**PETER BANK**
**Technische Universitat Berlin**

*Market Indifference Prices*

We consider a financial market model where a single large investor submits orders to a finite number of market makers. These orders are filled at what we call market indifference prices and they lead to a new efficient allocation of risk among the market makers. We show how this allocation depends on the size of the order, discuss the cash compensation between market makers and the large investor, and explain how convex duality techniques allow for a quantitative analysis of the permanent market impact resulting from a transaction. (This is joint work with Dmitry Kramkov.)

**TOMAS BJORK**
**The Stockholm School of Economics**

*Time inconsistent control and mean variance portfolios with state dependent risk aversion*

We present a fairly general class of stochastic control problems which are time inconsistent in the sense that they do not satisfy the Bellman optimality principle. Using a game theoretic approach we derive a system of equations, extending the HJB equation, for the determination of the equilibrium control and the equilibrium value function. The theory is then applied to solve a mean variance portfolio optimization problem where the risk aversion is a function of current wealth.

**BRUNO BOUCHARD**
**University Paris-Dauphine**

*Optimal Control under Stochastic Target Constraints - Application to portfolio optimization under risk constraints*

We study a class of Markovian optimal stochastic control problems in which the controlled process $Z^\nu$ is constrained to satisfy an a.s. constraint $Z^\nu(T) \in G \subset R^{d+1}$ P-a.s. at some final time $T > 0$. When the set is of the form $G := \{(x, y) \in R^d \times R \ : \ g(x, y) \geq 0\}$, with $g$ non-decreasing in $y$, we provide a Hamilton-Jacobi-Bellman characterization of the associated value function. It gives rise to a state constraint problem where the constraint can be expressed in terms of an auxiliary value function $w$ which characterizes the set $D := \{(t, Z^\nu(t)) \in [0, T] \times R^{d+1} \ : \ Z^\nu(T) \in G \ a.s. \text{ for some } \nu\}$. Contrary to standard state constraint problems, the domain $D$ is not given a-priori and we do not need to impose conditions on its boundary. It is naturally incorporated in the auxiliary value function $w$ which is itself a viscosity solution of a non-linear parabolic PDE. Applying ideas

recently developed in Bouchard, Elie and Touzi (2008), our general result also allows to consider optimal control problems with moment constraints of the form $E[g(Z^\nu(T))] \geq 0$ or $P[g(Z^\nu(T)) \geq 0] \geq p$.

**LUCIANO CAMPI**
**Université Paris-Dauphine**

*Markov bridges and Kyle-Back equilibrium models of insider trading*

We will present some new results on Kyle-Back equilibrium models. In particular, we will consider the case of an insider observing a dynamic signal, modelled as a Brownian Markovian martingale so that finding an equilibrium reduces to constructing a 'dynamic' Markov bridge in the sense that its terminal value is not known in advance, being the terminal value of insider's signal. We think that such a construction is also interesting from a purely probabilistic point of view. The end of the talk will be devoted to discussing a Merton-type model for credit risk with insider trading. This talk is based on joint works with Umut Cetin, Albina Danilova and Alessandro Sbuelz.

**RENE CARMONA**
**Princeton University**

*Levy Market Models (joint with S. Nadtochiy)*

We introduce a new class of market models for underlying assets given by a pure jump martingale. We capture the information contained in the surface of call options in the density of the Levy measure of an additive process, and we set this static code in motion by means of a stochastic dynamics of Ito's type in a function space, creating what we call a "tangent Levy model". We characterize the consistency of these models by a drift condition "a la HJM", and we construct explicit examples of consistent tangent Levy models.

**PATRICK CHERIDITO**
**Princeton University**

*Equilibrium pricing in incomplete markets under translation invariant preferences*

Conditions are given for the existence and uniqueness of equilibria in incomplete dynamic market models when agents have translation invariant preferences. This includes mean-variance type preferences and expected exponential utility. General results are provided in discrete time. Then a special case is discussed where equilibrium prices can be represented

as solutions to a system of backward stochastic difference equations. In the continuous-time limit, a system of coupled backward stochastic differential equations with drivers of quadratic growth appears. Joint work with Ulrich Horst, Michael Kupper and Traian Pirvu.

**JAKSA CVITANIC**
**California Institute of Technology**

*Complete Market Equilibrium with Heterogeneous Agents*

We study the market price of risk, the stock volatility and the hedging behavior in equilibrium of heterogeneous agents with arbitrary utility functions, consuming only at the end of the time horizon, and with the state variable following an arbitrary homogeneous diffusion process. We introduce a new notion that we call the "rate of macroeconomic fluctuations", and show that, in equilibrium, all the quantities and strategies can be characterized in terms of the dividend volatility and the interest rate volatility discounted at this rate. We also show that both the optimal portfolio strategies and the stock price volatility can be decomposed into a myopic and a non-myopic component. The market price of risk, the myopic volatility and the myopic portfolio are determined by the present market value of future discounted volatilities of the dividend and of the interest rate. By contrast, the non-myopic volatility and non-myopic portfolio are given in terms of covariances of equilibrium quantities with the discounted dividend volatility. These representations enable us to show that, under natural cyclicality conditions, the non-myopic volatility is always positive, and the non-myopic portfolio is positive for an agent if and only if the product of his prudence and risk tolerance is less than the same product corresponding to the log agent.

**DAMIR FILIPOVIC**
**Vienna Institute of Finance**

*Pricing and Hedging of CDOs: A Top Down Approach*

This paper considers the pricing and hedging of collateralized debt obligations (CDOs). CDOs are complex derivatives on a pool of credits which we choose to analyse in the top down model proposed in Filipovic et al. (2009). We reflect on the implied forward rates and bring them in connection with the top-down framework in Lipton and Shelton (2009) and Schonbucher (2005). Moreover, we derive variance-minimizing hedging strategies for hedgeing single tranches with the full index. The hedging strategies are given for the general case. We compute them also explicitly for a parsimonious one-factor affine model, and present some numerical results. This is joint work with Thorsten Schmidt and Zehra Eksi.

The paper is available on SSRN:
http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1472942

**HANS FOELLMER**
**Humboldt Universitt zu Berlin**

*Dynamic risk measures: time consistency, asymptotics, and the appearance of bubbles*

Different notions of time-consistency imply different supermartingale properties of the dynamic risk measure and the process of penalization. In particular we discuss the appearance of "bubbles" in the penalization process. They amount to an underestimation of the model risk, and as a result the risk assessment may not be asymptotically safe. The talk will be based on joint work with Irina Penner and Beatrice Accaio.

**MARCO FRITTELLI**
**University of Milan**

*Dual Representation of Conditional Quasiconvex Maps*

Quasiconvex analysis has important applications in several optimization problems in science and in particular in economics and finance, where convexity may be lost due to absence of global risk aversion, as for example in Prospect Theory. Quasiconvexity, i.e. the property $\rho(\lambda X + (1-\lambda)Y) \leq \max(\rho(X), \rho(Y))$, plays also an important role in the theory or risk measures, since it enforce the control of the risk but it allows diversification.

Moreover, the classical notion of the certainty equivalent, both in the static and in the dynamic formulations, is an example of a not convex but quasiconvex map.

The robust or dual representation of convex maps plays a central role in the theory of risk measuring, especially for its connections with uncertainty and ambiguity.

We provide a general dual representation of *quasiconvex dynamic* maps $\rho : L(\Omega, \mathcal{F}_t, P) \to L(\Omega, \mathcal{F}_s, P)$ and show its application in the above mentioned topics. This generalizes the representation of dynamic convex maps and of static (real valued) quasiconvex functions.

Based on a joint paper with Marco Maggis, Milano University.

**PAOLO GUASONI**
**Scuola Normale Superiore**

*The Incentives of Hedge Fund Fees and High-Water Marks*

Hedge fund managers receive as performance fees a large fraction of their funds' profits, in addition to regular fees proportional to funds' assets. Performance fees are paid only when a fund exceeds its previous maximum - the high-water mark. The most common scheme, dubbed Two and Twenty, entails performance fees of 202

We study the risk-shifting incentives created by such fees, solving the portfolio choice problem of a manager with constant relative risk aversion, constant investment opportunities, and a long horizon. The portfolio that maximizes expected utility from future fees is constant, and coincides with a Merton portfolio with effective risk aversion equal to the weighted average of the manager's true risk aversion and the myopic value of one, with the performance fee as the myopic weight. Moreover, the optimal portfolio coincides with that of an investor facing the constraint of a maximum drawdown less than one minus the performance fee, as a fraction of the last recorded maximum.

Since performance fees modify a manager's risk aversion, we investigate their potential as agency tools, solving a Stackelberg equilibrium between an investor and a manager. We find that an equilibrium exists only if both the manager and the investor have very low risk aversion. In all other cases, no equilibrium is consistent with positive performance fees.

**KOSTAS KARDARAS**
**Boston University**

*Financial equilibria in incomplete markets where heterogeneous agents with numeraire-invariant preferences act.*

The question of general equilibrium in an incomplete financial market model is undertaken. Economic agents all have numeraire-invariant preferences, but different subjective beliefs and stochastic consumption clocks. The market contains a borrowing and lending account in zero net supply, as well as a stock in positive unit net supply providing certain dividend stream, exogenously specified. A characterization of existence and uniqueness of equilibrium is provided in terms of stochastic differential equations. The proposed framework naturally allows for equilibria where assets in positive net supply contain bubbles, even in the case of complete markets with unconstrained acting agents.

**KASPER LARSEN**
**Carnegie Mellon University**

*Continuous equilibria with heterogeneous preferences and unspanned endowments*

We explicitly derive the equilibrium price process in continuous time and state equilibrium models where heterogeneous agents receive partially unhedgeble random endowments. Furthermore, we quantify the positive impact the incompleteness feature combined with the agents' preference heterogeneity has on the equilibrium risk premium relative to equivalent models where all risks are spanned.

**SEMYON MALAMUD**
**ETH-Zentrum**

*Information Percolation in Segmented Markets*

We calculate equilibria of dynamic double-auction markets in which agents are distinguished by their preferences and information. Over time, agents are privately informed by bids and off ers. Investors are segmented into groups that di ffer with respect to characteristics determining information quality, including initial information precision as well as market "connectivity," the expected frequency of their trading opportunities. Investors with superior information sources attain higher expected profi ts, provided their counterparties are unable to observe the quality of those sources. If, however, the quality of bidders' information sources are commonly observable, then, under conditions, investors with superior information sources have lower expected pro fits. This is joint work with Darrell Duffie and Gustavo Manso.

**MICHAEL MONOYIOS**
**University of Oxford**

*Optimal exercise of an executive stock option by an insider*

We consider an optimal stopping problem arising in connection with the exercise of an executive stock option by an agent with inside information. The agent is assumed to have noisy information on the terminal value of the stock, may not trade the stock, and maximises the expected discounted payoff over all stopping times with regard to an enlarged filtration which includes the inside information. This leads to a stopping problem governed by a time-inhomogeneous diffusion and a call-type reward. We establish the smooth fit condition for the corresponding free boundary problem governing the maximum expected reward, and derive the early exercise decomposition of the value function. The resulting integral equation for the unknown exercise boundary is solved numerically and

this shows that the insider may exercise the option before maturity, in situations when an agent without the privileged information may not. Hence we show that early exercise may arise due to the agent having inside information on the future stock price.

(Joint work with Andrew Ng (University of Oxford)

**MIKLOS RASONYI**
**Hungarian Academy of Sciences**

*Fragility of arbitrage and bubbles in diffusion models*

We show that, in a large class of diffusion models for price processes, there is always another "arbitrarily uniformly close" model which is arbitrage- and bubble-free. Our result applies to some well-known examples such as the inverse Bessel process and certain stochastic volatility models and raises questions about how to view arbitrage and bubbles in financial markets. This is joint work with Paolo Guasoni.

**EMANUELA ROSAZZA GIANIN**
**Università di Milano-Bicocca**

*g-expectations and the representation of the penalty term of dynamic convex risk measures*

Starting from the well known representation of time-consistent dynamic convex risk measures, we will provide a characterization of the penalty functional in such a representation. More precisely, such a characterization is deduced by applying the theory of Backward Stochastic Differential Equations and, in particular, of the so called g-expectations.

This talk will be based on the joint work with F. Delbaen and S. Peng.

**MIHAI SIRBU**
**University of Texas at Austin**

*Optimal investment on finite horizon with random discrete order flow in illiquid markets*

We study the problem of optimal portfolio selection in an illiquid market with discrete order flow. In this market, bids and offers are not available at any time but trading occurs more frequently near a terminal horizon. The investor can observe and trade the risky asset only at exogenous random times corresponding to the order flow given by an inhomogenous Poisson process. By using a direct dynamic programming approach, we first derive and solve the fixed point dynamic programming equation and then perform a verification argument which provides the existence and characterization of optimal trading strategies. We prove the convergence of the optimal performance, when the deterministic

intensity of the order flow approaches infinity at any time, to the optimal expected utility for an investor trading continuously in a perfectly liquid market model with no-short sale constraints. Joint work with Paul Gassiat and Huyen Pham.

**JOSEF TEICHMANN**
**University of Technology Vienna**

*Matrix-valued affine processes – theory and applications*

We present the complete characterization of positive matrix valued affine processes, show several interesting directions of further research and some applications.

**GORDAN ZITKOVIC**
**University of Texas at Austin**

*Incomplete-market equilibria with exponential utilities*

In addition to existence, the excess-demand approach allows us to establish uniqueness and provide efficient computational algorithms for incomplete-market stochastic financial equilibria when agents exhibit constant absolute risk aversion. An overview of recent results (including those jointly obtained with M. Anthropelos and with Y. Zhao) will be given.

**XUNYU ZHOU**
**Oxford**

*Finding Quantiles*

Existing portfolio choice models in continuous time typically reduce to finding optimal terminal cash flows which are random variables. While it works for expected utility maximisation, it generally fails to work for models with non-expected utility criteria, such as the goal-achieving model, Yaari's dual model, Lopes' SP/A model, behavioural model under prospect theory, models with coherent risk measures, as well as optimal stopping with probability distortions. This talk reviews the latest development in solving these non-classical models by changing decision variables - from random variables to their quantile functions.