was first diagnosed suffer from significantly more number of tumours in the first visit.

Fisher Information in Type II Censored Samples from Two Bivariate Exponential Distributions and Applications

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Southwestern University of Finance and Economics
H. N. Nagaraja
Department of Statistics
The Ohio State University

Abstract

We obtain expressions for the elements of the Fisher information matrix (FIM) for the three parameters of the Downton's bivariate exponential (DBVE) distribution for Type II right and left censored samples. We describe how these can be used to find the FIM in arbitrary Type II doubly censored samples. We evaluate the FIM for various values of the dependence parameter and sample sizes, and determine its limiting form as the sample size increases. We discuss implications of our findings to inference based on small and large samples from the DBVE parent. We also conduct a similar study for the Marshall-Olkin bivariate exponential distribution and compare the results for the two BVEs.

Keywords : Fisher information matrix, Downton's bivariate exponential distribution, Marshall-Olkin bivariate exponential distribution, Type II right censored sample, Type II left censored sample.

Multivariate Density Estimates Using Geometric Methods

Leonard B. Hearne
University of Missouri-Columbia

Abstract

In this talk I focus on two geometric density estimators. These estimators use the Delaunay tessellation or its geometric dual, the Voronoi diagram, to partition the support for an estimator into tiles. The proportion of probabilistic mass from observations on each tile divided by the content of the tile is used to estimate the probability density on each tile. Under suitable regularity conditions, geometric density estimators can be shown to be consistent multivariate estimators. For both types of tessellations, the level of density specificity is proportional to the number of tiles in the tessellation.

Bounds on the cardinality of these tessellations were presented by Klee in 1980. We present a significant refinement of these bounds.

To refine a density estimate, re-sampling methods can be employed. This partitions the support for the estimator into successively smaller tiles. With both the Voronoi and Delaunay tessellations the resulting refined density estimator is biased. By truncating the Voronoi tiles generated by points on the convex hull or by allowing some probability mass to be allocated beyond the convex hull in a Delaunay tessellation, these refined density estimators can be made unbiased.

This work has application in a broad class of multivariate estimation settings where geometric methods can be employed.

Handling Incomplete Observations with Supplementary Information

X. Joan Hu
Simon Fraser University

Abstract

Incomplete observations arise in many studies. Examples include missing data, censored data and truncated data. Problems such as measurement errors and latent variables may also be included as special cases, if we take incomplete observations more generally to mean that the available data lack desired information. We present a formulation for incomplete observations, which extends the notion of coarsening and incorporates truncation. The general framework allows us to uniformly investigate many incomplete data structures from observational studies or survey samplings and the associated inference methods, and to motivate new approaches to dealing with new types of incompleteness. Further, in many practical situations, additional information is readily available or easily collected by design from the same study or from different information sources. The additional information may be in the form of knowledge and/or data on one or both components of the underlying incomplete data model. We explore the usefulness of various supplementary information in identifying the incompleteness mechanism, improving inference efficiency and reducing computational intensity. Examples from public health are used for illustration.

Cross-Sectional Observations of Simple Counting Processes

Nicholas P. Jewell
University of California-Berkely

Abstract

Cross-sectional observations on counting processes stimulate a number of tantalizing questions. I will focus on the general idea concerning whether screening data information on intermediate stages can improve estimation--and by how much--on time-to-event questions regarding later or final stages, and vice-versa. A motivating example concerns estimation of HIV incidence based on concurrent test results from a standard ELISA and a negative detuned version of the same test. Here, interest focuses on the time until the first event when there is information on the second event at the time of testing. Other questions in this context include determination of optimal waiting times between events if that is under the control of the investigator. I will survey some past approaches to these kind of questions, and discuss some current work in progress that is joint with Karen McKeown.

A New Hybrid Estimation Method for Censored Quantile Regression

Mi-Ok Kim
Division of Biostatistics and Epidemiology,
Cincinnati Children's Hospital Medical Center
Department of Pediatrics, University of Cincinnati College of Medicine

Abstract

Quantile regression (QR) is a well established regression methodology that admits more than a location-shift or constant effect for each covariate (see Koenker (2005) for an overview). A quite common example of such interesting data heteroscedasticity present in censored data is crossing survival curves. Censored QR has appeared as an alternative tool that complements the Cox proportional hazard model. It is, however, underutilized, as we lack an estimation method that is not constrained by stringent assumptions among other things. Early approaches either required a strong censoring mechanism or imposed a "nearly homoscedastic" restriction (e.g. Ying, Jung and Wei, 1995; Yang, 1999). Recent developments (Portnoy, 2003; Peng and Huang, 2008; Wang and Wang, 2009) have succeeded in admitting both heteroscedastic errors and conditionally independent censoring mechanism. However, they impose their own restrictive requirements that are particularly constraining in a variable selection or regularized estimation setting. We propose a new estimation method that overcomes the limitations of the existing methods while still admitting both heteroscedastic errors and conditionally independent censoring mechanism. The proposed idea is also applicable to the accelerated failure time (AFT) model.

Efficient Estimation of Censored Linear Regression Model

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Yuanyuan Lin
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The Hong Kong University of Science and Technology

Abstract

In linear regression or accelerated failure time model, with or without censoring, the method of efficient estimation has long been overlooked. The popular estimation methods are the least squares, Wilcoxon-Mann-Whitney type rank methods and their counterparts in the presence of censoring: Buckley-James, log-rank and Gehan's methods. The main reason is that the efficient estimation has complications arising from multiple roots of the efficient score and density estimation. In particular, when smoothing is involved, uncertainty about the choice of bandwidth is inevitable. This paper proposes a one-step efficient estimation method based on counting process martingale which has several advantages. It avoids the multiple root problem. The initial estimator is easily available. The proposed method is easy to implement numerically with a built-in inference procedure. The requirement on bandwidth is rather loose and less restrictive than that imposed in Zeng and Lin (2007). The resulting estimator is proved to be semiparametric efficient with asymptotic variance the same as the efficient estimator when assuming the error distribution is known up to a location shift. Asymptotic properties of the proposed method are justified and the asymptotic variance matrix of the regression coefficients is provided in a closed form. Numerical studies with supportive evidence are presented. Applications are illustrated in two well known medical studies.

A Min-Max Combination of Biomarkers to Improve Diagnostic Accuracy

Chun-ling Liu
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The Hong Kong Polytechnic University

Abstract

Diagnostic accuracy can be improved considerably by combining multiple biomarkers. Although the likelihood ratio provides optimal solution to combination of biomarkers, the method is sensitive to distributional assumptions which are often difficult to justify. Alternatively simple linear combinations can be considered whose empirical solution may encounter extensive computation when the number of biomarkers is relatively large. Moreover, the optimal linear combinations derived under multivariate normality may suffer substantial loss of efficiency if the distributions are apart from normality. A new approach was presented which linearly combines the minimum and maximum values of the biomarkers. Such combination only involves searching for a single combination coefficient that maximizes the area under the receiver operating characteristic (ROC) curves and is thus computation-effective. Simulation results show that the min-max combination may yield larger partial or full area under the ROC curves and is more robust against distributional assumptions. The methods are illustrated using the growth-related hormones data from the Growth and Maturation in Children with Autism or Autistic Spectrum Disorder.

Instrumental Variable Estimation in Measurement Error Model under Exact Restrictions

Shalabh
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Indian Institute of Technology Kanpur

Abstract

The problem of consistent estimation of regression coefficients in a measurement error models can be overcome only when some additional information is available from some external sources. When such information is not available, then instrumental variable approach provides a solution to obtain the consistent estimators of regression coefficients. Moreover, in many situations, some restrictions on the parameters are imposed which can be expressed in the form of exact linear restrictions. The usual instrumental variable estimator of regression coefficients will not satisfy the exact restrictions. How to use the instrumental variable approach in measurement error models when regression coefficients are subjected to exact linear restrictions is the subject matter of this talk. Some consistent estimators of regression coefficients based on instrumental variable approach are obtained which satisfy the restrictions also. Their asymptotic properties are studied without assuming any specific form of the distribution of measurement errors and other random term in the model. A simulation study is conducted to study the finite sample properties and to compare the efficiencies of the proposed estimators.

Analysis of Recurrent Event Studies with Incomplete Information and Complex Structure

Jianguo Sun
University of Missouri-Columbia

Abstract

This talk discusses the analysis of recurrent event studies in which only incomplete information is available and the observation process may be informative. Specifically, we consider panel count data, which often occur in many studies concerning the occurrence rates of certain recurrent events of interest. For this, most of the existing statistical approaches assume that the observation process is independent or noninformative about the underlying recurrent event process of interest. In many situations, however, this may not be true or realistic. That is, the observation process may depend on or be related with the recurrent event process. This talk discusses some inference problems related to such panel count data.

Testing Independent Censoring for Longitudinal Data

Yanqing Sun
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University of North Carolina at Charlotte
Jimin Lee
Department of Mathematics
University of North Carolina at Asheville

Abstract

A common problem associated with longitudinal studies is the dropouts of subjects or censoring before the end of follow-up. In most existing methods, it is assumed that censoring is noninformative about missed responses. This assumption is crucial to the validity of many statistical procedures. We develop some nonparametric hypothesis testing procedures to test for independent censoring in the absence/presence of covariates. The test statistics are constructed by contrasting two estimators of the conditional mean of cumulative responses for each stratum of covariate space from sample subsets with different patterns of censoring. Our method does not require the modelling of longitudinal response processes, therefore is robust to model misspecifications. A diagnostic plot procedure is also developed that can be used to identify dependent censoring to certain covariate strata. The finite sample performances of the tests are investigated through extensive simulation studies. The potential of our methods is demonstrated through the application of the tests to a chronic granulomatous disease study.

Recent Advances for Non-randomized Response Techniques : The Parallel Model, A Variant and An Extension

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The University of Hong Kong

Abstract

Since the randomized response model to solicit sensitive information was proposed by Warner in 1965, it has been used in a broad range of statistical applications for surveys involving sensitive questions. However, the Warner model is limited in several ways including (i) a lack of reproducibility; (ii) a lack of trust from the interviewees; (iii) a higher cost due to the use of randomizing devices; and (iv) narrow range of applications. Recent developments of the non-randomized approach have shown the promise to alleviate or eliminate these limitations. Following a brief introduction of the Warner model and other randomized response model, we review the non-randomized crosswise model and the non-randomized triangular model. However, the crosswise and triangular models cannot be applied to situation where both {Y=0} and {Y=1} are sensitive. In addition, the triangular model still has a lower efficiency for some cases. Therefore, this article proposes a new non-randomized response model called the parallel model and corresponding statistical analysis methods. Theoretical and numerical comparisons show that the randomized parallel model is more efficient than the triangular model for some cases. A variant of the parallel model and a multi-category parallel model are also developed.

Classification of Exome-scan Genotype Data by an Algorithm of Screening and Detecting Interactions Among Variables with Present of Rare Variant Effect

Haitian Wang[*]*, Chien-Hsun Huang, Shaw-Hwa Lo, Tian Zheng, Inchi Hu*
[*]*The Hong Kong University of Science and Technology*

Abstract

We develop a classification method that incorporates epistasis and genetic interaction to analyze simulated exome-scan genotype data provided by GAW17 with 24,487 snps and 697 individuals. The information about epistasis and genetic interaction is incorporated by identifying snp clusters that display significant influence on the phenotype as measured by an influence score calculated from the data. A collapsing method is use to aggregate rare variant's effect and is used together with common variants for prediction. Bagging is used to handle imbalanced case and control present in the data set, and final prediction is carried out by logistic regression and boosting algorithm.

Efficient Estimation in Multi-phase Case-Control Studies

Chris J. Wild
Department of Statistics
University of Auckland

Abstract

In a recent paper (Lee, Scott & Wild, Biometrika, 2010), we developed efficient methods for fitting regression models to multi-phase case-control data in the special case where all covariates, apart from those measured in the final phase, are categorical. The method can be implemented by taking a linear combination of the estimating equations obtained by applying conditional maximum likelihood (see Breslow & Cain, Biometrika, 1988, 11-20) to the completely-observed units and equations similar to those used in calibrating (see Sarndal, Survey Methodology, 2007, 99-119) the sampling weights to quantities known for the partially-observed units. We can extend this procedure to get very good procedures for situations where implementable optimal solutions are not available, for example when continuous covariates are measured in earlier phases or when we have appreciable non-response.

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Phase II Trial Design with Bayesian Adaptive Randomization and Predictive Probability

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The University of Hong Kong

Abstract

We propose a randomized phase II clinical trial design based on the Bayesian adaptive randomization and predictive probability (BARPP) monitoring. Adaptive randomization assigns more patients to a more efficacious treatment arm by comparing the posterior probabilities of the efficacy between different arms. We continuously monitor the trial using the predictive probability. The trial is terminated early when it is shown that one treatment is overwhelmingly superior to others or that all the treatments are equivalent. We develop two different methods to compute the predictive probability by considering the uncertainty of the sample size of the future data. We illustrate the proposed BARPP design using a phase II lung cancer clinical trial, and conduct extensive simulation studies to examine the operating characteristics of the design. By coupling adaptive randomization and predictive probability approaches, the trial can treat more patients with a more efficacious treatment and allow for early stopping whenever sufficient information is obtained to conclude treatment superiority or equivalence. The proposed design is efficient, flexible, and ethical. It controls both type I and type II errors and compares favorably with frequentist designs in terms of patients' responses and flexibility of the design.

[This is a joint work with Nan Chen and J. Jack Lee at the University of Texas M. D. Anderson Cancer Center.]

Nonparametric Tests for Panel Count Data

Xingqiu Zhao
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The Hong Kong Polytechnic University
School of Statistics and Mathematics
Zhongnan University of Economics and Law

Abstract

This talk considers the problem of multi-sample nonparametric comparison of counting processes with panel count data, which arise naturally when recurrent events are considered. Such data frequently occur in medical follow-up studies and reliability experiments, for example. For the problem considered, we construct two new classes of nonparametric test statistics based on the accumulated weighted differences between the rates of increase of the estimated mean functions of the counting processes over observation times, wherein the nonparametric maximum likelihood approach is used to estimate the mean function instead of the nonparametric maximum pseudolikelihood. Furthermore, we propose a new class of nonparametric test procedures that allow different observation processes. The asymptotic distributions of the proposed statistics are derived and their finite-sample properties are examined through Monte Carlo simulations. The simulation results show that the proposed methods work quite well and are more powerful than the existing test procedures. Two illustrative examples are provided.

[This is a joint work with N. Balakrishnan (McMaster University) and Jianguo Sun (University of Missouri-Columbia)]

Stream 3

Financial Statistics
Organizers : Heung Wong, Cedric Yiu

Engineering for Whom?
Evidence in Retail Structured Equity Products

Dong-Hyun Ahn[*]*, Young-Min Choi, Young-Sik Kim and Won-Suk Liu*[*]
[*]*Department of Economics, Seoul National University*

Abstract

This paper explores three types of risk that unsophisticated retail investors may be exposed to when purchasing a structured product. First, the retail investors who are not sufficiently knowledged about derivatives bear knowledge asymmetry risk against the issuer. Not many investors understand the valuation model of derivatives embedded in the structured products they purchase. Even in the case that they understand the model, they are not knowledgeable enough to gauge the fairness of input parameters required and may overpay. Secondly, the retail investors are exposed to information asymmetry against the issuer. The issuer can optimally time the issuance of overvalued structured products given their superior information set and also determine structural parameters to maximize potential profits. Finally, unwinding a delta hedge position of the issuer puts negative pressure on the underlying security price to their disadvantage at redemption dates. If the retail investors were sophisticated enough to infer such incentives of the issuer, such risk should be factored into the price of the structured product at its issuance. We build up a theoretical model for gauging the amount of required discount. In addition, we provide empirical evidence for issuance timing behavior of the issuer and for negative price impact of unwinding hedge positions around redemption dates by using Two Asset Reverse Convertibles (TARCs) in Korea.

Keywords : Structured Equity Products, Embedded Derivatives, Information Asymmetry, Delta Hedge

Further Evidence of Turn-of-the-month Effect on Returns and Volatility in Asian Stock Indices

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Abstract

This paper investigates the existence of turn-of-the-month effect in stock indices of six Asian markets. Daily data from January 1995 to June 2010 are used with the estimates for month-end and mid-month are obtained from an Exponential GARCH model. The analysis provides empirical evidence that the turn-of-the-month effect exists significantly on the returns of stock indices in Malaysia, Hong Kong, China, Korea and Taiwan over the 16-year period. The results also show that returns volatility is higher at month-end as compared to mid-month except for China stocks. Interestingly, although returns volatility is higher at month-end, the turn-of-the-month effect is not significantly observed for stock index in Japan. Further analysis shows that the turn-of-the-month effect does not exist significantly in all the indices over shorter periods and thus reducing the possibility of consistently obtaining higher returns from systematic trading.

Keywords : Turn-of-the-month effect, EGARCH, Efficient market hypothesis

Minor Declines in Price as a Probable Precursor to Price-drop Events : An Extension of the ACD Model

Hui-Chih Chai
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Abstract

The purpose of this study is to investigate probable precursor to extreme decline in stock price (called here price-drop event). Building on evidences of clustering in price-drop events, empirical results of this study indicate that minor declines in stock price also conveys information about arrival time of price-drop event. Thus, a simple but meaningful extension of ACD model is proposed in the present article. The extended ACD model maintains the major advantage of Engle and Russell (1998)'s model, the arrival time of price-drop event can be predicted using irregular events which extracted from regular daily return, any auxiliary data except daily return can be included but not necessary in this framework. The evidence from three stock indices in the US market shows that higher intensity of minor price declines induces price-drop event to occur earlier. The arrival time of price-drop event can be used to measure the probability of price-drop. Thus, empirical findings shown in this study could be of use to any participates in financial risk management.

Keywords : irregular spaced time series data, ACD model, price-drop event, dependent point process, risk management.

Forecasting Tail Risk in Financial Time Series Using a Mixture of Distribution Approach

Ka-Shing Chan and Mike K. P. So
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Abstract

Financial return distribution is well recognized for its fat-tail behavior and its tail asymmetry. One natural question is whether the tail asymmetry is still significant after accounting for the conditional heteroskedasticity in returns. In this paper, we propose a mixture of distribution approach under a GARCH framework to capture the tail asymmetry. A key idea is to use the Peak-over-Threshold method of extreme value theories to construct a mixture distribution for the innovation in GARCH models. This mixture distribution combines a common distribution, like normal, and two generalized Pareto distributions for the two tail parts to capture both the leptokurtosis and the tail asymmetry. A Bayesian approach is adopted to estimate unknown parameters by using Markov Chain Monte Carlo (MCMC) methods. A Bayesian test for tail asymmetry is also established. We also study the performance of our approach in forecasting volatility and the tail risk, like Value at Risk and expected shortfall, using real data.

Shrinkage Method for Estimating the Optimal Expected Return of a Self-financing Portfolio

Ngai-Hang Chan and Yan Liu
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The Chinese University of Hong Kong

Abstract

The mean-variance portfolio optimization procedure proposed by Markowitz (1952) requires two crucial inputs : the theoretical mean and the theoretical covariance matrix of the portfolio for a one-time period. Since the traditional plug-in method using the sample mean and the sample covariance matrix of the historical data incurs huge estimation errors, this paper first explores how the sample mean and the sample covariance matrix behave on the optimization procedure individually and jointly based on the ideas of conditional expectation. A new estimator for calculating the optimal expected return of a self-financing portfolio is then proposed, which is applicable for a given portfolio dimension p and a given sample size n. Simulation studies show that the new estimator is superior to methods proposed previously.

Hong Kong as a Financial Centre : Global, Regional and China Dimension

Tim Chau
Census and Statistics Department
Hong Kong, China

Abstract

Hong Kong is a key financial centre where a wide range of financial activities are undertaken for investors and fund raisers, both local and overseas. In this presentation, Hong Kong's world position in different financial markets (e.g. equity, credit, bond, etc.) will be discussed. While there are some other prominent players worldwide, the prominence of Hong Kong becomes more obvious when the focus is brought to the Asian region. Furthermore, with the gradual financial liberalization in the Mainland of China and the wider external use of Renminbi (RMB), the development of Hong Kong as an offshore financial centre of the Mainland will also be explored.

On Modeling Correlated Default Risk

Wai-Ki Ching
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The University of Hong Kong

Abstract

In this talk, we consider the problem of modeling the temporal dependence of defaults and introduce a novel approach for describing the chain reaction of infectious defaults. The main idea is to extend a Markov chain model for crisis management in epidemiology, namely, Greenwood's model, to describe the chain reaction of infectious defaults of bonds across any pair of industrial sectors. We then employ two important risk measures, namely, Crisis Value-at-Risk (CRVaR) and Crisis Expected Shortfall (CRES), as proxies of risk over a default cycle. Numerical experiments are given to illustrate the practical implementation of the model and identify some main features of the model. We also perform empirical studies of the model and analyze the empirical behaviors of the risk measures arising from the model.

A Non-Zero-Sum Game Approach to Convertible Bonds : Tax Benefit, Bankrupt Cost and Early/Late Calls

Nan Chen
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The Chinese University of Hong Kong

Abstract

Convertible bonds are hybrid securities that embody the characteristics of both straight bonds and equities. In the current financial crisis, many investors are attracted to such securities because they offer conversion flexibility and "bond floor" protection.

The conflict of interests between bondholders and shareholders affects the security prices significantly. In this paper, we investigate how to use anon-zero-sum game framework to model the interaction between bondholders and shareholders and to evaluate the bond accordingly. Mathematically, this problem can be reduced to a system of variational inequalities, which has been studied systematically by Bensoussan and Friedman (1977). We explicitly derive a Pareto-optimal Nash equilibrium to the game.

Our model shows that credit risk and tax benefit have considerable impacts on the optimal strategies of both parties. The shareholder may issue a call when the debt is in-the-money or out-of-the-money. This is consistent with the empirical findings of "late and early calls" (Ingersoll (1977), Mikkelson (1981), Cowan et al. (1993) and Asquith (1995)). In addition, the optimal call policy under our model offers an explanation for certain stylized patterns related to the returns of company assets and stock on calls.

Modeling Dynamic Seasonality in Quantile Regression

S.W. Chung and Mike K.P. So
The Hong Kong University of Science and Technology

Abstract

In this research, a new risk model with heteroskedastic seasonal component is introduced. A structure of dynamic seasonality is constructed in GARCH models to account for the gradual change in intra-daily seasonality in high-frequency financial data. Quantile regression is used to estimate the time-varying percentiles of the modeled time series to avoid any misspecification of the underlying distribution while incorporating dynamic seasonality. A two-step approach for estimation is adopted to solve any problem arising from the use of non-linear regressors in quantile regression. Markov Chain Monte Carlo method is used to perform estimation and inference of model parameters. Simulation study is carried out to evaluate the efficiency of the estimation method. Empirical study on intraday stock returns demonstrate that the risk model can perform well in estimating value at risk even though the sample of stock prices lies in the period of financial tsunami when the volatility was extremely high.

Keywords : dynamic seasonality, high frequency data, intraday risk, quantile regression, value at risk.

Introduction to Mean Field Games and Numerical Recipes

Olivier Gueant
Université Paris-Diderot

Abstract

Mean field games were introduced by JM Lasry and PL Lions to model games with infinitely many players. In this presentation, we will present how mean field games arise naturally as the limiting case of games with N players when N tends to infinity. The PDE system will be presented and methods to solve it numerically will be discussed along with the various applications developed so far.

Models for Credit Risk

M. Jeanblanc
Equipe Analyse et probabilités
Université d'Evry-Val-D'Essonne and Institut Europlace de Finance

Abstract

In this talk, we present an extension of intensity based models for credit risk, based on a density approach. We start with a threshold model, where the default time is defined as

$$\tau = \inf\{t : \Gamma_t \geq \Theta\}$$

where the barrier Θ is not assumed to be independent of the reference filtration F. In that case, one needs to have the knowledge of the conditional law of the barrier, i.e., of

$$p_t(u)du = \mathbb{P}(\Theta \in du | \mathcal{F}_t)$$

In other words, we assume that the conditional density of the default time exists : for any pair (*t, u*), there exists a family of non-negative martingales, defined as

$$\alpha_t(u)du = \mathbb{P}(\tau \in du | \mathcal{F}_t)$$

Note that this family satisfies $\int_0^\infty \alpha_t(u)du = 1, \forall t$

We extend the study to a multidefault setting and we show how to compute prices of defaultable claims in that model, and to recover the intensity rate process.

Then, we provide many examples of density processes, or equivalently, of survival probabilities, i.e.,

$$G_t(\theta) = \mathrm{P}(\tau > \theta | \mathcal{F}_t)$$

Note that $G(\theta)$ is a family of martingales valued in [0, 1], which is decreasing w.r.t. θ. We study the properties of the forward intensity, which is the process $\lambda_t(\theta)$ defined as

$$G_t(\theta) = \exp - \int_0^\theta \lambda_t(u)du$$

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Integrated Volatility Estimation with Multiple Transactions

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Abstract

For many high-frequency financial data, e.g., those from the TAQ database, the smallest trading time interval is one second. As a result, multiple transactions/quotes are often recorded within one second. This phenomenon is common for a large number of heavily traded stocks, such as MSFT, IBM and INT. In practice, one common approach to handle multiple observations is to take the average of those multiple observations in that given time interval, and then to use those averages to estimate the quantities of interest, such as Integrated Volatility. In this talk, we will demonstrate that such estimates may fail to be even consistent, and propose ways to remedy the problems.

[This is a joint work with Zhi Liu and Xinbing Kong.]

Default Option and Optimal Capital Structure in Real Estate Investment

Jyh-Bang Jou
School of Economics and Finance (Albany), Massey University
Tan (Charlene) Lee
Department of Accounting and Finance, The University of Auckland

Abstract

This article investigates the determinants of optimal capital structure in real estate investment in a real options framework where an investor incurs transaction costs when purchasing a property through debt financing. The investor chooses a date at which to purchase the property, and at that date, decides a loan-to-value ratio, which balances the tax shield benefit and the transaction costs. After the purchase, the investor will default once the value of the property falls below the balance of the loan. An investor who incurs larger transaction costs will choose the same loan-to-value ratio, but will wait longer to purchase, and will thus gain more from the purchase. Moreover, an investor who expects the value of a property to evolve more volatile is more likely to default the loan. Anticipating this, the investor will accelerate purchasing the property and borrow less, thus gaining less from the purchase.

Keywords : Default, optimal capital structure, real estate investment, real options, transaction costs.

Liquidity, Market Microstructure, and Financial Crisis

Hyeng Keun Koo
Department of Financial Engineering
Ajou University

Abstract

I provide a review of the 2008-9 financial crisis, paying attention to liquidity provision by financial intermediaries and market microstructure issues. I conduct a survey on the literature on market microstructure and banking from the perspective of liquidity provision. I try to provide suggestions for policy makers based on the insight from the literature.

Keywords : agency problem, capital requirement, liquidity, oligopoly

On the Quasi-Maximum Likelihood Estimation of a Threshold Double AR Model

Dong Li and Shiqing Ling
Department of Mathematics
The Hong Kong University of Science and Technology

Abstract

This paper investigates the quasi-maximum likelihood estimator (QMLE) of the threshold double AR model. It is shown that the QMLE is strongly consistent and the estimated threshold is n-consistent and converges weakly to the smallest minimizer of a two-sided compound Poisson process. The remaining parameters are root-n consistent and asymptotically normal. Our results include the asymptotic theory of the QMLE for the threshold AR model with ARCH errors and the threshold ARCH model as special cases, each of which is also new in the literature. Simulation studies are conducted to assess the performance of the QMLE in finite samples. The results are illustrated with an application to the daily closing prices of Hang Seng Index.

Statistical Inference for the FBSDE and Its Application in Finance

Lu Lin
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Shandong University

Abstract

Backward Stochastic Differential Equation (BSDE) has been well studied and widely applied in finance. The main difference from the original stochastic differential equation is that the BSDE is designed to depend on a terminal condition. However, to the best of our knowledge, the terminal-dependent statistical inference for the related models is a new research field. This talk is concerned with the progresses of study on the statistical inference and its application in finance for Forward-backward Stochastic Differential Equation and its related statistical models.

A Mechanism to Detect and Decrease Insider Trading

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Abstract

Every publicly traded firm has insiders (e.g., managers) who are privy to information relevant to future stock price, which they could exploit in trades against other investors. Since trades are anonymous and uninformed traders would always lose in such trades, the possibility of facing a trader with inside information may deter trading by uninformed traders. Theory predicts that the fear of loss will be reflected in a greater bid ask spread, which would prevent efficiency increasing trades from being realized. The standard method of eliminating insider trading, by administratively or legally restricting the trades of insiders, may actually decrease efficiency, because

a) Some trades by insiders may be liquidity motivated trades and not be based upon insider information,

b) Such restrictions will not hinder the friends and family of insiders in their trades based upon insider information.

For all these reasons, the effectiveness and welfare implications of such restrictions are also not clear. Furthermore, current measures of insider trading cannot distinguish between trades on insider information and trades based upon clever interpretations of public information.

We propose a new method of measuring and decreasing insider trading that overcomes these problems. In regards to measurement, we rank stocks according to the correlation between their price movements and publicized news events. (Trades based upon insider information will move prices before public announcements.) Our method can separate the effects of such trades from those that are based upon insightful interpretations of publicly available information -- on the assumption that peculiar insights occur randomly across stocks within a given industry. Using our analysis, different stock markets can also be ranked by the amount of insider trading.

In an experimental follow up, we will test for the insider trading decreasing effect of this index by publicizing it for a randomly selected sample of stocks. Potential investors can then use it to determine the probability of facing an insider in a trade. Thus, they can demand a proportionally larger premium for trades that involve stocks whose prices are relatively less well explained by public information. If our theory is right, the bid ask spread of these stocks should increase relative to those with higher correlation. Furthermore, we predict that the average bid ask spread of these stocks should be lower than for stocks with unpublished indices. This difference would reflect the actual shift of investors to such stocks and the threat of further shifts should greater trading on insider information occur. Our method can be applied to any market. It also avoids the controversial surround regulatory measures to decrease insider trading decrease efficiency, which if they work may increase trades at the cost of decreasing informativeness of trades.

Forward Hedging of Swaptions and Related Derivatives in Bond Markets

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Nanyang Technological University

Abstract

We compute self-financing hedging strategies for interest rate derivatives by the forward measure technique and infinite-dimensional analysis. Our approach uses both Delta hedging and the Clark-Ocone formula, and applications are given to swaptions and other derivatives.

[This is a joint work with Dr. Timothy Robin TENG, University of Manila.]

Semi-Parametric Estimation of American Option Prices

Patrick Gagliardini
University of Lugano and Swiss Finance Institute
Diego Ronchetti
University of Lugano

Abstract

We introduce a new semi-parametric estimator of the price of American options. The estimator is based on a parametric specification of the stochastic discount factor and is non-parametric w.r.t. the historical dynamics of the Markov state variables. The estimation method exploits the no-arbitrage conditions for a set of risk-free bonds, the underlying asset and a cross-section of observed prices of American options written on it. We obtain an estimator of the transition density of the state variables process by minimizing a statistical measure based on the Kullback-Leibler divergence from a kernel-based transition density. We use the estimator to compute the price of American options not traded in the market by recursive valuation. Our approach is somehow close in spirit to stochastic mesh methods, with the historical realization of the state vector process taken as a mesh. The weights associated to the mesh are the non-parametric kernel weights adjusted by a tilting factor and multiplied by the stochastic discount factor. Other functionals of the transition density interesting for financial applications can be estimated by our approach. These functionals include physical and risk-neutral conditional cross-moments of the state variables, such as leverage effects.

Keywords : American option, kernel estimator, semi-parametric estimation, dynamic programming, recursive valuation, nonlinear functional.

A First-Order Spatial Integer-valued Autoregressive SINAR(1, 1) Model

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Abstract

Recently, there has been growing interest in modelling non-negative integer-valued time series. Counts of accidents, number of patients admitted to a hospital, number of crimes committed at a particular, counts of transmitted messages and detected errors, etc. are examples of these type of time series. A popular approach in modelling non-negative integer-valued data is by using the binomial thinning operator, which was introduced by Steutal and Van Harn in 1979. The first time series model based on this operator was by Mckenzie (1985).

The purpose of this paper is to extend the use of the binomial thinning operator to the spatial case. Specifically, we define the First-Order Spatial Integer-Valued Autoregressive SINAR(1,1) Model and obtain some of its properties namely, the theoretical Autocorrelation Function (ACF), the mean and the variance of this model. In this paper, the Yule-Walker estimates for the parameters of this model are also established.

We also simulated some realisations of this process and computed the sample ACF, the sample mean and the sample variance for some selected parameter values. Comparisons were then made with the theoretical ACF, the theoretical mean and variance. Further a simulation study was conducted to evaluate the performance of the proposed Yule-Walker estimates. Finally to illustrate the fitting of the SINAR(1, 1) model to a real data set, we considered the yeast cell counts presented by Student (1906). Our results extend the theory and practice of spatial models.

Keywords : Spatial Models, autocovariance function, autocorrelation function, Yule-Walker estimates.

Stochastic Covariance Models

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Abstract

We propose a new class of stochastic covariance models based on Wishart distribution. Three categories of dynamic correlation models are introduced depending on how we formulate the time-varying covariance matrix and whether it is a latent variable. We also develop a stochastic covariance filter for filtering and prediction of covariances. Extensions of basic models enable us to study the long memory properties in dynamic correlations, threshold correlation effects and the portfolio analysis. Suitable parameterization in our stochastic covariance models and the stochastic covariance filter facilitate efficient calculation of the likelihood function in high-dimensional problems, no matter the covariance matrix is observable or latent. We conduct Monte Carlo experiments to investigate finite sample properties of the maximum likelihood estimator. Two empirical examples are presented; one deals with the realized covariance using the high frequency data for exchange rates, while the other examines daily stock returns.

Keywords : Covariance prediction, Dynamic correlation, Nonlinear time series, Long memory, Stochastic covariance filter, Threshold model.

Any-Utility Neutral and Indifference Pricing and Hedging

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and
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Abstract

Using recent, original approach, neutral and indifference pricing PDEs are derived for general multi-dimensional Markovian diffusive market models and for any utility of wealth. In the case of portfolios of contracts the pricing PDE system is proved for neutral, while conjectured and discussed for indifference pricing. Hedging formulas are given too. Some special cases are derived as well to demonstrate the consistency with the well known results.

Estimation of High-Frequency Volatility : An Autoregressive Conditional Duration Approach

Yiu-Kuen Tse
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Tao Yang
Boston College

Abstract

We propose a method to estimate the intraday volatility of a stock by integrating the instantaneous conditional return variance per unit time obtained from the autoregressive conditional duration (ACD) models. We compare the daily volatilities estimated using the ACD models against several versions of the realized volatility (RV) method, including the bipower variation realized volatility with subsampling, the realized kernel estimate and the duration-based realized volatility. The ACD volatility estimates correlate highly with and perform very well against the RV estimates. Our Monte Carlo results show that our method has lower root mean-squared error than the RV methods in most cases. A clear advantage of our method is that it can be used to estimate intraday volatilities over intervals such as an hour or 15 minutes.

From Persistent Random Walk to the Telegraph Noise. Application to Insurance

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Institut Elie Cartan
Université Henri Poincaré

Abstract

Associated with a Markov chain $(Y_n)_{n\geq 0}$ taking its values in {-1,1} consider the *persistent* random walk : $X_n := Y_0 + Y_1 + \cdots + Y_n, n \geq 0$.

1) We determine the mean, the variance and the generating function of X_n.

Then, we give an application to insurance.

2) Suppose : $P(Y_1 = 1 | Y_0 = -1) = \alpha_0 + c_0\Delta_x$ and $P(Y_1 = -1 | Y_0 = 1) = \beta_0 + c_1\Delta_x$, where $\alpha_0, \beta_0 \in [0,1], c_0, c_1 \in \mathbb{R}$ and Δ_x is a small positive parameter. Set $(\widetilde{Z}_s^{\Delta})_{s\geq 0}$ the linear approximation of $(\Delta_x X_{s/\Delta_t}, s \in \Delta_t \mathbb{N})$. When $\rho_0 := 1 - \alpha_0 - \beta_0 \neq 1$ and $\Delta_t = (\Delta_x)^2$, it is proved that $(\widetilde{Z}_s^{\Delta})$ converges in distribution as $\Delta_x \to 0$ to a Brownian motion with drift. In the case $\rho_0 = 1$, choosing $\Delta_t = \Delta_x$ (and $c_0 = c_1$ for simplicity) leads to the convergence in distribution (as $\Delta_x \to 0$) to non-Markov zig-zag process $\left(-\int_0^t (-1)^{N_u} du, t \geq 0 \right)$, where (N_u) is a Poisson process with parameter $1/c_0$. This result allows to give a representation of certain solutions of the telegraph equation.

3) We also consider two extensions : when either (Y_n) is a two order Markov chain or a Markov chain taking valued in finite subset of $\mathbb{R}$

[This is a joint work with S. Herrmann (Nancy), R. Keinj (Nancy) and C. Tapiero (Re-search fellow, the Department of Finance and Risk Engineering, New-York University, Polytechnic Institute).]

On a Reduced Form Credit Risk Model with Thinning-dependence Structure for Default Intensities

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Abstract

In this paper, we propose a reduced form credit risk model with the correlation among the default intensities of firms being described by the thinning of some point processes. We present some properties that is associated with the correlation among the default intensities. We derive the joint distribution for the default times and investigate the pricing formulas for the credit spread and for the fair premium for zero-coupon bond. We give some explicit expressions for pricing the credit value adjustment (CVA) under the proposed model.

Keywords : default time, thinning, fair premium rate, reduced form credit risk model, zero-coupon bond, credit value adjustment.

Survival in Equilibrium with Other-than-me Welfare Improvement

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Abstract

It is well-known that quasiequilibria may not be qualified as an equilibrium if agents possess no consumption cheaper than the initial endowment. A survival condition is required to make sure that quasiequilibrium is in fact an equilibrium. We provide a new survival condition for the equilibrium existence in exchange economies. Specifically, we demonstrate that if for each agent, there exists a reallocation of consumptions which makes all the other agents get better off, then every agent possesses a cheaper consumption and thus, quasiequilibrium becomes equilibrium. This intuitive condition is called other-than-me welfare improvement (in short, OWI) condition. The OWI condition is weaker than time-honored irreducibility condition of McKenzie (1959, 1961) and its recent developments such as Bergstrom (1976), Hammond (1991), and Florig (2001).

Insight into the Application of Mathematical Models to Real Estate Investment

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Hang Seng Management College

Abstract

Real estate as an investment has become increasingly popular and been investigated by researchers and practitioners. The major concern of many researchers is the risk-return relationship in real estate market. This paper discusses some recent mathematical models applicable to real estate investment. It analyses the risk-adjusted performance and relationships among properties of different classes and stocks in Hong Kong. Moreover, it assesses and compares the portfolio diversification benefits of investing in real estate and property stocks. Such analysis provides some insights into the strategy of real estate investment.

Modeling Threshold Conditional Heteroscedasticity with Regime-Dependent Skewness and Kurtosis

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Abstract

Construction of nonlinear time series models with a flexible probabilistic structure is an important challenge for statisticians. Applications of such a time series model includes ecology, economics and finance. In this paper we consider a threshold model for all the first four conditional moments of a time series. The nonlinear structure in the conditional mean is specified by a threshold autoregression and that of the conditional variance by a threshold generalized autoregressive conditional heteroscedastic (GARCH) model. The Grame-Charlier (GC) density is used as the conditional innovation density and the skewness and kurtosis parameters are also allowed to have a threshold structure. The regime dependent feature for the first four conditional moments allows more flexibility in modelling and provides better insights into the structure of a time series. A Lagrange-Multiplier (LM) test is developed for testing for the presence of threshold structure. The test statistic is similar to the classical tests for the presence of a threshold structure but allowing for a more general regime dependent structure. The new model and the LM test are illustrated using some real world financial data.

Empirical Analysis on the Effect of Insurance Development on Economic Growth in China

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Abstract

By employing Non-linear STR model of time series and panel Threshold regression model, this paper empirically analyses the effect of insurance development on economic growth in China, from both national and regional aspects. The empirical analysis indicates that the insurance development in current period strongly promote economic growth with the typical gradual and non-linear characteristics; To some extent, the insurance development in one lag period restraints the economic growth; The effects of both regional life insurance and regional non-life insurance development on economic growth take on double-threshold effects, however, the threshold of regional life insurance development begin to promote economic growth is obviously higher than that of non-life insurance development.

Keywords : Insurance Development, Economic Growth, STR Model, Panel Threshold Regression Model.

A Note on the Properties of Stein-rule and Inequality Restricted Estimators when the Regression Model is Over-fitted

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Abstract

This note considers the effect of an erroneous inclusion of regressors on the risk properties of the Stein-rule, positive-part Stein-rule and inequality restricted least squares estimators in a linear regression model. It is shown that the inclusion of wrong regressors has only minimal effect on the Stein-rule and positive-part Stein-rule estimators' properties and no effect at all on the risk properties of the inequality restricted least squares estimator when there is a single inequality constraint on the coefficients.

Keywords : Stein-rule estimator, Inequality restricted estimator, Model misspecification, Linear regression model

Stream 4

Probability Theory with Applications
Organizers : Zhiming Ma, Phillip Yam

A New Look at the Lagrange Method for Continuous-time Stochastic Optimization

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Abstract

This talk concerns with the Lagrange method for continuous-time stochastic optimization. We take a new look at the method and consider the rational formulation of it. Conditions for the optimality are rigorously given in an appropriate norm space for cases of twice-differentiable utilities and concave utilities. Some examples selected from control theory and financial mathematics are presented to test and illustrate the potential applications of the method.

[This is a joint work with Jia-an Yan.]

On the Complete Monotonicity of the Compound Geometric Convolution with Applications in Risk Theory

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Hong Kong Baptist University

Chuancun Yin
School of Mathematical Sciences
Qufu Normal University

Abstract

We study the complete monotonicity of the compound geometric distribution and the compound geometric convolution, and show that the ruin probability as a function of the initial surplus in the classical risk model perturbed by diffusion or in the Sparre Andersen model is completely monotone if (and only if, when we consider the perturbed classical model) the claim size distribution has a completely monotone density. For the spectrally negative Lévy risk model, a sufficient (and often necessary) condition for a completely monotone ruin probability is that the Lévy measure has a completely monotone density.

Understanding Risk Neutral Option Pricing During Times of Market Stress

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Abstract

Option pricing is one of the great success stories of modern finance. The Black-Scholes model, with its many variants and extensions, is universally accepted by academics and practitioners as the appropriate framework for valuing options and other contingent claims Market prices for all financial instruments, including options, impound both the market's objective expectation of the security's monetary payoff, and also the market's risk preferences. As Harrison and Kreps proved, these two properties can be combined into a single "risk neutral" probability distribution (RND), and Breeden and Litzenberger showed how that distribution can be extracted from current option prices in the market.

It was already established that under the returns process Black and Scholes assumed, the RND for pricing options is just the objective distribution displaced so its mean equals the risk free interest rate, but subsequent research has demonstrated conclusively that the lognormal diffusion process does not hold in the real world.

The technology for extracting the RND remains valid but volatility and higher moments, tail properties, etc., can change under risk neutralization.

During the financial crisis in Fall 2008 stock return volatility, both risk neutral and empirical, rose to exceedingly high levels. It also seemed apparent that risk tolerance had changed markedly and had become much more volatile. I believe that if we want to capture market behavior during times of stress, like Fall 2008, we need to model the dynamics of the risk neutralization process and incorporate it into our pricing models. The RND offers a way to examine such effects directly. I currently have several completed papers in this area, including the one in the conference binder that that documents the huge increase in risk neutral risk measures and examines intraday dynamics of the RND during this period. A related project that is currently in progress explores the factors that influence risk neutral variance.

[This is a joint work with Mr Justin Birra, New York University Stern School of Business.]

Modeling and Quantifying the Multiple Perspectives of Risk to Multi-Scale Complex Systems

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Abstract

Government agencies, the military, and major corporations—all seek to understand the trends of risks associated with emergent forced changes that affect the states of their systems, in order to prevent, mitigate, or prepare for undesirable future occurrences. The term emergent forced changes connotes trends in external or internal sources of risk to a system that may adversely affect or enhance specific states of that system, and consequently affect the entire system. Unanticipated, undetected, misunderstood or ignored emergent forced changes, whether they originate from within or from outside a system, are likely to affect a multitude of state variables of that system with potentially adverse consequences. Therefore, it is imperative to be able--through scenario structuring, modeling and risk analysis--to envision, discover, and track emergent forced changes. The premise of this presentation is that it is impracticable to represent within a single model the multiple aspects of truly complex multi-scale (e.g., time, functionality, perspectives, objectives) systems. Practitioners of fine arts, as the quintessential modelers, represent through their work the influence of the culture and social environment within which they live. In an analogous way, system modelers attempt to represent the multi-perspective and multifaceted system under study in order to gain understanding of its inherent interconnectedness and interdependencies, and to answer specific questions relevant to the system. Both artists and system modelers address a similar creative, systemic, and challenging task of representativeness. The Phantom System Models (PSM) and the PSM Cloud-Computing Laboratory are aimed to facilitate the creative environment that is necessary for modelers to develop overlapping representative models. The Laboratory enables a research team to: (i) explore, experiment, simulate, and learn about complex multi-scale systems, (ii) design new complex multi-scale systems to explore responses to experimentation in a system's configuration/reconfiguration and to emergent forced changes, and (iii) investigate systems whose adaptability, risks, opportunity, and resilience are in need to be determined.

Conditional Moments, Sub-Independence and Independence

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Abstract

Aureo De Paula (2008), presented a bivariate distribution for which

$$E(Y^n \mid X) = E(Y^n) \text{ and } E(X^n \mid Y) = E(X^n),\ n = 1, 2, \ldots \quad (1)$$

i.e., X^m and Y^n are uncorrelated for all positive integers m and n, but X and Y are not independent. De Paula.s goal was to show a sense of dissociation between two random variables X and Y beyond the concept of uncorrelatedness : We recall a concept called sub-independence, which provides a stronger sense of dissociation than the simple uncorrelatedness. The random variables considered by De Paula are not sub-independent. We present a bivariate distribution for which Equation (1) holds, X and Y are sub-independent, but not independent. The assumption of sub-independence is formulated in terms of the characteristic function and convolution, as a much weaker assumption than independence for derivation of the distribution of the sum of random variables. The concept of sub-independence can replace that of independence in most of the theorems in Probability and Statistics which are formulated in terms of distribution of the sum of the random variables.

Reform of Liquidity Risk Management after Global Financial Tsunami

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Abstract

The Basel Committee on Banking Supervision issued in (i) February 2008, a regulatory guideline "Principles for Sound Liquidity Risk Management and Supervision"; and (ii) December 2009, a consultative document "International framework for liquidity risk measurement, standards and monitoring". These two documents set out the initiatives from national regulators on reforming the liquidity risk management framework for banking industry after the global financial tsunami.

Under this topic, the speaker will summarize and analyze the above two documents, in particular how these liquidity risk regimes may impact the banking industry. The speaker will highlight the implementation issues facing the banks in light of those guidelines and put forward suggestions to meet these challenges. In addition, the speaker will proposed a simple stochastic model to measure the banks' funding liquidity risk and address the shortfall of the proposed regulatory liquidity measures. An Excel implementation of the proposed stochastic model will be presented and the applications of the proposed stochastic model for liquidity risk management will be illustrated.

An Inverse Problem for a Quasilinear First Order Hyperbolic Equation

Zhiyuan Li and Shumin Li
University of Science and Technology of China

Abstract

In this paper, we consider the following quasilinear first order hyperbolic equation :

$$u_t + a(t,x,u)u_x = f(x)g(t,x,u), \quad t > 0,$$
$$u(0,x) = \phi(x), \quad x \in \mathbb{R}. \tag{1}$$

We assume that $a(t,x,u)$ and $g(t,x,u)$ are given functions and $a(t,x,u) \geq a_0$ in the domain under the consideration. Here $a \geq a_0$ is a given constant. We set

$$t_1(x) \stackrel{\Delta}{=} a_0 x - a_0(c-\delta),$$

$$R(\delta) \stackrel{\Delta}{=} \{(t,x) : c-\delta \leq x \leq c, 0 \leq t \leq t_1(x)\},$$

where δ is a suitably given positive constant.

We investigate an inverse problem of determining $f(x), c-\delta \leq x \leq c$ from the measurement data: $u(t,c) = h(t), t \in [0, a_0\delta]$. We proposed an existence and uniqueness proof for the inverse problem via applying the Banach's Fixed Point Theorem. Furthermore, via some more sophisticated analysis : the continuous modulus, we point out that $f \in C^0([c_\delta, c]), u \in C^0(R(\delta))$ and $\frac{\partial_u}{\partial_t} \in C^0(R(\delta))$, that we obtain by applying the Banach's Fixed Point Theorem, satisfy $f \in C^0([c_\delta, c]), u \in C^1(R(\delta))$ and satisfy (1) in the domain $R(\delta)$.

Valuation of Contingent Credit Interest Rate Swap

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Abstract

The aim of this paper is to establish a pricing model for a hybrid financial product named the Contingent Credit Interest Rate Swap (CCIRS), which is sensitive to interest rate and credit risk. Like vanilla CDS, the CCIRS is an instrument used by two counterparties to buy or sell protection against the default of a reference of an interest rate swap (IRS).

It is assumed that the interest rate r_t and credit rist rates λ_t of the reference satisfy the following stochastic processes respectively :

$$r_t = a(t) + X_{1t} + X_{2t}, \quad \lambda_t = b(t) + X_{1t} + X_{3t},$$

where $a(t)$ and $b(t)$ are given functions and $X_{it}, i = 1,2,3,$ are affine jump diffusion (AJD) processes as follows :

$$dX_{it} = \kappa(\mu - X_{it})dt + \sigma\sqrt{X_{it}}dW_{it} + dZ_{it}, \quad dZ_{it} = \sum_{j=1}^{N_t} \varepsilon_j, \quad i = 1,2,3.$$

Under the intensity-based framework, the risk-neutral pricing formula $V(t)$ of CCIRS is :

$$V(t) = E[(1-R)1_{\{\tau \le T\}} e^{-\int_t^\tau r_s ds} NPV^+(\tau) \mid G_t]$$
$$= 1_{\{\tau \le T\}} \int_t^T (1-R)NPV^+(w)E(\lambda_w e^{-\int_t^w (r_s+\lambda_s)ds} \mid F_t)dw,$$

where R is the recovery rate, NPV is the net present value of the CCIRS, and τ is the default time of the underlying IRS.

Now, the key point turns to solve the conditional expectation of contingent cash flow of the CCIRS. By using PDE approach and the Affine technique, a semi-close solution to the price of single name CCIRS is derived. The method can be extended to the one with counterparty risk involved.

We use the real market data to calibrate the interest rate and default intensity models. Some satisfying results in line with market practice are obtained. Finally, we give a computing scheme to calculate the pricing formula of the single name CCIRS and its CVA presented numerically. Then analysis of the relationship between model parameters and the numerical results are undertaken.

Collocation Method on Triangular Elements, Theory, Method and Examples from Financial Mathematics

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Hunter College of CUNY

Abstract

Introduction: We present collocation on partitioned spatial domains of dimension greater than one.

Collocation (CM) has a long history as a numerical method used to approximate solutions for PDE in one spatial dimension. In this context, Topper [1] makes a strong case for collocation as the method of choice in finance and economics. The basis of his argument is that in CM the discrete form is derived directly from the differential equation. The same argument should apply to settings of higher dimensions. However, in this regard, the literature is largely silent.

Our goal is to demonstrate that CM can be a useful tool in higher dimensional cases. In this regard we present the supporting theory for collocation applied to a PDE of more than one spatial dimension, the specifics of the implementation of the method to two spatial dimensions and examples comparing our results to published results derived using other techniques.

CM and FEM: Both CM and FEM (finite element method) begin with an interpolation of the existent but unknown solution to the PDE. In both cases the interpolating function is resolved through as linear system of equations. If the CM implementation is based on a finite element partition, then the size of the corresponding linearization is the same.

Theory: The theoretical foundation for the method is derived by modifying existing theorems to the case at hand. In particular we prove that the collocation solution converges as the polynomial interpolation converges. The hypotheses include a usual bounded condition on the underlying linear operator. Additionally, CM provides an error estimate in sup norm that is not available for FEM. The effectiveness of CM depends directly on the correctness of the interpolating function.

Implementation: The nature of the implementation follows from the theory. Any robust implementation of CM must be based on a decomposition of the domain into triangular or tetrahedral elements. In two dimensions we focus on the 6 nodal triangular, 21 degree of freedom model. This model, based on degree 5 polynomials, is C1 continuous. The assignment of collocation points depends on the ratio of element count to the total degrees of freedom. In this regard it is important to consider triangulation techniques and refinement procedures.

Financial Examples : Our implementation is written in Mathematica. We include several examples indicating the usability of the proposed method.

Reference

[1] Topper, Jurgen, Financial Engineering with Finite Elements, Wiley Finance, 2005.

Continuous-Time MV Analysis in Presence of Lévy Jumps

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Abstract

This paper is on continuous-time intertemporal mean-varaince analysis. A dynamic consistent trading strategy is obtained for investors who try to maintain the cash balance to grow at a pre-fixed target rate (μ_0) across a pre-specified trading session [0,T], and who, in the mean time, wish to minimize the risk exposure w.r.t the terminal balance. The optimal trading strategy is shown to fall into the `temporal efficient frontier' (t.e.f.). Analytic characterizations of the t.e.f. are provided, in addition to insights on (i) the temporal mutual-fund separation; (ii) the risk decomposition; (iii) the existence of market anomalies, and (iv) the relevance of t.e.f. for rational investors whose preferences, as partial orders, display variance aversion in the sense of Duffie (1988).

Preventing Emotional Investing : An Added Value of an Investment Advisor

Phil Maymin
Polytechnic Institute of New York University

Abstract

We analyze a unique, comprehensive, multi-decade dataset of all communications with clients by a boutique investment advisory and investment management firm to explore the behavior of individuals involved in financial decision making. We propose and test a theory of self-regulation to explain both the appeal and the value of investment managers to individual investors, and we find that all of the predictions of the theory are borne out by the data. In short, our unique dataset allows us to provide evidence that an important service provided by investment advisors, and apparently desired by individual investors, is the barrier the advisor provides to prevent the individual from aggressively trading and thereby losing money.

[This is a joint work with Gregg S. Fisher.]

Hysteretic Regime Switching Diffusions, and Applications in the Theory of Real Options

John Moriarty
School of Mathematics
University of Manchester

Abstract

We will present some recent work at the interface between probability theory and Real Options Analysis. We show that certain industrial planning problems lead to the study of stochastic processes defined on graphs. We characterise the average values of certain statistics (such as first-passage times) for these processes, as solutions of a system of partial differential equations of Feynman-Kac type. We then use this characterisation to give numerical solutions to previously unsolved problems with applications to the mining industry.

Influence of Trading Strategies on Market Prices

George Papanicolaou
Mathematics Department
Stanford University

Abstract

Prof. George Papanicolaou will present a review of several mathematical models that have been proposed to assess systemic risk, that is, the probability that a sharp overall transition will occur in a highly interconnected stochastic system which functions in a seemingly normal state until this event occurs.

Taking, Avoiding and Managing Risks : An Engineering Perspective and a Few Lessons Learned

Elisabeth Paté-Cornell
Stanford University

Abstract

Engineering risk analysis is performed using systems analysis and Bayesian probability because there are not enough statistical data at the system level. The first challenge is the formulation of the problem: which variables, parameters and dependencies to include in the model. The second is to gather data (operational data, surrogate data, test results, or expert opinions) to support probability estimation. One thus needs to decide what level of analytical detail is sufficient and where to find the information. After the results are computed, another challenge is to communicate them. This paper describes some of the methods that are used to assess engineering failure risks, including human errors, and presents a few examples, from the heat shield of the space shuttle to the dynamic modeling of patient risk in anesthesia. In conclusion, a description of a few lessons learned are presented, which may be useful if one wants to transfer the engineering approach to other fields such as finance.

Explicit Formulas for Pricing of Callable Mortgage-backed Securities in a Case of Prepayment Rate Negatively Correlated to Interest Rate

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Abstract

In this paper we deal with the pricing of Mortgage-backed Securities (MBS) in the reduced form framework. Mortgage-backed securities are debt obligations that represent claims to the cash flows from pools of mortgage loans. Based on the ideas presented in Breunel and Jribi (2008) and Rom-Poulsen (2007), we introduce a stochastic process $Q_t = e^{-\int_0^t \lambda_s ds}$ to model prepayment factors. Inspired by the fact that prepayment rates of mortgage are usually negatively correlated to the interest rate in the market, we assume that the prepayment rate λ_t is in inverse proportion to the instantaneous risk-free interest rate r_t, whose movement is governed by the CIR model. An explicit formula for pass-through MBS is obtained by using techniques of PDE and special functions such as confluent hypergeometric functions. We also obtain a semi-analytical solution for sequential pay collateralized mortgage obligations (CMO) through splitting method. Based on the formulas, numerical results are made to explain the dependence of pricing on the mortgage parameters and the negative correlation between MBS prices and the interest rate, and calibration is worked to show how to determine the parameters of inversely proportional relationship from MBS market. Our results will be very useful not only for valuation of MBS but also for estimating the prepayment risk from market information by using calibration technique without Monte Carlo simulation.

References

[1] Brunel, V. and F. Jribi (2008): Model-independent ABS duration approximation formulas, working paper.
[2] Rom-Poulsen, N. (2007): Semi--analytical MBS Pricing, Journal of Real Estate Finance and Economics, 34: 463-498.

On the Orthogonal Component of BSDEs in a Markovian Setting

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Abstract

In this talk we consider a Lipschitz backward stochastic di_erential equation (BSDE) of the form (1) driven by a continuous martingale M :

$$Y_s = F(X_T, M_T) - \int_t^T Z_r dM_r + \int_t^T f(r, X_r, M_r, Y_r, Z_r) d\langle M, M \rangle_r - \int_t^T dN_r \qquad (1)$$

where Xs denotes the strong solution of the (Lipschitz) forward SDE

$$X_s = x + \int_t^s \sigma(r, X_r, M_r) dM_r + \int_t^s b(r, X_r, M_r) d\langle M, M \rangle_r$$

A solution to the BSDE (1) is a triple of stochastic processes (*Y, Z, N*) where *Y* and *Z* are square-integrable adapted processes and N is a continuous martingale strongly orthogonal to *M* (that is $<M, N> = 0$). The fact that we have to add an orthogonal part *N* to the usual if *M* does not enjoy this latter then one has to add an orthogonal martingale *N* in order to obtain existence of a solution.

In this talk we show that if *M* is a strong Markov process and if the deterministic functions *F* and *f* are regular enough then the unique solution (*Y, Z, N*) of the BSDE is reduced to (*Y, Z*) i.e. the orthogonal martingale *N* is equal to zero, showing that in a Markovian setting the "usual" solution *(Y, Z)* (of a BSDE with regular data) has not to be completed by a strongly orthogonal component even if *M* does not enjoy the martingale representation property. This quite surprising fact is linked with a paper of Jacod, Méléard and Protter published in the Annals of Probability (2000). Finally we will present an application of this result to the utility maximization problem in Finance.

Games with Exhaustible Resources

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Abstract

We study N-player continuous-time Cournot games in an oligopoly where firms choose production quantities. These are nonzero-sum differential games, whose value functions may be characterized by systems of nonlinear Hamilton-Jacobi partial differential equations. When resources are in finite supply, such as oil, exhaustibility enters as boundary conditions for the PDEs. We analyze the problem when there is an alternative, but expensive, technology (for example solar power for energy production), and give an asymptotic approximation in the limit of small exhaustibility. We illustrate the two-player problem by numerical solutions, and discuss the impact of limited oil reserves on production and oil prices in the duopoly case.

Bertrand and Cournot Competition under Asymmetric Costs : Number of Active Firms in Equilibrium

Andrew Ledvina and Ronnie Sircar
ORFE Department, Princeton University

Abstract

We compare the number of active firms, i.e. the number of firms producing a positive quantity, in equilibrium across four different models of oligopoly: Cournot and Bertrand with homogeneous or differentiated goods. We concentrate on the linear demand structure with constant marginal but asymmetric costs. (With symmetric costs, the results trivialize to all firms active or all firms inactive.) When firms have different costs, we show that, for fixed good type, Cournot always results in more active firms than Bertrand. Moreover, with a fixed market type, differentiated goods result in more active firms than homogeneous goods. Hence, consumers pay for more choice in a Cournot market relative to Bertrand.

JEL Classification : C72; D43; L11; L22
Keywords : Oligopolies, Bertrand model, Cournot model, Differentiated goods.

Dynamic Bertrand Oligopoly

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Abstract

We study continuous time Bertrand oligopolies in which a small number of firms producing similar goods compete with one another by setting prices. We first analyze a static version of this game in order to better understand the strategies played in the dynamic setting. Within the static game, we characterize the Nash equilibrium when there are N players with heterogeneous costs. In the dynamic game with uncertain market demand, firms of different sizes have different lifetime capacities which deplete over time according to the market demand for their good. We setup the nonzero-sum stochastic differential game and its associated system of HJB partial differential equations in the case of linear demand functions. We characterize certain qualitative features of the game using an asymptotic approximation in the limit of small competition. The equilibrium of the game is further studied using numerical solutions. We find that consumers benefit the most when a market is structured with many firms of the same relative size producing highly substitutable goods. However, a large degree of substitutability does not always lead to large drops in price, for example when two firms have a large difference in their size.

The Scaling Limit of 2-d Myopic Random Walk

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Abstract

Consider the hexagonal or square lattice in the two-dimensional upper half-plane. Myopic random walk is the following walk on the lattice from 0 to infinity: Starting from the origin, it moves to adjacent points chosen uniformly amongst the neighbouring points that do not lead to the walk getting trapped. It has been conjectured (by W. Werner and others) that the scaling limit (i.e. as the mesh size of the lattice tends to 0) of myopic random walk is SLE(6). In the hexagonal lattice, this is already known (Smirnov, Camia and Newman) due to its relation with percolation. We will present a proof of the convergence of myopic random walk to SLE(6) that does not require percolation.

[This is a joint work with Phillip Yam.]

The Liquidity Model in Financial Market with Reynolds Criterion

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Abstract

The level of liquidity in financial market substantially affects the market efficiency, risk and return. But only limited measures such as the turnover rate and trading volume had been considered in previous models. In order to set an accurate liquidity model we implemented a dozen times of simulation experiments. It is discovered that the assets condition of traders are similar to the viscosity of fluid which has a decisive effect to liquidity level. In this paper, by introducing the Reynolds Criterion in fluid mechanics, firstly the fluid status of security market can be divided into steady state fluid market and unsteady state fluid market. Secondly, the liquidity model is established in the form of a coefficient multiplying the ratio of turnover rate and market viscosity which is represented as the percentage of trader's asset composition, then the threshold of fluid state conversion can be calculated. Empirical results show that the liquidity in these two fluid statuses differs obviously. The Reynolds Criterion-based model can not only effectively identify the measuring problem in liquidity of financial market, but also provide fundamentals for further research of some significant characteristics of steady state fluid market and unsteady state fluid market.

Keywords : Market Liquidity, Fluid Status, Reynolds Criterion, Experimentation

Note : Reynolds Criterion reveals that if the in two fluids are in proportion, the Reynolds number of the two fluids is same. Reynolds number is a measure of the ratio of inertial forces and viscous forces. Consequently, it quantifies the relative importance of these two types of forces for given flow conditions. The main contribution of Reynolds number is that it can be used to identify and predict different flow regimes, such as laminar or turbulent flow. Laminar flow occurs at low Reynolds numbers, where viscous forces are dominant, and is characterized by smooth, constant fluid motion, while turbulent flow, on the other hand, occurs at high Reynolds numbers and is dominated by inertial forces, which tend to produce random eddies, vortices and other flow fluctuations.

A New Pseudo Bayesian Model for Financial Crisis

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Abstract

Barberis, Shleifer and Vishny (1998) and others have developed Bayesian models to explain investors' behavioral biases by using the conservatism heuristics and the representativeness heuristics in making decisions. To extend their work, Lam, Liu, and Wong (2010) have developed a model of weight assignments using a pseudo-Bayesian approach that reflects investors' behavioral biases.

In this parsimonious model of investor sentiment, weights induced by investors' conservative and representative heuristics are assigned to observations of the earning shocks of stock prices. Such weight assignments enable us to provide a quantitative link between some market anomalies and investors' behavioral biases. This paper extends their work further by developing properties to explain some market anomalies including short-term underreaction, long-term overreaction, and excess volatility during financial crisis. We also explain in details the linkage between these market anomalies and investors' behavioral biases during financial crisis.

A Girsanov Type Theorem under G Frame Work and Its Application in Finance

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[**]*Institute of Statistics and Probability, School of Statistics,*
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Abstract

This article establishes a Girsanov type theorem under the G-Framework of Peng (2006). Our result generalizes the classical Girsanov theorem for Brownian motion. As an application, we price the European call option when the underlying asset's price follows the Geometric G-Brownian motion, and get the related partial differential equations.

Keywords : G-Brownian motion, G-expectation, Girsanov theorem.

New Perspectives in Optimal Portfolio Choice

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Department of Information, Risk, and Operations Management &
Red McCombs School of Business
The University of Texas at Austin
and
Oxford-Man Institute and University of Oxford

Abstract

A new approach to portfolio management will be discussed. It offers flexibility with regards to variable horizons, different numeraires and alternative market views. The performance process is characterized as the solution of a stochastic partial differential equation. An interesting connection between this formulation and the classical static mean-variance one will be also presented.

Mathematicalising Behavioural Finance

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Abstract

This talk presents an overview of the recent development on mathematical treatment of behavioural finance, primarily in the setting of continuous-time portfolio choice under the cumulative prospect theory. Financial motivations and mathematical challenges of the problem are highlighted. It is demonstrated that the solutions to the problem have in turn led to new financial and mathematical problems and machinery.

Stream 5

Actuarial Science / Insurance Mathematics
Organizers : Elias Shiu, Ping-Kei Leung, Hailiang Yang

Claim Dependence Modelling with Lévy Copulas

Benjamin Avanzi
Luke Cassar
Bernard Wong
Australian School of Business
University of New South Wales

Abstract

Insurance claims in multiple classes of business are often characterised by dependence in both frequency and severity. Whilst compound Poisson processes are a natural choice to model the incurrence of insurance claims over time, the case of multiple classes of business requires careful consideration of the dependence structure inherent in such a setting. Lévy copulas enable a coherent way of modelling dependence between compound Poisson processes with dependence in both frequency and severity being modeled simultaneously. Furthermore, Lévy copulas model dependence between stochastic processes as opposed to random variables alone.

We provide a methodology for modelling dependence with Lévy copulas and discuss ways of assessing the fit of different Lévy copulas to a dataset. This is illustrated with a new real data set of worker's compensation claims in Switzerland. Motivated by this data analysis, new Lévy copulas are introduced and compared.

It is found that there are many merits of using Lévy copulas as an alternate tool for modelling dependence in insurance portfolios over existing methods of modelling dependence such as distributional copulas.

Keywords : Lévy copula, Dependence, Compound Poisson process, Insurance claims, Data fitting

Asymmetric Risk Measures

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Abstract

The asymmetric financial and actuarial risk measures based on Wang's distortion risk measures, which reflect distinct risk perceptions in the cases of profits and losses, are defined and studied. This difference in terms of risk attitude was established in Kahneman-Tversky's prospect theory. Asymmetric variants of some other risk measures such as Pedersen-Satchell measure, Orlich measure, spectral measure are defined. New risk measures based on Value-at-Risk and Conditional Value-at-Risk which take into account the weights of both left and right tails of profit distribution are defined too.

The described risk measures are applied in portfolio optimization. For this purpose some special characteristics of profitability are defined and the technique of estimating of risk measure efficiency is developed. The results of numerical experiments for estimating efficiency of these measures in different markets are described.

They show that defined risk measures are efficient in many cases.

[This research is supported by Russian Foundation for Basic Researches (project 10-06-00001).]

Markowitz's Mean-Variance Asset-liability Management with Regime Switching : A Multi-Period Model

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[**]*Department of Statistics and Actuarial Science, The University of Hong Kong*

Abstract

This paper considers an optimal portfolio selection problem under Markowitz's mean-variance portfolio selection problem in a multi-period regime switching model. We assume that there are $n + 1$ securities in the market. Given an economic state which is modeled by a finite state Markov chain, the return of each security at a fixed time point is a random variable. The return random variables may be different if the economic state is changed even for the same security at the same time point. We start our analysis from the no-liability case, in the spirit of Li and Ng (2000), both the optimal investment strategy and the efficient frontier are derived. Then we add uncontrollable liability into the model. By direct comparison with the no-liability case, the optimal strategy can be derived explicitly.

Keywords : discrete-time, multi-period, regime switching, Markov chain, asset-liability management, portfolio selection, efficient frontier.

A Two-Dimensional Risk Model with Proportional Reinsurance

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The University of Hong Kong

Abstract

In this paper, we consider an extension of the two-dimensional risk model introduced by Avram, Palmowski and Pistoris (2008, IME). To this end, we assume two insurers in which the first is subject to claims arising from two independent compound Poisson processes. The second insurer, which can be viewed as a different line of business of the same insurer or as a reinsurer, covers a proportion of the claims caused by one of these two compound Poisson processes. An explicit formula for the Laplace transform of the time until at least one insurer is ruined is derived when the claim severities follow arbitrary distribution. If time permits, numerical examples are given to illustrate the effect of risk sharing or reinsurance on the time of ruin.

[This is a joint work with Andrei Badescu and Landy Rabehasaina.]

Conditional Comonotonicity and Its Applications

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Abstract

The notion of conditional comonotonicity was first employed implicitly in Kaas et al. (2000) and was formally introduced in Jouini and Napp (2004) as a generalization of the classical concept of comonotonicity. In this talk, construction and characterization of conditionally comonotonic random vectors will be discussed. The usefulness of this concept is then illustrated through some actuarial applications such as improved convex upper bounds construction and optimal allocation of policy limits.

The Finite- and Infinite-time Ruin Probabilities of a Bivariate Lévy-Driven Risk Process with Heavy Tails

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[**]*Department of Statistics and Actuarial Science, The University of Iowa*

Abstract

We study the infinite- and infinite-time ruin probabilities of an insurance risk model proposed in a series of papers by Paulsen. In this model, the surplus process is modeled as a general bivariate Lévy-driven risk process in which one Lévy process, representing a loss process in a world without economic factors, is compounded by another Lévy process, describing return on investments. Motivated by a conjecture of Paulsen (2002; *Ann. Appl. Probab.*), we consider the case in which the first Lévy process has a heavy-tailed Lévy measure and the other Lévy process fulfills a certain moment condition, and we obtain a simple unified asymptotic formula, which confirms Paulsen's conjecture.

Reference

[1] Paulsen, J. On Cramér-like asymptotics for risk processes with stochastic return on investments. *Ann. Appl. Probab.* 12 (2002), no. 4, 1247-1260.

Designing an Insurance Programme to Deal with Systemic Risk

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Phelim Boyle
School of Business and Economics, Wilfrid Laurier University

Abstract

This paper proposes a framework for measuring and managing systemic risk. Current approaches to solvency regulation have been criticized for their focus on individual firms rather than the system as a whole. Our procedure shows how an insurance program can be designed to deal with systemic risk through a risk charge on participating institutions. We use the Conditional Tail Expectation (Tail VaR) to compute the risk exposure and the premiums. One of the frequent criticisms of the current regulations is that the capital requirements have a pro-cyclical impact since they require extra capital in periods of extreme stress thus exacerbating a crisis. We show how to implement an insurance program that is counter-cyclical and we illustrate the procedure using a numerical example.

Keywords : Systemic risk, pro-cyclical risk charge, risk capital, CoVaR, CoCTE, regime switching

Guaranteed Minimum Withdrawal Benefit in Variable Annuities

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Abstract

We develop a singular stochastic control model for pricing variable annuities with the guaranteed minimum withdrawal benefit. This benefit promises to return the entire initial investment, with withdrawals spread over the term of the contract, irrespective of the market performance of the underlying asset portfolio. A contractual withdrawal rate is set and no penalty is imposed when the policyholder chooses to withdraw at or below this rate. Subject to a penalty fee, the policyholder is allowed to withdraw at a rate higher than the contractual withdrawal rate or surrender the policy instantaneously. We explore the optimal withdrawal strategy adopted by the rational policyholder that maximizes the expected discounted value of the cash flows generated from holding this variable annuity policy. An efficient finite difference algorithm using the penalty approximation approach is proposed for solving the singular stochastic control model. Optimal withdrawal policies of the holders of the variable annuities with the guaranteed minimum withdrawal benefit are explored. We also construct discrete pricing formulation that models withdrawals on discrete dates. Our numerical tests show that the solution values from the discrete model converge to those of the continuous model.

[This is a joint work with Min Dai and Jianping Zong, Department of Mathematics, National University of Singapore.]

Optimal Insurance with Investment and Consumption Using a Regime Switching Model[#]

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***Department of Actuarial Studies, Macquarie University*
****Department of Mathematics, The University of Hong Kong*

Abstract

In this work, we investigate the optimal insurance problem together with investment and consumption. We assume that market parameters change over time according to the state of the economy, which is corresponding to a continuous time Markov Chain. By dynamic programming principle, the problem is reduced to solving a system of regime-switching HJB equation. For power utility and exponential utility, we derive analytical solutions to the optimal strategy. To document the impact of switching regimes, we present some numerical results.

[# This research is supported by RGC Grant PolyU 5321/07E.]

Mutual Reserve as a Governance Structure : Optimization and Coordination

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Abstract

Mutual Reserve Optimization Problem

1. Individual versus mutual insurance: competition versus collaboration
2. Two-way contingent option: call and refund
3. Two-band control policy: ($a, A; B, b$)
4. QVI Characteristics of ($a, A; B, b$): Optimal band [a^*, b^*]
5. Computational solution methods and algorithms

Mutual Reserve Coordination

1. Linear premium; non-linear option distribution
2. Coordination with principle of mutuality under uncertain claims
3. Incentive mechanism with linear premium under symmetric information

Application of Comonotonicity Theory in Stochastic Life Annuity

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Abstract

A life annuity contract is an insurance instrument which pays pre-scheduled living benefits conditioning on the survival of the annuitant. In order to manage the risk borne by annuity providers, one needs to take account of all sources of uncertainty that affect the value of future obligations of the contract. In this paper, we define the concept of annuity rate as the conditional expected present value random variable of future payments of the annuity. The annuity rate deals with the non-diversifiable systematic risk containing in the life annuity contract, and it involves mortality risk as well as investment risk. While it is plausible to assume that there is no correlation between two risks, each on its own possesses a strong positive dependence among its components. In order to understand the probabilistic profile of the annuity rate, we apply comonotonicity theory to derive the convex order upper and lower bounds of the studied variable. More specifically, we use Lee-Carter model for mortality risk and Vasicek model for the term structure of interest with an annually renewable fixed-income investment policy. We have shown that our analytical comonotonic formulas can provide very accurate approximations to the annuity rate.

Market Versus Self Insurance of Longevity Risk

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Abstract

Empirical studies of demography in the OECD countries show that the decline in mortality adheres to the Monotone Probability Ratio Order criterion (introduced by Eeckhoudt and Gollier, 1995). According to this criterion, the ratio of changes in mortality along time decreases with age (Machnes, 2003). This trend shows that pooling the liabilities of annuities and life insurance contracts can protect their providers from longevity risks but, as most of the financial institutions act separately in these insurance branches, pooling arrangements require a market.

Managers of insurance companies and pension funds try to avoid volatility in their accounting reports, but before applying to the capital markets, pension funds need to protect their balance sheet by immunizing their bonds according to the life expectancy of their insured clients and holding assets that are positively correlated with longevity, such as shares of pharmaceuticals, long term home-care ownership etc. Holding shares of life insurance companies does not always contribute positively. The decline in mortality in the last decade was not enough to prevent losses for many life insurers. Other changes in the financial markets including fluctuating interest rates and competition hurt insurers and were followed by mergers and acquisitions that decreased the number of life insurers. Applying to the capital markets for re-insurance of longevity risks can be done in the case of risks that are anticipated for the near future and cannot be hedged by assets.

This study analyzes the optimal welfare of an individual who has to choose a pension plan as part of his/her employment contract or country regulations. It has been shown (Machnes, 1978) that pooling independent risks by a group of individuals is Pareto optimal and is in the core of the economy. But in the real world, there are transaction costs in pension plans and the loading factor reduces the size of the optimal insurance coverage (Davidoff, Brown and Diamond, 2005). Usually, a pension plan provides benefits up to 70% of the worker's average salary over time. Empirical surveys have not found individuals who voluntarily bought an annuity in addition to their pension plan. On the other hand, many members of pension funds cash in their benefits when they retire, although the present value of future benefits is based on a relatively high discount rate, assuming that the health status and life expectancy of these members is relatively low, leaving the healthier members behind in the fund.

Individuals also face background risks in several dimensions including their own health and that of their spouse and children, medical expenditures and the purchasing power of their future nominal income. Most of them have bequest motives and want to leave assets after their death. All these factors influence their demand for annuities. In fact, studies of individuals' preferences show that partial insurance coverage of their old age income is optimal and thus a participating pension plan

should be suggested to them. In this plan there are no defined benefits (DB) and the pension depends on the returns from their accumulated contributions and the future national life expectancy projections estimated by an official institute. Individuals can move their accumulated contributions from one pension fund to another to assure competition among the pension funds. Defining the pension benefits on retirement for each age cohort can be done by immunization of bonds and re-insurance of longevity risk but these arrangements through the capital markets will reduce benefits. The pension fund should suggest to its insured members to choose the contract they prefer.

Participating pension plans reduce the uncertainty that pension funds face and increase the expected value of pensions. Designing a pension plan with DB, both for newcomers and pensioners will allow individuals to compare and choose the plan they prefer. It is important for the members of the pension fund to be involved in the choice of their plan and be aware of the cost of longevity re-insurance and the guaranteed rate of returns. Presenting alternative pension plans to individuals will let them optimize their welfare and can eliminate the principal-agent gap. When sharing the longevity risk with members of the pension fund who are willing to participate in risk, the demand by the pension funds for longevity re-insurance reflects the risk aversion of its members and not of their managers.

The actuarial deficits of the existing pension funds that already promised DB when mortality rates and returns to assets were relatively high is mainly a social and political problem. Governments should decide whether to help these funds by imposing their deficits on the younger generations or by establishing a legal solution that will cut down the pension defined benefits.

Corporate Bond Modelling for Insurance Applications

Hal Pedersen
University of Manitoba

Abstract

Insurer's hold a variety of debt instruments that involve credit risk. Simple examples are corporate bonds, municipal bonds and in some cases sovereign bonds. Consequently, insurers require models that are capable of producing realistic spread and default scenarios as well as realistic total returns. Furthermore, in most applications the model must provide a rating for the bond so that risk-based capital requirements can be applied. In this paper we discuss the fundamental attributes of the corporate bond market. We then review various approaches to the modelling of corporate bonds and discuss some recent models that are able to meet the needs of robust insurance modelling. Lastly, we talk about possible modelling adjustments that might be of use in capturing aspects of the credit crisis to achieve rich but plausible simulation scenarios.

Life Insurance and Annuity Demand under Hyperbolic Discounting

Sachi Purcal[*] *and Siqi Tang*
[*]*Macquarie University*

Abstract

In the tradition of Merton (1969, 1971) we seek to describe the optimal behaviour of an individual through his lifetime. Our model is based on a stochastic control model of Richard (1975), which includes optimal insurance and annuity demand. We extend that work by allowing for hyperbolic discounting, rather than the typical exponential discounting structure. This extension provides a theoretical explanation for the observed thinness of voluntary annuity markets worldwide.

Keywords : Hyperbolic discounting, optimal portfolio selection, life insurance, annuities, stochastic control.

Credit Risk Charge Determination Using Default Probability

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Abstract

The objective of this paper is to measure the risk charge for credit risk as one of the components in the risk-based capital of capital adequacy framework. Currently, risk charge for credit risk is measured by referring to the credit rating of a company. Following the subprime crisis in 2007, the markets start to question the soundness of the credit rating issued as it has resulted inadequate risk charge. Therefore, this study attempts to determine the risk charge for credit risk using the probability of default. Firstly, the credit risk is categorized into several types of debt obligations. Then, the KMV-Merton model is used to measure the distance to default and hence the probability of default is estimated. The estimation of default probability is based on movement in the price index of several debt obligations. The price index of debt obligations from year 1994 to 2008 is collected inclusive of the financial crisis period. The finding shows that there is an increase probability of default during the financial crisis. Therefore, the default probability could come into play as a new reliable measure for risk charge of credit risk.

Keywords : credit risk, risk charge, probability of default, KMV-Merton

On the Design of Mutual Insurance Contracts

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Ajou University

Abstract

We present a model for the design of mutual insurance contracts in the presence of moral hazard. The contract includes such components as insurance premium, accident loss coverage, excess-premium redistribution, and shortage costs. Unlike Lee and Ligon (2001), we show that the full loss coverage of each accident cannot be optimal.

Executive Pay and Firm Size in the Presence of Career Concerns and Labor Market Competition

Jaeyoung Sung
Ajou University

Abstract

We exposit an integrated agency model of multi-period career concerns and labor market equilibrium with managerial reservation utility levels, and thus pay levels, determined endogenously for firms of different sizes. Stochastic managerial talent takes two forms : a manager drawn from a tighter talent distribution with a higher mean is *ipso facto* more talented. Managerial talent enters into a nested stochastic production function that encompasses an agency model with a manager that responds to effort incentives and a multiplicative talent assignment model with the most talented manager assigned to the largest firm. Effort incentives are redundant in the assignment specification. Utilizing observations from a long time-series of S&P 1500 companies, we estimate this function describing the incremental wealth created by the manager as a function of "effort", latent raw "talent", idiosyncratic firm risk (asset volatility) and the opening value of assets employed. Our empirical findings support the agency specification such that incentives matter rather than the assignment specification. We show that CEO talent affects the marginal productivity of the firm at approximately twice the rate as effort. Since asset volatility is also more subject to scale effects than effort, risk per marginal product of effort is higher in larger firms. Due to the cost of compensating managers for risk, pay-performance sensitivity optimally declines with size given the empirical parameters that we estimate. We believe ours to be the first to explain this well-established empirical fact. Furthermore, our talent estimates explain much of the increments to real CEO pay levels and income over recent decades as a response to increases in talent and as compensation for higher risk borne by executives, with firm size growth playing a negligible role. The explanatory power of talent and risk is high with an R^2% 82% in the model explaining increments to pay. Our estimated talent distribution is largely uncorrelated with firm size. We also identify the most talented CEOs who earned enterprise returns 17 times higher than the CEOs of the largest firms.

[This is a joint work with Peter L. Swan, University of New South Wales.]

Extreme Value Theory in the Study of Ruin with Risky Investments

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The University of Iowa

Abstract

We look at a discrete-time insurance risk model in which periodic claim amounts and premium incomes form a sequence of i.i.d. random vectors. The insurer is allowed to invest a constant fraction of his/her wealth in a risky stock and keep the remaining wealth in a risk-free bond. We use extreme value theory to study the finite-time ruin probability. If the periodic net losses follow a subexponential distribution, we obtain a general exact asymptotic formula. If the loss distribution also belongs to the max-domain of attraction of the Fréchet or Gumbel distribution and that the return rates jointly follow Sarmanov's distribution, the general formula can be refined to be completely transparent.

[This is a joint work with Raluca Vernic and Zhongyi Yuan.]

The Demand for Insurance and its Market Price

Charles Tapiero
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Abstract

Insurance is a risk sharing agreement between two or more parties, based on an agreement tailored to meet the needs and the requirements of each of the parties. Fundamental papers to assess the demand for insurance were based on a utility rationale. Such demand for insurance is then a function of the taste for risk and the price of insurance. The growth of financial markets and credit derivatives based on securitized portfolios has expanded further both the financial marketing of insurance and financial markets' ability to price insurance contracts. Insurance has contributed in an essential manner to the commoditizing financial products such as CDO's. The purpose of this paper is to assess the demand for insurance using an insured utility and its implied financial market price. A number of results will point out to coherence with classical results in insurance (for example, Arrow deductibility theorem) and provides an explicit definition of the demand for insurance. In particular, the consumers' deductibility preferences, embedded in the market price of risk, combined with a personal assessment of the underlying risk of the insured, are shown to define the explicitly the implied inverse demand function for insurance. Applications to financial insurance and the implication of insurance to the future of financial credit markets is discussed as well.

On Esscher Transforms : Theory and Financial Applications

Serena Tiong

Abstract

The method of Esscher transforms is a time-honored tool in actuarial science and statistics. Its applications range from approximating the tail distribution of aggregate insurance claims to pricing financial options and derivatives. In an incomplete market, the Minimum Entropy Martingale Measure is a popular method for pricing options as the option price obtained by the Minimum Entropy Martingale Measure is consistent with the price achieved by maximizing the exponential utility function. For exponential Lévy process, the Minimum Entropy Martingale Measure turns out to be the same as the measure obtained under the method of Esscher Transform. Examples of financial applications will be given in the talk.

Stress Testing Bank's Credit Risk Using Mixture Vector Autoregressive Models

Albert Chun Shan Wong
The Chinese University of Hong Kong
Tom Pak Wing Fong
Hong Kong Monetary Authority

Abstract

This paper estimates macroeconomic credit risk of banks' loan portfolio based on a class of mixture vector autoregressive models. Such class of models can differentiate distributions of default rates and macroeconomic conditions for different market situations and can capture their dynamics evolving over time, including the feedback effect from an increase in fragility back to the macroeconomy. These extensions can facilitate the evaluation of credit risks of loan portfolio based on different credit loss distributions.

A Benchmarking Approach to Optimal Asset Allocation for Insurers and Pension Funds

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University of California

Bernard Wong
School of Actuarial Studies
University of New South Wales

Abstract

We solve the optimal asset allocation problem for an insurer or pension fund by using a benchmarking approach. Under this approach the objective is an increasing function of the relative performance of the asset portfolio compared to a benchmark. The benchmark can be, for example, a function of an insurer's liability payments, or the (either contractual or target) payments of a pension fund. The benchmarking approach tolerates but progressively penalizes shortfalls, while at the same time progressively rewards out-performance. Working in a general, possibly non-Markovian setting, a solution to the optimization problem is presented, providing insights as to the impact of benchmarking on the resulting optimal portfolio. We further illustrate the results with a detailed example involving the an option based benchmark of particular interest to insurers and pension funds, and present closed form solutions.

Keywords : Asset-Liability Management, Portfolio Optimization, Benchmarking.

A Threshold-based Risk Process with a Waiting Period to Pay Dividends

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Abstract

For many of the threshold-based risk models found in the literature, it is typically the case that the dividends modification involves the introduction of a fixed level $b > 0$, so that whenever the surplus process upcrosses level b, the insurer automatically begins paying dividends to shareholders at some specified rate. The same essential principle applies as the surplus process moves up and down over time, potentially upcrossing level b several times in the process. A particular shortcoming in this type of model lies in the fact that the company is presumed to be healthy enough to begin paying dividends the very moment level b is reached, instead of perhaps trying to assess whether the company can sustain a good period of health by remaining above the threshold for a certain length of time.

Motivated by the concept of Parisian implementation delays in both finance and insurance literature, a variation of the threshold-based risk model is proposed in this talk. In such a model, dividends only get paid provided that a constant threshold level b is reached and some period of "good health" is sustained above the threshold. In the ordinary (or delayed) Sparre Andersen insurance risk model under this modified threshold assumption, recursive formulas for the expected discounted dividend payment and finite-time ruin probabilities are derived. In several numerical examples, we examine the effect of health period on the expected discounted dividend payment and the ruin probabilities, which vary depending on distributions for the interclaim times and the claim sizes.

[This is a joint work with Steve Drekic, Department of Statistics & Actuarial Science, University of Waterloo, Ontario, Canada.]

Insurance Risk Models : With and Without Dividends

Hailaing Yang
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The University of Hong Kong

Abstract

Risk theory is one of the most important research areas in actuarial science. In the literature, sophisticated methods have been developed and applied, such as renewal theory, Laplace transforms, and deep analytical tools. In this talk I shall present a new and accessible approach to establishing certain results concerning the Gerber-Shiu function. We consider insurance risk models with two sided jump. The method consists of two steps. In the first step, results are derived for the case where the claim amount distribution is a combination of exponential distributions. A rational function is a handy tool in this context. The second step is based on the observation that any claim amount distribution can be obtained as a limit of a sequence of combinations of exponential distributions. Thus it suffices to translate in general terms the results of the first step, in order to obtain results for an arbitrary claim amount distribution. Then we introduce the dividend payments into the insurance risk model, we consider the dividends-penalty identity. Using the dividends-penalty identity, we study the problem of maximizing the expected discounted total dividends and minimizing the penalty. This talk is based on two joint papers, one with Albrecher and Gerber and the other one with Gerber and Lin.

Bayesian Dynamic Modeling of Implied Default Correlation : An Empirical Study on Japan Credit Default Swap Market

Jiashen You[*] *& Tomohiro Ando*[**]
[*]*University of California*
[**]*Keio University*

Abstract

After the subprime mortgage crisis, market participants have realized that default correlation, a measure of the dependence among risks, is a central premise of credit risk modeling along with probability of default and loss given default. An accurate quantification of default correlation not only helps us to price collateralized debt obligations, but also provides useful information for overall portfolio management.

Empirically, it is known that default correlation is time-varying. This paper thus investigates the time-varying default correlation in a credit default swap market, which has been growing rapidly. Although the notional amount had fallen after the subprime mortgage crisis, International Swaps and Derivative Association estimated that the notional amount outstanding still remained over $30 trillion by the end of 2009.

In the Bayesian dynamic modeling framework, we develop a new method to quantify time-varying default correlation from panel data of credit default swap returns along with information from other financial markets, including economic variables that would simultaneously affect the default probabilities of many firms. To implement the dynamic update of the time-varying default correlations easily, the analytical Bayesian updating system is obtained.

Data from the Japan CDS market is analyzed using the proposed method. The results suggest that the number of factors that governs implied default correlation changes little over an extended period but dropped quickly when the subprime mortgage crisis hits the world economy. Further analysis on the data segmented by different economic environments is carried out. Details will be presented at the conference.

On a Discrete-Time Risk Model with Delayed Claims and Dividends

Kam Chuen Yuen[*], *Jinzhu Li*[**], *Kam Pui Wat*[*], *Wai Keung Li*[*]
[*]*Department of Statistics and Actuarial Science, The University of Hong Kong*
[**]*School of Mathematical Sciences, Nankai University*

Abstract

In the actuarial literature, the study of dependence among claims and the issue of dividend payments have become popular topics in recent years. In this talk, we consider the discrete-time compound binomial risk model with delayed claims and randomized dividends. For the risk model, we derive explicit expressions for the Gerber-Shiu discounted free function. Using these expressions, we are able to obtain formulae for some useful insurance quantities, including the ruin probability, the density of the deficit at ruin, the joint density of the surplus immediately before ruin and the deficit at ruin, and the density of the claim causing ruin.

Keywords : By-claims, Compound binomial risk model, Delayed claims, Generating function, Gerber-Shiu function, Randomized dividends, Ruin probability.

Dividend Optimization in a General Risk Model

Jinxia Zhu
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Abstract

As a widely discussed topic, the dividend optimization problem is to determine the times and the amount of dividend payments such that the expected value of the cumulated discounted dividends will be maximized, which, sometimes, is considered as the value of the company. We first review the commonly used approach in solving this problem in a variety of situations in the literature. Then the applicability of such approach to generalized models is examined and the main technical issues that may arise when applying the approach to general models are pointed out. Furthermore, we study a more sophisticated model with external impacts included, where the above-mentioned common approach does not work. The method of solving the optimization problem in this case is demonstrated and the obtained results are discussed.

Stream 6

Financial Mathematics and Risk Management
Organizers : Shige Peng, Cedric Yiu, James Huang, Xun Li

Efficient Simulation Schemes for some Multidimensional Stochastic Volatility Models

Aurélien Alfonsi
Ecole des Ponts (Paris Est University)

Abstract

Recently, a great attention has been paid in mathematical finance to Wishart processes and affine diffusions on positive semidefinite matrices. These processes arise naturally when modeling the stochastic volatility in a multidimensional framework. We will present both exact and high-order discretization schemes for Wishart processes, by using a remarkable splitting of their infinitesimal generator. Numerical results and financial applications will be given.

Some Estimates in Extended Stochastic Volatility Models of Heston Type

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Universite Paris-Est

Abstract

We show that in log-normal like stochastic volatility models with additional local volatility functions, the tails of the cumulative distribution of log-returns behave as exp(-*c*|*y*|), where c is a positive constant depending on time and on model parameters. This estimate stems from the proof of a stronger result : using some estimates for the probability that an Itô process remains in a tube around a deterministic curve, we lower bound the probability that the couple (*X*, *V*) remains around a two-dimensional curve up to a given maturity, *X* being the log-return process and V its instantaneous variance. Then we set an optimization procedure on the set of admissible curves, leading to the desired lower bound on the terminal cdf. Even though the involved constants are less sharp than the ones derived for stochastic volatility models with a particular structure such as Heston ([1, 12, 6]), these lower bounds entail moment explosion.

Keywords : Law of the Stock price, Local and Stochastic Volatility, Moment Explosion, Ito processes around deterministic curves

Monte Carlo simulation on American Option Sensitivities

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Abstract

We investigate efficient Monte Carlo simulation estimators to American option ensitivities. Using the continuous-fit condition of the optimal exercising boundary, we manage to derive unbiased pathwise estimators for first-order derivatives. This method can be easily embedded to some popular pricing algorithms to generate sensitivities as by-products. A mix estimator for second-order sensitivities are also suggested in the paper. Numerical experiments under single and multi asset-based American options illustrate accuracy and efficiency of our method.

Strong Laws of Large Numbers for Sublinear Expectations

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Abstract

In this paper, with the notion of independent identically distributed random variables under sub-linear expectations initiated by Peng, we derive three kinds of strong laws of large numbers for capacities. More over, these theorems are natural and fairly neat extensions of the classical Kolmogorov's strong law of large numbers to the case where probability measures are no longer additive. Finally, an important feature of these strong laws of large numbers is to provide a frequentist perspective on capacities.

The Timing and Pricing for IPO Based on Motivation

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**Lehigh University*
***Business School, Sun Yat-sen University*

Abstract

Using the real options and game theory, the paper research the timing and pricing for IPO. Four kinds of closed solutions of optimal timings and equilibrium pricings for IPOs are given, which be driven by financing, investment and merger, respectively. The results shows, if other conditions are unchanged, the timing for IPO is increasing in equilibrium IPO price, increasing in capital of the IPO firm. The equilibrium pricing for IPO is increasing in the offer proportion. The exchange costs will delay IPOS. The reduction of the volatility will delay the IPO, but there are dual effects.

Optimal Stopping with Time Consistency

Hanqing Jin
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University of Oxford

Abstract

When the objective in an optimal stopping problem depends on the starting time and status, the problem usually admits no classical optimal solution. In this case, time-consistency optimal stopping time is defined only in a finite discrete-time system. In this paper, we define a time-consistent optimal stopping time in a continuous-time Markovian system with finite or infinite time horizon, which is compatible with both the classical one in a continuous-time system and the general one in a finite discrete-time system. Our definition ensures the uniqueness of the time-consistent optimal stopping time. Furthermore, we develop a scheme to find out the optimal stopping time under some technical conditions.

Pricing Spread Options by Approximate Operator Splitting Method

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The Chinese University of Hong Kong

C.H. Hui
Research Department, Hong Kong Monetary Authority

Abstract

Despite the wide applicability of spread options, the pricing of this class of options remains a formidable task. The major difficulty encountered in spread option pricing lies in the lack of knowledge about the dynamics of the difference between two correlated stochastic processes, except the Ornstein-Uhlenbeck (OU) processes. For instance, the difference between two correlated lognormal random variables does not possess an analytical probability density, and thus it is impossible to derive a closed-form formula for the option price. Moreover, since no analytical joint probability density is available for two underlyings obeying the Cox-Ingersoll-Ross (CIR) processes with correlation, one must resort to time-consuming numerical methods to tackle the pricing problem. Nevertheless, the market practitioners often find the analytic approximations more desirable because of their computational ease.

In this paper we propose an approximate operator splitting method to valuate spread options near expiry. By means of this new approach we are able to derive the short-term dynamics of the difference between two correlated (i) OU processes, (ii) CIR processes and (iii) lognormal processes in a straightforward manner. As expected, in case (i) the short-term dynamics of the spread is found to obey an OU process. In case (ii) the resultant process of the difference can be identified as a CIR process. It is well known that these two cases admit closed-form option price formulae. However, in case (iii) the short-term spread dynamics is shown to be modelled by a stochastic variable subject to correlated multiplicative and additive noise, and the corresponding option price can be analytically expressed by a numerical quadrature. Numerical tests indicate that the proposed approximate operator splitting method is able to give accurate estimates to the prices of spread options with maturities up to one or two years, and the computational time is minimal compared with other standard numerical methods.

Valuation of CEV American put Option with Time-dependent Model Parameters

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The Chinese University of Hong Kong

C.H. Hui
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Abstract

In the past few decades the financial market has undergone a revolutionary period of tremendous growth and dramatic changes. The explosive growth in the use of derivatives by investors has led major banks and financial firms around the globe to seek ever more powerful means of their efficient and accurate valuation. Despite more than three decades of efforts, efficient and accurate valuation of American options is still a fundamental problem in mathematical finance.

The major difficulty of pricing American put option lies in the unknown optimal early exercise boundary. Once the early exercise boundary is determined, the valuation of option price does not generally present any difficulties, whether in terms of accuracy or efficiency. Only recently, the explicit early exercise boundary of American put option under Black-Scholes model was presented by Zhu (2006) in terms of infinite series expansion. However, the evaluation of the infinite series expansion is computationally intensive. Moreover, empirical evidence has shown that the CEV process seems to give a better description of stock behaviour than the lognormal process employed by Black-Scholes model because the CEV process allows for a non-zero elasticity of return variance with respect to underlying prices. Pricing a CEV American option is thus of considerable interest.

In this paper we present an accurate and efficient moving boundary approach to tackle the CEV American put option with time-dependent model parameters. Our new method transforms the original free boundary problem into a monotonic sequence of moving boundary problems each of which can be solved by analytic techniques. Illustrative examples demonstrate that the moving boundary approach is able to provide accurate approximations to both the optimal early exercise boundary and the fair value of the American option very efficiently. The accuracy of the approximations can be improved systematically by the proposed multi-stage approximation scheme without compromising the efficiency. The computational time is minimal compared with other standard numerical methods. Furthermore, the model parameters are assumed to be time-dependent whose term structures can provide a better description of the financial market.

Stochastic Representation for Solutions of Isaacs' Type Integral-Partial Differential Equations

Juan Li
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Shandong University

Abstract

In this talk we study the integral-partial differential equations of Isaacs' type by zero-sum two players stochastic differential games (SDGs) with jump-diffusion. The results of Fleming and Souganidis (1989) and those of Biswas (2009) are extended, we investigate a controlled stochastic system with a Brownian motion and a Poisson random measure, and with nonlinear cost functionals defined by controlled backward stochastic differential equations (BSDEs). Furthermore, unlike the two papers cited above the admissible control processes of two players are allowed to rely on all events from the past. This quite natural generalization permits the players to consider those earlier information, and it makes more convenient to get the dynamic programming principle (DPP). However, the cost functionals are not deterministic any more and hence also the upper and the lower value functions become a priori random fields. We use a new method to prove that, indeed, the upper and the lower value functions are deterministic. On the other hand, thanks to BSDE methods (1997) we can directly prove a DPP for the upper and the lower value functions, and also that both these functions are the unique viscosity solutions of the upper and the lower integral-partial differential equations of Hamilton-Jacobi-Bellman-Isaacs' type, respectively. Moreover, the existence of the value of the game is got in this more general setting under Isaacs' condition.

[This is a joint work with Rainer Buckdahn, Université de Bretagne Occidentale, France; Ying Hu, Université Rennes 1, France.]

A Fast Numerical Scheme for Discrete-Monitored Interest Rate Barrier Options

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The Hong Kong Polytechnic University

Abstract

Discretely monitored barrier options are path-dependent options whose Payoff is determined by the value of the underlying asset at some discrete time epochs along its path. Traditional numerical schemes suffer from either the curse of dimensionality or the barrier-too-close difficulty. In this paper, we have successfully designed a fast algorithm to overcome these difficulties. The barrier option has an interest rate as the underlying asset, which is assumed to follow some stochastic models. Error estimations of our scheme is also obtained.

[This is a joint work with H.K. Fung, S.P. Yung and Wei Zhou.]

Modeling Selection and Calculation of CVA

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Department of Mathematics
Tongji University

Abstract

In 2007 the world economy started to experience one of the worst financial crisis, some financial institutions failed including the extremely high profile bankruptcy of the investment bank Lehman Brothers and even more institutions needed external support to avoid their failure. This kind of "Domino effect" that made Counterparty Risk to be the one of the hottest topics within the financial markets. To be the measurement of Counterparty Risk, the calculation of CVA (Credit Value Adjustment) has the critical meaning.

Our presentation divides into two parts. In Part I based on the calculation of "Default Correlation" below, we decide which model will be better to describe CVA :

$$\rho(t,T)=\frac{P(t<\tau_1\le T,t<\tau_2\le T)-P(t<\tau_1\le T)P(t<\tau_2\le T)}{\sqrt{P(t<\tau_1\le T)(1-P(t<\tau_1\le T))}\sqrt{P(t<\tau_2\le T)(1-P(t<\tau_2\le T))}}$$

where τ_i is the default time of i^{th} company, $P(t<\tau_i\le T)$ is the default probability of i^{th} company, $P(t<\tau_1\le T,t<\tau_2\le T)$ is the default probability of both companies.

We find that in Reduced Form Approach which was mostly used in financial crisis, the default correlation is very small without jump and in Jump-Diffusion Model it has more meaning. In Structural Approach the correlation between companies' assets has significant affect of default correlation. So from our calculation the conclusion is that Structural Approach is better than Reduced Form Approach to calculate CVA unless the Jump-Diffusion Model is used in Reduced Form Approach.

In Part II we calculate CVA for CDS by the First Passage Model in the framework of Structural Approach. One of the key points is the calculation of cash flows at the time counterparty defaults. In the traditional models (Brigo and Pallavicini (2007), Lipton and Sepp (2009)) they set the value of CDS at the default time of counterparty equals to RU^+-U^-, where U is the CDS value without Counterparty Risk, R is the recovery rate. In the latest papers (Crepey, etc.(2009), Wei and Jiang(2010)), they set value of CDS at that time equals to RV^+-V^-, where V is the CDS value with Counterparty Risk. They are quite different that the former one is linear problem and later one is nonlinear problem for calculating the value of CDS. Following the idea of Crepey, Wei and Jiang, etc., we get a new fully nonlinear partial differential equation and use penalty method (it is called the incentive function in finance) and iterative process to solve the PDE problem. We get the results which including the comparison between traditional models and the model in our presentation and the relation between companies' assets correlation and CVA to show the effect of Wrong-way Risk.

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Energy Portfolio Investment with Entry Decisions

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Missouri University of School & Technology

Abstract

Climate change is recognized as the major environmental problem faced by the world. Of most concern factors is the increase in carbon dioxide levels due to emissions from fossil fuel combustion. Therefore construction of a greener power plant, which is subject to huge initial capital investment, is crucial to reducing carbon dioxide emission. The decrease in coal reserves is also pushing power plant to generate more new green energy. Due to the uncertainties in electricity prices, alternative green energy prices, and the cost of carbon dioxide emissions, an energy portfolio should be formed to diversify the risks faced by generators. We formulate the decision-making as an optimization problem to maximize long-term profit through stochastic control and up-wind finite difference method, and solve the following problems : (1) the optimal time to build a new alternative green energy power generating plant, and (2) the optimal dispatch from the existing coal plant and the new plant.

Non Gaussian Optimization Model for Systematic Portfolio Allocation : How to Take Advantage of Market Turbulence?

Papa Momar Ndiaye
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Abstract

The financial crisis has shown, if anything, that a prudent approach based on open-loop optimization is not enough to build successful quantitative strategies for Asset Allocation. In situations where Markets deviates from normality, Traditional Markowitz allocation can be significantly improved by Dynamic Non-Gaussian optimization. Using an Incremental (two-step approach), we have successfully implemented of a Non Gaussian Model of Allocation with Positive Asymmetry Preference which yields enhanced performance in terms of Portfolio Sharpe Ratio, Sortino Ratio and Skewness.

- First, we build the best second order portfolio using a short window for observation covariance and then using a robust estimate of the covariance matrix to build a Markowitz portfolio for a dynamic auto-calibrated performance Target based on a Market volatility Index.

- In a second stage, we re-optimize the second order portfolio given a mixed objective function that combines Variance and Skewness to identify the best Market Value positions depending on observations of market regime changes, especially pattern detection for turbulent modes coming from joint dynamics of Volatility and 3rdOrder Moment.

In more mathematical terms, we have to cope with different ingredients such as Semi-definite optimization for robust representation of covariance matrices with poor condition numbers, and for the Non-Gaussian problem, we use a convex relation approach to regularize the objective term so to end up with a well-posed decision function.

The approach is illustrated on a Global macro strategy back-tested from August 2007 to November 2008 and behaved particularly well in the second-half of 2008 at the peak of the financial crisis : more than 14% of annualized performance with a Sharpe Ratio of 3.9 and Skewness between 0.4 and 0.5 depending on how the model is calibrated.

Presentation on 973 Project : "The Quantitative Analysis and Computation in the Control of Financial Risks"

Shige Peng
Shandong University

Abstract

Presentation of research objectives, main themes, some recent achievement and the prospective of Chinese National 973 Project 'Quantitative Analysis and Calculation in Financial Risk Control'. Our presentations will be focused on the following :

1. Dynamic risk measures and risk controls
2. Credit risk analysis and estimation for Chinese banks
3. Large scale computations in financial data analysis

Reduced Basis for Option Pricing with PDEs

Rama Cont[**], Nicolas Lantos[*] and Olivier Pironneau[*]
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[**]School of Mathematical Finance, University of Columbia

Abstract

To compute several options with non-constant volatilities or/and jumps, we introduce a one dimensional Galerkin basis for solving the parabolic partial integro-differential equations which arise from an Itô calculus when the random evolution of the underlying asset is driven by a Wiener process, or a Lévy process or more generally, a time-inhomogeneous jump-diffusion process.

The choice of the basis of functions is driven by the two main contraints : the numerical efficiency in the computation of the basis and the suitable global shape and correct asymptotic behavior. A convergence proof is given and numerical tests are performed on calls with nonconstant vols such as CEV. The basis is tried also for calibration of a local volatilities.

Optimal Control for Forward-Backward Doubly Stochastic Systems and Applications

Yufeng Shi
School of Mathematics
Shandong University

Abstract

In this talk we will introduce forward-backward doubly stochastic systems and their numerical simulations and the optimal control problem of fully coupled forward-backward doubly stochastic system. A necessary condition, called stochastic maximum principle (SMP in short) for the optimal control problem is proved. We apply the SMP to solve a kind of forward-backward doubly stochastic linear quadratic optimal control problem. The applications to control problem of stochastic partial differential equations (SPDEs in short) and stochastic games are shown.

Robust Portfolio Optimization and Backward Stochastic Differential Equations Games

Agnes Sulem
Inria Paris-Rocquencourt

Abstract

We consider some robust optimal portfolio problems for markets modeled by (possibly non-Markovian) jump diffusions. Mathematically the situation can be described as a stochastic differential game, where one of the players (the agent) is trying to find the portfolio which maximizes the utility of her terminal wealth, while the other player ("the market") is controlling some of the unknown parameters of the market (e.g. the underlying probability measure, representing a model uncertainty problem) and is trying to minimize this maximal utility of the agent. This leads to a worst case scenario control problem for the agent.

In the Markovian case such problems can be studied using the Hamilton-Jacobi-Bellman-Isaacs (HJBI) equation, but these methods do not work in the non-Markovian case. We approach the problem by transforming it to a stochastic differential game for backward differential equations (BSDE game). Although the relation between stochastic control and BSDEs is well-known, the application to stochastic differential games is new. Using comparison theorems for BSDEs with jumps we arrive at tractable criteria for the solution of such games, in the form of a kind of non-Markovian analogue of the HJBI equation. The results are illustrated by examples.

[This is a joint work with Bernt Øksendal, University of Oslo.]

Optimal Non-Proportional Reinsurance Control and Stochastic Differential Games

Michael Taksar
Department of Mathematics
University of Missouri College of Arts & Science

Abstract

We study a competition between two companies in the framework of the insurance market. Each of the companies has a goal to take over the other one. It is assumed that when the difference of the surpluses becomes large enough than the company with the largest surplus takes over its competitor. The companies can reduce their business risk by applying reinsurance (which also reduces their potential profit). The objective of each company is to maximize probability to take over the other company. We formulate this problem as a stochastic differential game and describe its Nash equilibrium. A closed form solution for this game is found. It is shown that finding the Nash equilibrium is equivalent to finding saddle points for a family of functions of two variables.

Investment under Uncertainty with Switching Cost using Oblique Reflected BSDE

Shanjian Tang
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School of Mathematical Sciences
Fudan University

Abstract

In this talk, we present our study on a continuous time framework on investments under uncertainty with switching costs. We have introduced a new method, of multi-dimensional backward stochastic differential equation (BSDE) with oblique reflection, which is a new type of BSDE reflected on the boundary of a special unbounded convex domain along an oblique direction, and which connects naturally to the optimal switching problem. The existence of the adapted solution is obtained by the penalization method, the monotone convergence, and the a priori estimates. We provide several typical examples to illustrate our further applications of this method to the risk analysis and management in finance and industry.

Developments and Problems for Banking and Insurance in China

Lan Wu
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Peking University

Abstract

We have been participated a project about the methodology and application of stress testing for Chinese commercial banks. We have some basic research on the assumptions and model valuations of best estimation of reserve and fair value accounting for life insurance company of China. There are some pressing problems for quantitative finance application to Chinese banks and insurance, one is the localization, another is the systematic risk. The first point means how to apply the general quantitative finance to Chinese market. More precisely, it is about how to pricing based on a rare market experience and very specific OTC contract. The latter point is highlight and more realistic, which means how to modeling the macroeconomic scenarios and the transform mechanism from macro to the industrial and individual institutions.

Inflation Derivatives : From Market Model to Foreign Currency Analogy

Lixin Wu
Department of Mathematics
The Hong Kong University of Science and Technology

Abstract

In this paper, we establish a market model for the term structures forward inflation rates based on the risk-neutral dynamics of nominal and real zero-coupon bonds. Under the market model, we can price inflation caplets as well as inflation swaptions with a formula similar to the Black's formula, thus justify the current market practice. We demonstrate how to further extend the market model to cope with volatility smiles. Moreover, we establish a consistency condition on the volatility of real zero-coupon bonds using arbitrage arguments, and with that re-derive the model of Jarrow and Yildirim (2003) with forward real rates based on "foreign currency analogy", and thus interconnect the two modeling paradigms.

Optimal Control Problem of Stochastic Delayed System and Applications

Zhen Wu
School of Mathematics
Shandong University

Abstract

In this talk, we study optimal control problem for the stochastic system described by stochastic delayed differential equations which has the practical background. We give maximum principles–the necessary condition of the optimal control for this problem by virtue of the duality method and the anticipated backward stochastic differential equations. We also apply our maximum principle to two kinds of optimal control problems with delay. One is a production and consumption choice problem, the explicit optimal consumption rate and some numerical results are given. The second one is a linear-quadratic optimal control problem with delay, using the solution of a kind of general forward-backward stochastic differential equations, we give the unique optimal control for this problem. At last, for the stochastic delayed control system which depends on the past path segment of the state process in a general form, we give the dynamic programming principle for the recursive utility optimization problem and show that the value function is the viscosity solution of the corresponding infinite dimensional Hamilton-Jacobi-Bellman partial differential equation.

Keywords : Maximum principle, Stochastic system with delay, Anticipated backward Stochastic differential equations, Dynamic programming principle, Hamilton-Jacobi-Bellman equations

Credit Risk Management Featuring Chinese Commercial Banks

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Shandong University

Abstract

In this talk we will present a summary report of our last two years practice aiding several Chinese city commercial banks facilitating their credit risk management. The frames of Basel II Capital Accord have been taken as the fundamental reference. The applicability of the basic principles and the feasible compromises related to the capital market dynamics of the Chinese active economic zones were explored. The effectiveness (indexed by, say, the ROC and/or CAP curves) are justified. Some challenging and interesting features are demonstrated. These results, we believe, would be beneficial to a wide range of practitioners and researchers. We also presents our research objective of implementations of certain new mathematical models to measure the risk.

A Linear-Quadratic Time-Inconsistent Optimal Control Problem

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Abstract

A general time-inconsistent optimal control problem is formulated. To fully understand such kind of problems, we concentrate on a problem with linear state equation and quadratic cost unctional. By means of multi-person differential games, we obtain a time-consistent equilibrium strategy for such an optimal control problem. It turns out that the time-consistent equilibrium strategy can be represented by the solution to a Riccati-Volterra integral equation systems.

Mean-Variance Porfolio Selection with a Benchmark Constraint

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Abstract

Optimal portfolio selections under the mean-variance framework have become very common since the pioneer work of Markowitz. We shall investigate the same problem with an addition benchmark constraint to protect against under-performance. We find that the optimal portfolio can be replicated by a put option and a binary call option. Description of the efficient frontier is also obtained.

Premia : A Numerical Platform for Pricing Financial Derivatives

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Abstract

PREMIA (http://www.premia.fr) is a computational platform designed to set up a technology watch for numerical problems related to the evaluation of financial derivative products and the management of pertinent risks. It is developed by the MATHFI research team (http://www-rocq.inria.fr/mathfi/) which gathers researchers in probability and mathematical finance from INRIA Paris-Rocquencourt and the University of Paris-Est.

Efficient computation of prices and hedges for derivative products is a major issue for financial institutions. The development of increasingly complex financial products requires advanced stochastic and numerical analysis techniques. The software PREMIA offers numerical solutions to the problems of pricing and hedging financial derivatives, with a collection of algorithms stemming from recent research in financial mathematics.

This project keeps track of the most recent advances in the field of computational finance. Premia contains various numerical algorithms : deterministic methods (finite difference and finite element algorithms, wavelets, Galerkin, sparse grids), stochastic algorithms (Monte-Carlo simulations, quantization methods, Malliavin calculus-based methods), tree methods and approximation methods (Laplace transforms, Fast Fourier transforms). These algorithms are

implemented for the evaluation of vanilla and exotic options on equities, interest rates, inflation, credit and energy derivatives. For equity derivatives for example, the multi-dimensional Black-Scholes is available as well as stochastic volatility and various Lévy models with jumps. The most recent Monte-Carlo algorithms are implemented for high-dimensional American options. Various models of interest rate derivatives are included, as for example affine models, quadratic term structure models, Heath-Jarrow-Morton model and the Libor Market Model. Moreover, Premia provides a calibration toolbox for the Libor Market model, using a database of swaptions and cap implied volatilities and a toolbox for pricing credit derivatives (CDS and CDO).

The Premia software provides a collection of C/C++ routines and scientific documentation in PDF and HTML, and is available for both Windows and Linux operating systems. Interfaces for Excel and NSP/Scilab are available. Premia is composed of (i) a library designed to describe derivative products, models and pricing methods; (ii) a numerical library (PNL) available for contributors; (iii) a collection of pricing routines which can easily be plugged, if necessary, into other financial softwares; and (iv) a scientific documentation system.

The development of Premia is being undertaken along with a consortium of banks presently composed of Credit Agricole Corporate & Investment Bak, Natixis, Société Générale, Bank of Austria and Raiffeisen Zentralbank Österreich. The consortium contributes to finance the development of Premia and help to determine the directions in which the project evolves. Every year, a new release is delivered to the consortium members. All algorithms are provided with their source codes, solid research documentation and extended references. A restricted, open-source version of Premia is available on the Premia Web site.

[This is a joint work with Agnès Sulem, Inria Paris-Rocquencourt.]

A New Numerical Scheme and Its Error Estimates for Backward Stochastic Differential Equations

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Abstract

We propose a new numerical scheme for solving backward stochastic differential equations with its generator f = f(t, y, z) linearly depending on z. And we theoretically prove that the convergence rate of the proposed scheme is high-order.

[This is a joint work with Yang Li.]