

# LGS PhD Day: Friday 13 March 2009

## List of abstracts

### **Antoine Jacquier**

*Asymptotics of the volatility surface in the Heston model using large deviation theory and complex analysis*

Using Large Deviations Theory, and in particular the Gartner-Ellis theorem, we characterise the leading-order behaviour of call option prices and implied volatilities under the Heston model for small and large maturities. In this context we also show how to derive similar results if we add an independent Levy component to the stock price process. In the large maturity regime, we can make this statement even more precise by providing the first-order behaviour using Cauchy's theorem and Saddlepoint Approximations. This talk is based on several joint papers with Martin Forde.

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### **Ed Hoyle**

*A stable bridge process and its application to non-life reserving*

We review the properties of the stable subordinator with  $\alpha=1/2$ , and go on to derive some properties of the corresponding bridge process.

We then use a generalisation of the bridge process to model the cumulative paid claims arising from a book of business of an insurance company. Taking a Bayesian approach to the reserving problem, we are able to derive the conditional distribution of the total liability at all times. This allows the calculation of moments and confidence intervals for the total liability, and the expected reinsurance recoveries. It is shown that this method is particularly suited to the modelling of claims where there is a non-trivial probability of a catastrophic loss. The model is extended to include information other than the paid claims (e.g. case estimates).

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### **Richard Bell**

*Credit spreads with regime switching and exogenous default*

Models of credit risk typically assume that risk free interest rates are independent of the probability of default. This assumption is normally made for the purposes of analytical tractability. However, observed default rates are highly correlated with economic activity which is in turn closely linked to the level of interest rates. As the maturity of a risky cash flow increases, the assumption of independence between risk free interest rates and default becomes increasingly less realistic. In this paper, an elemental dependence between default probabilities and risk free interest rates is introduced in the form of a regime-switching framework. The stochastic dynamics of the assets of a firm partly financed by a rollover debt strategy are modeled by a regime-switching jump diffusion process under which the level of the risk free interest rate and both asset return and volatility are modulated according to a finite state

Markov chain. Total debt value, bond prices and credit spreads are derived under the assumption that default occurs on first passage of the asset process below an exogenously determined level.

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## **Flavia Giammarino**

### *An adaptive nonparametric model for the systematic factors of portfolio credit risk premia*

The aim of this paper is to investigate the empirical relationship between daily fluctuations in the risk premium for holding a large diversified credit portfolio, which we approximate by a benchmark credit index, and some tradeable market factors which capture systematic risk.

The analysis is based on an adaptive nonparametric modelling approach which allows for the data-driven estimation of the nonlinear dynamic relationship between portfolio credit risk premia and their hypothetical components. Our main finding is that the empirical weights of the systematic factors display sudden jumps during market crises and a less intense time dependent behaviour during normal market conditions. In addition, we find that during market crises the directions of the empirical relationships are often inconsistent with ordinary economic intuition, as they are influenced by the specific circumstances of financial markets distress.

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## **Takeshi Yamada**

### *Exploring the spot and forward relationship in carbon emissions markets*

This work extends that of Cetin and Verschuere (2008), Pricing and hedging in carbon emissions markets. We propose a framework to study the spot prices of carbon allowances traded in EU ETS. In this market, simple spot and forward relationship does not hold. We derive the pricing formulas by assuming an exogenous price process for the forward contract and using the minimal martingale measure. Two settings are considered, complete information and incomplete information about the market. Filtering theory is used in the setting of incomplete information.

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## **Diego Jimenez-Huerta**

### *Stochastic models for earthquake risk assessment*

The problem of earthquake risk assessment and management in insurance is a challenging one at the interface of geophysics, engineering seismology, stochastics, and insurance mathematics and economics. In this work we propose a unified methodology comprising models and methods for the assessment of earthquake risk from an insurer's point of view, where the aim is not to address problems in the financial mathematics and economics of risk selection, pricing, portfolio management, and risk transfer strategies such as reinsurance and securitisation, but to enable the latter through the characterisation of the cornerstone of any risk management consideration in insurance: the distribution of aggregate losses over a period of time for a portfolio of risks.

We formulate the concept of a loss generating mechanism, whereby total losses are governed by an earthquake generating mechanism, a point process marked with the earthquake's hypocentre and

magnitude, and a conditional loss distribution which accounts for the physical characteristics of the portfolio at any time. We examine the minutiae around the infrastructure underpinning these mechanisms, proposing extensions to models in instances where we found a void, or new models altogether, and illustrate the applicability of the latter through the analysis of a residential homeowners property catastrophe portfolio exposed to earthquake risk in California.

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## **Sujin Park**

### *Improving realized kernel by nonparametric prewhitened spectral density estimator*

We propose new bias corrected realized kernel to estimate the ex-post variation of log-prices. Our new estimator is based on multiplicative bias correction of the crude spectral density estimator under the second-order spectral window, which can be viewed as generalization of prewhitening method. In the literature, the nonparametric prewhitened spectral density estimator is known to achieve faster convergence in the mean squared error without inflating the variance or sacrificing positive definiteness. Our simulation study shows that the proposed estimator reduces bias and mean squared error in estimating ex-post variation in the presence of microstructure noise, compared with the bias-uncorrected estimator.

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## **Yong Shih**

### *Modeling commodity prices with the CEV process*

This paper introduces the constant elasticity of variance (CEV) model for commodity prices and examines its calibration to four strategic commodity trajectory prices over the period 1990 - 2007 by using a Generalized Method of Moments. Six other models are compared to the CEV one by performing a test of goodness-of-fit. Estimating the model for crude oil, coal, copper and gold and comparing the results during the sub- periods 1990-1999 and 2000-2007, we find that the constant elasticity of variance exponent can efficiently account for the stochastic volatility observed after 2000 in commodity prices. Moreover, we exhibit that although mean-reverting processes well captured the pattern of commodity prices prevailing before 2000, they do not apply to the recent past

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## **Nika Novak**

### *Martingale properties of some generalized stochastic exponentials*

The stochastic exponential  $Z_t = \exp\{M_t - M_0 - \frac{1}{2}\langle M \rangle_t\}$  of a continuous local martingale  $M$  is itself a continuous local martingale. We consider the question when is the process  $Z$  a true martingale in the case where  $M_t = \int_0^t b(Y_s)dW_s$ ,  $Y$  is a one-dimensional diffusion, and the process  $W$  is a Brownian motion. A necessary and sufficient condition expressed only in term of the function  $b$  and the drift and the diffusion coefficients of  $Y$  were found by A. Mijatović and M. Urusov. We will present their results and suggest some generalizations.

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**Bjorn Eriksson***Pricing American options by optimizing over measures*

We will see how, by applying Dynkin's formula, the value of the American option can be expressed as a the optimal stopping problem of an integral over time. We will then show how this can be reformulated as a stochastic optimal control problem. Using results from Bhatt and Borkar (1996) or Kurtz and Stockbridge 1998 the stochastic optimal control problem can be expressed as an optimization over occupation measures.

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**Sergei Siyanko***Financial Modelling with mean reversion through jumps*

Speculative activity in financial markets can result in assets being over or under valued with respect to what market participants perceive as a fair price. This leads to sudden and unpredictable price corrections that we may want to account for when pricing derivatives. It is the objective of this research to consider the effect of speculative activity on derivatives prices. We modelled price corrections as mean reverting jumps with asset price following Geometric Brownian Motion. We have numerically solved the problem of pricing European Call Options and shown how different shapes of volatility surfaces appear depending on the intensity of jumps and relative position of the asset price with respect to its mean. By linking volatility surface to these two variables we offer an alternative approach to stochastic volatility models which arguably gives better accuracy when jumps are rare events and may therefore be ignored if not present in historic data.

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**Polly Lon***A monotone follower model with discretionary stopping*

We formulate and solve a problem that combines the features of the so-called monotone follower of singular stochastic control theory with optimal stopping. In particular, we consider a stochastic system whose uncontrolled state dynamics are modelled by a general one-dimensional  $It^{\{0\}}$  diffusion. The aim of the problem that we solve is to maximise the utility derived from the system's state at the discretionary time when the system's control is terminated. This objective is reflected by the performance criterion that we maximise, which also penalises control expenditure as well as waiting. The model that we study is motivated by the so-called goodwill problem, a variant of which is concerned with how to optimally raise a new product's image, e.g., through advertising, and with determining the best time to launch the product in the market. In the presence of the rather general assumptions that we adopt, we fully characterise the optimal strategy, which can take one of four qualitatively different forms, depending on the problem data.