Research in Options: RIO 2008
Abstracts of Talks and Minicourses

November 24th - 26th, 2008

Speaker: **Marco Avellaneda** (avellaneda@courant.nyu.edu), Courant Institute, NYU & Finance Concepts

Title: *Option pricing on stocks which are hard to borrow, short-selling restrictions and asset bubbles..*

Abstract: This talk introduces a new model for pricing options on stocks which are hard to borrow (HTB). A stock may become hard to borrow due to the absence of inventory of available float or to a restrictive regulatory environment, as witnessed by the recent partial ban on short-selling of financial stocks imposed by the US Securities and Exchange Commission. The options market is an excellent laboratory for the study of HTB stocks, due to certain "anomalies" in pricing and to stock buy-ins by clearing firms. Modeling the dynamics of these buy-ins, we propose a coupled jump-diffusion model for the price of the stock and the buy-in rate. Using the model we extract several things: (i) functional put-call parity is restored, i.e. puts and calls co-exist wihout arbitrage opportunities, despite the fact that texbook put-call partity does not hold (ii) American-style calls on stocks that don't pay dividends should be exercised before exipration if the stock price is high enough (iii) limiting cases of the model can be used to study the dynamics of stocks in which short-selling is prohibited. The corresponding price process in this case turns out be be a strict local semi-martingale, with "wild" stochastic volatility. In practical terms, our model suggests that stock prices become artificially high and extremely volatile following short-selling restrictions by regulators. We conclude (with other authors) that short-selling restrictions are detrimental to the functioning of markets and not beneficial, as often argued by regulatory bodies and echoed in the media. (Updated November 15, 2008)

Speaker: **Rama Cont** (rama.cont@gmail.com), Mathematics Dep., Columbia University

Title: *Understanding correlations among asset returns.*

Abstract: Correlations among asset returns play a significant role in portfolio optimization and risk management.One important stylized fact in equity markets is the significantly positive level of realized correlations among asset returns; however their exact values fluctuate a lot across time. Also, it is frequently observed that return correlations are much higher during periods of market crisis. These properties hold across time periods and markets but have no theoretical counterpart in most dynamics models which assume an exogenous, typically constant, covariance structure, the focus being on the accurate estimation of (realized) covariance and correlation matrices.

We propose a simple model consistent with these empirical facts, where correlation among returns is endogenously generated by the impact on prices of trading strategies commonly used by mutual fund managers is an important factor for understanding the origins of correlations in returns. We first study a discrete-time model where the excess demand from fund managers has a linear price impact on returns and show that this mechanism leads to significantly positive realized correlations even when assets are driven by independent noise sources (i.e. under the null hypothesis of zero fundamental correlation). Studying the continuous-time limit of this discrete-time model allows us to derive a formula which links the level of realized correlations correlations among fundamentals and market depth. This asymptotic formula, whose accuracy is confirmed by numerical simulations, shows that liquidity effects, not "fundamental correlations", are the main component of realized correlations. We illustrate this phenomenon on some examples from emerging markets. Our model suggests that liquidity effects constitute a major component of "correlation risk". We show that these ideas can be used to design stress scenarios for liquidity crises. (Updated November 15, 2008)

Speaker: **Raphael Douady** (raphael.douady@riskdata.com), Risk Data,

Title: *Risk Management for Investors in Hedge Funds: How to cope with nonlinearities in troubled environment.*

Abstract: The current financial crisis demonstrates a radical regime change in the behaviour of markets. However, quantitative risk models cannot rely on past data analysis to compute the risk of invetsments, that is, their possible FUTURE changes. We put ourselves in the position of an investor in hedge funds that only has the information of their returns, but not of their detailed positions (as this is most often the case in practice). We shall explore which type of mathematical models can be prepared for such changes of regime in order to still give analysis that correspond to the real risk of the funds. In particular, we shall see how to select and calibrate nonlinear factor models and come up with models that are able to extract the risk hidden in funds that never experienced a loss. Finally, we shall show how such risk analyses can be used in practice to boost the performances of portfolios of hedge funds. (Updated November 15, 2008)

Speaker: **Bruno Dupire** (bdupire@bloomberg.net), Bloomberg L.P., New York

Title: *Functional Ito Calculus and Volatility Hedging.*

Abstract: We present an extension of Ito calculus to functionals of price paths. When applied in a diffusion framework to the expectation of a path dependent claim conditional on the path so far, it leads to a Black-Scholes like PDE for path dependent options, even if the path dependency cannot be summarized by a finite number of state variables, with the classical Gamma/Theta (properly defined) trade-off. It also gives an alternative expression of the Clark-Ocone formula for the Martingale Representation Theorem.

We apply the functional Ito Formula to obtain the difference of price of an exotic option in two different models and deduce the sensitivity of the price to local deformations of the implied volatility surface. It leads to a decomposition of the Vega across strikes and maturities and the associated hedge in terms of a portfolio of European options. (Updated November 15, 2008)

Speaker: **Bruno Dupire** (bdupire@bloomberg.net), Bloomberg L.P., New York

Title: *Minicourse: 15 Years of Local Volatility.*

Abstract: The Local Volatility Model (LVM, 1993)) is the simplest extension of the Black-Scholes model (1973) that is consistent with the market price of European options. It offers two important contributions:

1. On a conceptual level, it establishes the notion of forward volatility, or more precisely, instantaneous forward volatility conditional on a price level

2. On a practical level, it is the second (after Black-Scholes) most used model on equity derivatives

This short mini-course summarizes the approach, the results and the extensions of LVM and shows how to apply it in practice. (Updated November 15, 2008)

Speaker: **Jean-Pierre Fouque** (fouque@pstat.ucsb.edu), Mathematics, UCSB

Title: *Short maturity asymptotics for fast mean-reverting stochastic volatility models.*

Abstract: Implied volatility skew for models with fast mean-reverting stochastic volatility is well understood using singular perturbation methods (Fouque-Papanicolaou-Sircar, CUP 2000). Here, we consider a regime where SV is fast mean reverting and maturities are short. We derive a large deviation principal for the Heston model via an explicit computation of moment generating functions. An alternative approach using homogenization of HJB equations for more general SV models will also be presented.

Joint work with Jin Feng and Martin Forde. (Updated November 15, 2008)

Speaker: **Matheus Grasselli** (grasselli@math.mcmaster.edu), Department of Mathematics, McMaster University

Title: *Systems of RBSDEs and real options in incomplete markets.*

Abstract: Real options in incomplete markets typically involve a utility optimization problem, related to the indifference value of the relevant cash-flows, combined with an optimal stopping problem, related to the early exercise nature of the managerial decisions. I will explain how to formulate both problems in framework of systems of reflected backward stochastic differential equations, use comparison results for their solutions to characterize how the exercise thresholds vary with the model parameters, and confirm these dependencies through numerical experiments. (Updated November 15, 2008)

Speaker: **Matheus Grasselli** (grasselli@math.mcmaster.edu), Department of Mathematics, McMaster University

Title: *Minicourse on Real Options (IN PORTUGUESE).*

Abstract: Toda decisão estratégica que envolva (i) flexibilidade temporal, (ii) irreversibilidade e (iii) incerteza com relação aos possíveis resultados pode ser tratada como uma Opção Real. Exemplos típicos incluem o momento oportuno de iniciar a construção de um edifício de apartamentos, ou expandir a capacidade produtiva de uma fabrica, ou mesmo abandonar um empreendimento não-lucrativo.

Em todos esses casos, ao tomar a decisão, o agente deve pagar (ou receber) um valor determinístico em troca de um fluxo de caixa estocástico. Nesse sentido a decisão é formalmente equivalente a decisão de exercer uma opção americana em mercados financeiros.

Nessa serie de três palestras eu pretendo rever os desenvolvimentos teóricos e algumas aplicações empíricas do arcabouço de opções reais. No modelo clássico de Black-Scholes o preço de uma opção americana é solução de uma inequação variacional cujo operador diferencial é o gerador de uma difusão com coeficientes constantes. Embora a fronteira de exercício possa ser caracterizada com precisão arbitraria, não há solução em forma fechada para essa equação, e métodos de diferenças finitas ou de Monte Carlo devem ser empregados. Claramente, a complexidade do problema (e dos métodos numéricos de solução) aumenta consideravelmente ao se introduzirem opções interdependentes (como por exemplo a opção de iniciar um projeto que contem a opção embutida de abandono futuro).

Alternativamente, no regime de tempo de maturidade infinito, Dixit e Pindyck reduzem as inequações variacionais acima a um sistema de equações diferencias ordinárias, cujo domínio é dividido em regiões demarcadas por fronteiras economicamente relevantes (por exemplo as fronteira de investimento, suspensão, reativação e abandono de um projeto).

Ambos os modelos acima assumem a existência de um "spanning assest", permitindo a aplicação da teoria de replicação em mercados completos. Na ausência desse tipo de ativo (como é o caso na grande maioria dos casos práticos), os valores de opções reais tem que ser calculados baseados em preferências de risco do agente. Na parte final das palestras discutirei métodos recentes de solução em mercados incompletos baseados em funções de utilidade, tanto no regime estacionário com tempo de maturidade infinito (onde uma solução analítica é possível), quanto no regime de fronteiras dinâmicas, onde apenas soluções numéricas são disponíveis. (Updated November 15, 2008)

Speaker: **Sebastian Jaimungal** (sebastian.jaimungal@utoronto.ca), Department of Statistics and Mathematical Finance Program, University of Toronto

Title: *Minicourse on Commodity Derivatives.*

Abstract: This course focuses on the modeling and valuation issues arising in the context of energy commodities and commodity derivatives. The dynamics of commodity prices differ substantially from traditional financial assets and a large variety of specialized financial products, mathematical models, and numerical methodologies have been developed to deal with the peculiar nature of this growing market sector. This short mini-course will explore how to mathematically model commodity prices, value derivatives backed by commodities, perform simulation price curves, and numerically value various commodity options.

Tentative Topics:

Fundamentals of Spot and Forward Commodity Markets; Stochastic Modeling of Commodity Prices; Diffusion and Jump-Diffusion Models; Monte Carlo Simulations; Fourier Space Time-Stepping for Commodities; Real Options (Updated November 15, 2008)

Speaker: **Sebastian Jaimungal** (sebastian.jaimungal@utoronto.ca), Department of Statistics and Mathematical Finance Program, University of Toronto
Title: *Incorporating Risk Aversion and Model Uncertainty into Structural Models of Default.*

Abstract: It is well known that purely structural models of default cannot explain short term credit spreads, while purely intensity based models of default lead to completely unpredictable default events. Neither of these features are realistic. Furthermore, investor preference may play an important role in introducing correlation of defaults as well as setting spreads themselves. Leung, Sircar and Zariphopoulou(2008) recently introduced a structural model, in which default of the reference entity is triggered by a credit worthiness index correlated to its stock price and utilized indifference pricing to value defaultable bonds. We take this base structural model and add a new regime which allows for unpredictable defaults, thus creating a hybrid model of default. Furthermore, in an unrelated paper, Uppal and Wang(2003) study portfolio optimization when model parameters are unknown. By combining the hybrid default model with the uncertain parameter portfolio optimization problem, we succeed in determining corporate bond spreads and CDS spreads using indifference valuation. Our framework therefore allows for risk aversion, parameter uncertainty and both structural and intensity default features. (Updated November 15, 2008)

Speaker: **Marc Jeannin** (marc.jeannin@uk.nomura.com), Department of Mathematics, Imperial College& Nomura International

Title: *First Passage for stochastic volatility models.*

Abstract: In this paper, we present a new approach to valuing first passage probabilities for stochastic volatility processes, where the price and volatility processes are correlated. By appro- priately approximating the volatility process with a continuous Markov chain on a finite space, we can define the Laplace transform of the supremum and infimum over time. We derive semi-analytic formulae for the supremum and infimum employing matrix Wiener-Hopf factorization techniques. We illustrate the algorithm by calculating the values and Greeks of barrier products. Barrier options are contracts that are activated or de-activated when the underlying process crosses a specific level; they are among the most widely traded of exotic contracts. The pay-offs of barrier options are path dependent and their valuation requires the specification of the first-hitting-time distribution. For Heston and SABR we obtain the first-passage-time distribution in a semi-analytical form, and then develop an algorithm to value barrier options and to calculate the corresponding Greeks. We compare the outcomes with Monte Carlo simulation results. The numerical calculations show that the method is accurate, and stable. It provides an alternative to PDE and Monte Carlo methods.

Joint work with Martijn Pistorius (Imperial College).

(Updated November 15, 2008)

Speaker: **Lane P. Hughston** (lane _ hughston@yahoo.com), Dep. of Math., Imperial College London

Title: *Implied Density Models for Dynamics Asset Pricing.*

Abstract: This paper addresses aspects of the interesting and still largely unsolved problem of how best to model the dynamics of an asset when one is given option prices for a range of strikes and maturities as initial data. The approach taken is to model the risk-neutral probability density process for the asset price. In particular, it is assumed that the density process satisfies an infinite dimensional stochastic differential equation driven by one or more Brownian motions, with a restriction on the volatility structure that is sufficient to ensure that the relevant normalisation condition is preserved. The resulting system is put into integral form, and several specific models of increasing generality are examined in detail, for which explicit solutions are constructed. The solutions are obtained in a surprising way by use of a filtering technique. Work carried out in collaboration with Damir Filipovic, Vienna Institute of Finance, and Andrea Macrina, King's College London. (Updated November 15, 2008)

Speaker: **Alberto Ohashi** (ohashi@ime.unicamp.br), Dep. de Matemática, UNICAMP & IBMEC

Title: *Weak approximations of Wiener functionals.*

Abstract: In this talk, we introduce a space-filtration discretization scheme on Wiener space given by a family of suitable stopping times which measures the instants where the Brownian motion reaches some a priori levels. We give sufficient conditions for a class of abstract Wiener functionals can be realized as the limit of special semimartingales with respect to discrete jumping-filtrations. The main novelty of our approximation scheme is the obtention of explicit expressions for a sequence of special semimartingales which converges to a given Dirichlet process with finite energy.

In the second part, we apply our abstract results for hedging portfolios in a Black-Scholes market setting where no a priori regularity of a given payoff is assumed in the sense of Malliavin calculus. Contrary to previous works, the resulting hedging portfolios can be fully based on direct simulation by Monte Carlo methods. Possible extensions for diffusions and general semimartingale price processes will also be discussed. Joint work with Dorival Leão.

(Updated November 15, 2008)

Speaker: **Ludger.Overbeck** (Ludger.Overbeck@math.uni-giessen.de), Institut für Mathematik, Universität Giessen

Title: *Term structure of CDOs.*

Abstract: This paper provides a unifying approach for valuing contingent claims on a portfolio of credits, such as collateralized debt obligations (CDOs). We introduce the defaultable (T, x)-bonds, which pay one if the aggregated loss process in the underlying pool of the CDO has not exceeded x at maturity T , and zero else. Necessary and sufficient conditions on the stochastic term structure movements for the absence of arbitrage are given. Background market risk as well as feedback contagion effects of the loss process are taken into account. Moreover, we show that any exogenous specification of the volatility and contagion parameters actually yields a unique consistent loss process and thus an arbitrage-free family of (T, x)-bond prices. For the sake of analytical and computational efficiency we then develop a tractable class of doubly stochastic affine term structure models. Joint work with Damir Filipović & Thorsten Schmidt. (Updated November 15, 2008)

Speaker: **Chris Rogers** (L.C.G.Rogers@statslab.cam.ac.uk), Statistical Laboratory, Cambridge University

Title: *The dual approach to American options.*

Abstract: Some years ago now, a different characterisation of the value of an American option was discovered, which can be thought of as the viewpoint of the seller of the option, in contrast to the conventional characterisation which took the viewpoint of the buyer. Since then, there has been a lot of interest in finding numerical methods which exploit this dual characterisation. The talk will discuss various attempts to do this, some of which seem plausible but on reflection cannot be expected to work, some of which are reasonably usable. We shall also present a pure dual algorithm for pricing and hedging American options, which turns out to be quite effective in some situations. (Updated November 15, 2008)

Speaker: **Gyorgy Varga** (varga@fce.com.br), FCE, Rio de Janeiro, Brazil

Title: *Dynamic Trading Strategies on Brazilian (Local) Hybrid Funds.*

Abstract: The objective of this work is to find out and explain active investment management strategies. Based on a sample of hybrid funds offered in Brazil, we checked investment policy, portfolio holdings, return based style analysis and factor analysis to obtain those strategies. The results show no evidence of a passive management pretending to be active and some evidence of market timing. (Updated November 15, 2008)