The Decision to Lever  
Robert ANDERSON, University of California, USA

We express the return to a levered strategy in terms of five key drivers. A novel element of our expression is the covariance between leverage and excess borrowing return of the fully-invested source portfolio that underlies the levered strategy. In an empirical study of several volatility-targeting strategies over the period 1929–2012, the covariance term was negative for all of the volatility-targeting strategies, with the reduction in return ranging from 0.64% to 4.23% per year. Consequently, the Sharpe ratios of volatility-targeting strategies were diminished relative to their source portfolios and fixed leverage benchmarks.

Authors: Robert M. ANDERSON, Stephen W. BIANCHI, Lisa R. GOLDBERG, University of California, USA.

Keywords: Leverage; Sharpe ratio; source portfolio; trading cost; financing cost; unintended market timing; magnified source return; excess borrowing return; risk parity; pension fund; fixed leverage; dynamic leverage; volatility target

A Novel Approach to Markov Chain Monte Carlo and its Applications  
Hock Peng CHAN, National University of Singapore, Singapore

Particle filters are well-known to be able to estimate latent states of complex hidden Markov models (HMMs), by simulating the states dynamically using a large number of particles, and then resampling each particle, either periodically or sequentially, according to its relevance to the observed variables. They have many applications, ranging from engineering to computational biology and finance. A long-standing challenging problem is in the design of adaptive particle filters, on HMMs with unknown parameters. Because the model parameters are static, degeneracy of the particles with respect to the unknown parameters occurs as a result of repeated resamplings. We have been able to address this problem by using a novel substitution step that rejuvenates the particles efficiently. This also leads to new MCMC methods that involve sequential state substitutions. We describe the basic theory and some applications.

This is a joint work with Tze Leung LAI.
Adaptive Functional Autoregressive Modeling for Stationary and Non-Stationary Functional Data
Ying CHEN, National University of Singapore, Singapore

We propose adaptive functional autoregressive (AFAR) modeling with time varying operators that allow it to be safely used in both stationary and non-stationary situations. Under stationarity, we develop a consistent maximum likelihood (ML) estimator with closed form, where the likelihood function is defined on the parameters' subspace or Sieves. For non-stationary data, the estimation is conducted over an interval of local homogeneity, over which the time varying data generating process can be approximated by an FAR mode with constant operators. The local interval is identified in a sequential testing procedure. Simulation study illustrates finite sample properties of the proposed AFAR modeling. Real data application on forecasting California electricity daily price curves demonstrates a superior accuracy of the proposed AFAR modeling compared to several alternatives.

This is a joint work with Bo LI.

Using Short-Term Predictions for Participation-Rate Driven Trading Algorithms
Ngoc-Minh DANG, Kepler Cheuvreux, France

We propose a decomposition of algorithm's a priori performance, from which we separate contributions came from different factors related to the algorithm's constraints, to the execution context and to the quality of execution. This key idea leads to an unified framework allowing one to plug-in any price and volume related signals to optimize execution. We show that, in combining estimations on volume and price and always taking into account the price-impact effect, one is able to optimize the execution in a sequential manner, which we refer to as on-line optimization. We illustrate the ability to adapt to real execution context, respect algorithm's constraint and achieve better performance of the proposed method in the optimal execution problem. The proposed framework is also shown suitable to design participation-rate driven algorithm: Percentage of Volume, Volume Weighted Average Price and Implementation Shortfall.

Key words: optimal liquidation, on-line optimization, VWAP, IS, PVOL, slippage

Authors: Ngoc-Minh DANG, Kepler Cheuvreux and JVN Institute, VNU HCM, Vietnam; Charles-Albert Lehalle, Capital Fund Management, France.
On Buy-and-Hold Mean-Variance Portfolio with Strategic Exit  
Cheng-Der FUH, National Central University, Taiwan

In this paper, we study a Markowitz-equivalent portfolio selection problem subject to one particular market exit strategy. The strategy is a threshold stopping rule and hence the resulting investment time horizon is uncertain. Under some regularity assumptions, we provide an analytical approximation, to which it can be used to characterize the optimal portfolio weights precisely. By using this obtained formula, we show that the portfolio decision is influenced by three features: the risk of original price movement, the risk of random market exit, and the interaction effect of the previous two risks. Indeed, the magnitude of such interaction effect along with the predetermined reference defining the stopping rule. Furthermore, we identify a specific reference indicator such that a risk-averse investor can benefit from such portfolio, in the sense of extended Sharpe ratio. This claim is confirmed by numerical simulations and an empirical study.

Keywords: portfolio selection, random horizon, Sharpe ratio, multivariate renewal theory.

This is a joint with Sheng-Feng LUO.

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Functional Principal Component Analysis for Derivatives of High-Dimensional Curves  
Maria GRITH, Humboldt Universität zu Berlin, Germany

This study is motivated by the evolution of state price densities (SPD) implied by option data. For a fixed maturity and under some general arbitrage conditions the SPD is proportional to the quotient of the European call options with respect to the strike price. If only options with a pre-specified maturity are to be analyzed, then SPDs are one-dimensional functions. A two-dimensional point of view can be adopted if maturities are taken as an additional argument and the SPDs are viewed as a family of curves. Our paper addresses both the challenge of statistical modeling the derivatives of higher dimensional functions and that of extracting the economic content embedded in the dynamics of SPD functions. We analyze a sample of noisy curves, recover their derivatives using functional principal component analysis and summarize their time variability with a few interpretable parameters.

This is a joint work with Wolfgang K. HÄRDLE, Alois KNEIP, and Heiko WAGNER.
Limit Order Books with Stochastic Market Depth  
Steven KOU, National University of Singapore, Singapore

We propose a model for limit order books with stochastic, reverse U-shaped, market depth, consistent with empirical studies. Stochastic market depth is necessary to accommodate various order activities, such as limit order submission at and outside the best quotes and order cancellation, which may account for a large proportion of limit order activities. To show the analytical tractability of the model, in addition to a dynamic programming formulation of the optimal execution problem, we provide easily computable and tight upper and lower bounds for the optimal execution cost, as well as their resulting trading strategies via quadratic programming and jump-linear-quadratic control.

This is a joint work with Ningyuan CHEN and Chun WANG.

Adaptive Particle Filters: Theory and Financial Applications  
Tze Leung LAI, Stanford University, USA

This talk is a continuation of that of Hock Peng Chan and shows how MCMC with sequential state substitutions introduced therein can be used to develop efficient adaptive particle filters, thereby resolving two long-standing problems related to particle filters. One is efficient estimation of unknown parameters in the nonlinear state-space model, as mentioned in Chan's talk. The other is related to estimation of the standard errors of the Monte Carlo estimates. Since the simulated trajectories (particles) are dependent ("interacting particles"), classical standard error formulas are no longer applicable. Applications to dynamic frailty models in joint default modeling of multiple firms and to stochastic volatility models with contemporaneous jumps in asset price and volatility are given to illustrate the approach.

This is a joint work with Hock Peng CHAN.
Numerical Computation of VIX-Futures Risk Components
Marco MARCHIORO, Quant Island, Singapore

We describe a method to perform risk simulations of VIX futures, according to the historical-simulation model. We assume a stochastic-volatility mean-reverting constant-elasticity-of-variance process to model the VIX dynamics. Following non-arbitrage arguments the market expectation of VIX futures price results in a function of three financial variables: the spot VIX index, the long-term expected VIX value, and a time-scale parameter.

Using the latest historical data we compute risk measures for VIX futures at different maturities and compare them with those of the VIX index. Finally, using a recently developed technique, we compute the component of risk coming from each risk driver. We show some numerical results that highlight the dependence on the maturity of the risk components of the VIX-futures risk drivers.

Keywords: Volatility models, risk management, risk measures, risk components, VIX index, and VIX futures.
Combining Returns and Option Prices in Empirical Likelihood
Tony SIT, The Chinese University of Hong Kong, Hong Kong

Empirical likelihood based on asset return series has been introduced in Chan et al. (2009) to estimate the parameters of various Levy processes via their characteristic functions. In addition to return series, prices of actively traded derivatives also contain information about the parameters of the underlying process. In this paper, we extend Chan et al. (2009) by proposing an empirical likelihood based method to combine the return series and the associated derivative prices for the purpose of estimation. The new method leads to shorter confidence intervals and more efficient ways to reflect current market information embedded in the derivative markets, which is especially useful during financial crises. In particular, empirically the estimators may be quite different even only one day option data are incorporated. The usual asymptotic properties, including consistency and asymptotic normality, are established under suitable regularity conditions.

This is a joint work of Steven KOU, Tony SIT and Zhiliang YING.

Modeling Market Impact
Raja VELU, Syracuse University, USA

We study the effect of multiple market impact (MI) determinants in algorithmic trading (AT) using a large scale proprietary data on parent trades. We focus on the number of child orders and trade duration, two determinants that are unique to AT, in addition to trade size, volatility and market cap. The power law models that we develop, counter to the conventional wisdom to split a parent order, show that MI is increasing in the number of child orders. We also observe that the buy-sell MI asymmetry reported for block trades in the literature is significantly weaker in AT. We connect these findings to an ongoing debate on whether 'trade size' is the source for information leakage than 'order flow'.

This is joint work of Steven KOU, Tony SIT and Zhiliang YING.
Nonlinear Shrinkage of the Covariance Matrix for Portfolio Selection: Markowitz Meets Goldilocks
Michael WOLF, University of Zurich, Switzerland

Markowitz (1952) portfolio selection requires estimates of (i) the vector of expected returns and (ii) the covariance matrix of returns. Many proposals to address the first question exist already. This paper addresses the second question. We promote a new nonlinear shrinkage estimator of the covariance matrix that is more flexible than previous linear shrinkage estimators and has ‘just the right number’ of free parameters (that is, the Goldilocks principle). In a stylized setting, the nonlinear shrinkage estimator is asymptotically optimal for portfolio selection. In addition to theoretical analysis, we establish superior real-life performance of our new estimator using backtest simulations.

Authors: Olivier LEDOIT and Michael WOLF, University of Zurich, Switzerland.

Keywords: Large-dimensional asymptotics, Markowitz portfolio selection, nonlinear shrinkage.