TOULOUSE SCHOOL OF ECONOMICS FINANCIAL ECONOMETRICS CONFERENCE

TOULOUSE, MAY 15 & 16, 2009

Tim Bollerslev (Duke University), Natalia Sizova (Duke University), **George Tauchen** (Duke University). **Volatility in Equilibrium: Asymmetries and Dynamic Dependencies**: Stock market volatility clusters in time, carries a risk premium, and exhibits asymmetric leverage effects. This paper develops a first principles equilibrium based explanation for these empirical facts. The model is cast in continuous-time and entirely self-contained, involving non-separable recursive preferences. We show that the qualitative theoretical implications from the new model match remarkably well with the distinct shapes and patterns, including long memory, in the sample autocorrelations of the volatility and the volatility risk premium, and the dynamic cross-correlations of the volatility measures with the returns calculated from actual high-frequency intraday data on the S&P 500 aggregate market and VIX volatility indexes.

Victor Chernozhukov (MIT), Emre Kocatulum (MIT), Konrad Menzel (MIT). **Inference on Sets in Finance**: In this paper we introduce various set inference problems as they appear in finance and propose practical and powerful inferential tools. Our tools will be applicable to any problem where the set of interest solves a system of smooth estimable inequalities, though we will particularly focus on the following two problems: the admissible mean-variance sets of stochastic discount factors and the admissible mean-variance sets of asset portfolios. We propose to make inference on such sets using weighted likelihood-ratio and Wald type statistics, building upon and substantially enriching the available methods for inference on sets.

Andrea Carriero (Queen Mary University), **Raffaella Giacomini** (University College London). **How Useful are No-Arbitrage Restrictions for Forecasting the Term Structure of Interest Rates?** We develop a general framework for analyzing the usefulness of imposing parameter restrictions on a forecasting model. We propose a measure of the usefulness of the restrictions that depends on the forecaster's loss function and that could be time varying. We show how to conduct inference about such measure. The application of our methodology to analyzing the usefulness of no-arbitrage restrictions for forecasting the term structure of interest rates reveals that: 1) the restrictions have become less useful over time; 2) using a statistical measure of accuracy, the restrictions are a useful way to reduce parameter estimation uncertainty, but are dominated by restrictions that do the same without using any theory; 3) using an economic measure of accuracy, the no-arbitrage restrictions are no longer dominated by a theoretical restrictions, but for this to be true it is important that the no-arbitrage restrictions incorporate a time-varying risk premium.

Takakai Hayashi (Keio University), **Jean Jacod** (Université Pierre et Marie Curie), Nakahiro Yoshida (University of Tokyo). **High Frequency Statistics with Irregularly Spaced Observations**: In the context of high frequency data, one often has to deal with observations occurring at irregularly spaced times, at transaction times for example. With this kind of data we want to estimate the integrated volatility, or

the integrated squared-volatility, or the sum of some power of the jumps when the process is discontinuous. We will examine how the usual estimators for such quantities behave with irregular observation grids, either deterministic grids or Poissonian grids or even more general sampling schemes, and in particular sampling schemes which are dependent on the observed process itself. We will see in particular that for Poisson-type observations (as are typically transaction times) some additional terms occur in the asymptotic estimation variance.

Torben Andersen (Northwestern University), Oleg Bondarenko (University of Illinois-Chicago). **Dissecting the Market Pricing of Equity and Bond Return Variance via Corridor-Implied Volatility**: The equity-index option market is known to price return volatility risk at a steep premium, indicating a large negative variance risk premium. Moreover, exposure to this broad volatility risk factor has been found also to impact the cross-section of expected stock returns. We explore the composition of this equity-index volatility premium by studying the separate pricing of upside and downside variance risk, exploiting the concept of corridor option implied volatility. Moreover, we expand the analysis to cover the (up- and down-) volatility pricing in the U.S. Treasury bond option market. We find a significant volatility risk premium in the bond market as well. In addition, we document that these two priced macro volatility risk factors are distinct, as they are only mildly positively correlated. The findings suggest that volatility risk more generally is priced at a substantial premium across multiple asset classes. The findings point towards the need for incorporating important new risk factors in theoretical and empirical asset pricing.

Scott Joslin (MIT), Marcel Priebsch (Stanford University), Kenneth Singleton (Stanford University). **Risk Premium Accounting in Macro-Dynamic Term Structure Models**: This paper reassesses the risk-premium accounting - the decomposition of variation in bond yields into expectations and term premium components - within a dynamic term structure model that explicitly incorporates information about inflation and the growth in real output. Consistent with the historical evidence, our framework incorporates (i) components of the macroeconomic variables that are orthogonal to the yield curve, (ii) cointegration of the underlying economic state variables, and (iii) flexible dimensionality of bond risk premia. We present evidence that two risk factors underlie variation in expected excess returns, and that these factors are driven by information in the yield curve, the growth rate in output, and inflation. The growth rate of output is a particularly important determinant of both term premia and compensation for exposure to unpredictable changes in the slope of the yield curve. These results help shed light on the macroeconomic fundamentals underlying time-variation in bond risk premia.

Stephane Gregoir (EDHEC Business School), Tristan-Pierre Maury (EDHEC Business School). **Liquidity Risk and Housing Price Dynamics**: We complement the empirical analyses that have illustrated the influence of price risk on price dynamics by considering the role of liquidity risk proxied by a measure of volatility in sales volumes. Our empirical approach is based on a panel VAR model with GARCH in means effects estimated on data from several areas in and around Paris. In line with microeconomic arguments

explaining risk-adverse buyers and sellers' strategies, uncertainty in liquidity negatively affects price changes and sales volumes, but price risk affects negatively price changes but positively sales volumes. The spatial dimension associated to the panel structure decomposes shocks into a local and a common component. Common shocks explain in the long-run more than 75% of the variability in prices and its larger part is related to the consequences of uncertainty. The situation is reversed when turning to the variance in sales volumes. Moreover, persistence of uncertainty is short lived for the common shocks and long lived at a local level. This gives a contrasted picture whose economic empirical properties are analyzed in detail with help of a structural identification scheme in terms of demand and supply shocks.

Bruno Biais (Toulouse School of Economics), **Fany Declerck** (Toulouse School of Economics). **Liquidity, Competition and Price Discovery in the European Corporate Bond Market**: Using a new trades and quotes dataset, we study European corporate bonds. In this OTC market, Euro denominated bonds trade on average 4 times a day and Sterling bonds 1.5 times a day. Spreads increase with maturity, default risk and dealers market power. For a 100 bond price, in 2005, effective spreads ranged from 12 cents for small trades to 8 cents for large ones. For Sterling bonds, effective spreads ranged from 28 to 15 pence. Greater competition and liquidity and tighter spreads in the Euro market reflect participation by investors and banks from many countries. Trades have significant information content, especially for bonds with low ratings. It takes at least five trading days for the information content of a trade to be fully impounded in market pricing, reflecting lack of post trade transparency.

Christian-Yann Robert (CREST-ENSAE, Paris), **Mathieu Rosenbaum** (Ecole Polytechnique, Paris). **Volatility Estimation Under Endogeneous Microstructure Noise**: We consider practically appealing procedures for esti- mating intraday volatility measures of underlying asset prices in a model that accommodates the inherent properties of ultra high frequency data with the assumption of continuous e?cient price processes. In this model, the microstructure noise is endogenous but do not only depend on the prices themselves. Using the (observed) last traded prices of the assets, we develop a new approach that enables to approximate the values of the e?cient prices at some random times. Based on these approximated values, we build an estimator of the integrated volatility and give its asymptotic theory. We also give a consistent estimator of the integrated co-volatility when two assets (asynchronous by construction of the model) are observed.

Lars Peter Hansen (University of Chicago), José Scheinkman (Princeton University). **Pricing Growth-Rate Risk**: A standard result from asset pricing theories is the characterization of the local risk-return tradeoff. This tradeoff is particularly simple in the case of Brownian information structures. In mathematical Finance the risk prices are embedded in the transformation to a risk-neutral measure. Applying Girsanov's Theorem, this change of measure adds a drift vector to the multivariate standard Brownian motion. The vector of local prices is the negative of this drift vector. It reflects the local compensation in terms of the drift for exposure to alternative components of the Brownian motion. From these local prices, we price exposure to linear combinations of the Brownian risks by forming the corresponding linear

combination of prices. While derivative claims are often priced using the risk neutral measure, structural models of asset prices interpret these prices in terms of the fundamentals of the underlying economy. In this paper, as in Hansen and Scheinkman (2008) and Hansen (2008), we are interested in characterizing the compensation demanded by investors for a added risk at different time horizons, that is a term-structure of risk prices. This compensation will typically depend on how investors discount risky payoffs and the risk they already face. Our approach is as follows. There is an underlying Markov diffusion X that governs the state variables in the economy. The economic model implies a stochastic discount factor process S and a reference stochastic growth process G for the macroeconomy. Both are modelled conveniently as multiplicative functionals of the Brownian motion. We normalize the growth functional to a be a martingale in order to feature the role of price dynamics. This martingale can be the martingale component in a factorization of a more general growth functional (as in Hansen and Scheinkman (2008)). To study pricing we parameterize the risk exposure of the logarithm of the growth process $logG^\epsilon$ as a function of ϵ and study its pricing for alternative horizons. The risk price is: $\rho_t = -\frac{d}{d\epsilon}\frac{1}{t}\log E[G_t^\epsilon S_t \mid X_0 = x] \mid_{\epsilon=0}$. It is the elasticity of the expected rate of return (per unit of time) with respect to the exposure to growth-rate risk. The expected return implicit in this calculation is the reciprocal of the price $E[G_t^\epsilon S_t \mid X_0 = x]$ since G_t^ϵ has expectation one by construction. The resulting prices of growth-rate risk extend the local prices to arbitrary investment horizons. While we focus on scalar parameterizations, we can interpret our calculations as producing prices for an arbitrary linear combination of exposure to the Brownian motion risks. By changing the exposure weights, we feature alternative components of the Brownian increments and thus construct the counterpart to the local risk-price vector. For a given investment horizon, we characterize our risk prices by applying tools from option used to compute sensitivities (the *Greeks*). These prices we compute reveal the local risk prices as the horizon t shrinks to zero: $\lim_{t\to 0}\rho_t = \rho_0$. We add to this a characterization of the limit prices as the investment horizon tends to ∞: $\lim_{t\to\infty}\rho_t = \rho_\infty$, along with formulas for the intermediate investment horizons.

Gabriele Fiorentini (Università di Firenze), **Enrique Sentana** (CEMFI, Madrid). **New Testing Approaches for Mean-Variance Predictability**: Many empirical studies with financial time series data indicate that the distribution of asset returns is usually rather leptokurtic. Casual observation also suggests that many financial series move closely together over time, at least in the short run. Bilateral exchange rates against one specified currency, interest rates on bonds with different maturities, and share prices for different companies trading on the same stock market constitute obvious examples. Nevertheless, most existing tests for predictability of the means, variances and covariances of asset returns ignore those two facts by implicitly relying on normality and ignoring cross-sectional dependence. In contrast, we propose new testing approaches for mean-variance predictability that explicitly account for those regularities. Specifically, in the univariate case we propose tests for smooth but persistent serial correlation in expected returns and volatilities that exploit the non-normality of returns. In addition, in the multivariate case we propose analogous mean-variance predictability tests that not only exploit the non-normality of returns but also the strong common variation in financial time series. Once again, our tests are specifically designed to capture smooth but persistent movements in expected returns, volatilities and correlations. We present detailed Monte Carlo exercises that confirm the power gains

that our new testing approaches deliver over existing methods. Finally, we also illustrate our methods with some empirically relevant examples.

David Backus (New York University), **Mikhail Chernov** (London Business School), Ian Martin (Stanford University). **Extreme Events Implied by Equity Index Options**: We contribute to disaster research by using prices of equity index options to quantify the impact of extreme events on asset returns. We define extreme events as departures from lognormality and summarize their impact with high-order cumulants of the (log) pricing kernel. We show that high-order cumulants are quantitatively important in the both the examples of Barro and Rietz and in a statistical pricing model estimated from equity index options. Option prices provide independent confirmation of the role of extreme events in asset returns, but imply a somewhat different distribution of them.

Fousseni Chabi-Yo (Ohio State University). **Pricing Kernels with Coskewness and Volatility Risk**: I investigate a pricing kernel in which coskewness and the market volatility risk factors are endogenously determined. I show that the price of coskewness and market volatility risk are restricted by investor risk aversion and skewness preference. Consistent with theory, I find that the pricing kernel is decreasing in the aggregate wealth and increasing in the market volatility. When I project my estimated pricing kernel on a polynomial function of the market return, doing so produces the puzzling behaviors observed in pricing kernel. Using pricing kernels, I examine the sources of the idiosyncratic volatility premium. I find that nonzero risk aversion and firms' non-systematic coskewness determine the premium on idiosyncratic volatility risk. When I control for the non-systematic coskewness factor, I find no significant relation between idiosyncratic volatility and stock expected returns. My results are robust across different sample periods, different measures of market volatility and firms characteristics.

Peter Christoffersen (McGill University), Kris Jacobs (McGill University), Chayawat Ornthanalai (McGill University). **Exploring Time-Varying Jump Intensities: Evidence from S&P500 Returns and Options**: Standard empirical investigations of jump dynamics in returns and volatility are fairly complicated due to the presence of latent continuous-time factors. We present a new discrete-time framework that combines heteroskedastic processes with rich specifications of jumps in returns and volatility. Our models can be estimated with ease using standard maximum likelihood techniques. We provide a tractable risk neutralization framework for this class of models which allows for separate modeling of risk premia for the jump and normal innovations. We anchor our models in the literature by providing continuous time limits of the models. The models are evaluated by fitting a long sample of S&P500 index returns, and by valuing a large sample of options. We find strong empirical support for time-varying jump intensities. A model with jump intensity that is affine in the conditional variance performs particularly well both in return fitting and option valuation. Our implementation allows for multiple jumps per day, and the data indicate support for this model feature, most notably on Black Monday in October 1987. Our results also confirm the importance of jump risk premia for option valuation: jumps cannot significantly improve the performance of option pricing models unless sizeable

jump risk premia are present.

Eric Jacquier (HEC-Montréal), Shirley Miller (Université de Montréal). **The Information Content of Realized Volatility, and What we Learnt in the Fall of 2008**: We seek to quantify in a practical way the amount of information which various implementations of realized volatility can bring to the forecasting of volatility. The forecasting horizon is daily or weekly. The realized volatility uses intra-day observations. We consider SV models of the type: $r_t = \sqrt{h_t}\epsilon_t$, $\log h_t = \alpha + \delta \log h_{t-1} + v_t$ where v_t can be a normal noise as in a basic SV model, or exhibit fat tails as in Jacquier, Polson, Rossi (2004) and others. That is, we start from a discrete time model of true daily volatility at the base forecasting horizon. This model is estimated by Bayesian MCMC techniques which provide an optimal filter for volatility. Then, we incorporate the intra-day information to this parametric model, initially under the form of an exogenous variable1. This leads to augmented filters of the type: $\log h_t = \alpha + \delta \log h_{t-1} + \beta X_t + v_t$. In contrast to the estimation of (1), the MCMC estimation of (2) makes optimal use of the intraday information contained in the realized volatility. We simulate models as in (1). We when estimate and forecast volatility, using (1) and versions of (2). For (2), we look at the effect of using more and more intraday observations in the quality of volatility forecasts. We consider the use of 12 to 256 intraday returns for computing realized volatility. We also evaluate the range, which contains some intra-day information about volatility, see Alizadeh, Brandt and Diebold. This allows us to document the improvement in volatility forecasting that one can expect from using realized volatility for different scenarios. This approach is in contrast with most of the empirical realized volatility literature which documents the ability of realized volatility to forecast itself. A paper close to us is Maheu et McCurdy (2008) who write a model for returns based upon realized volatility. In our empirical application, we use the S&P500 and the SPY (Spyder ETF) as in Maheu and McCurdy. However, we apply these competing models to the second half of 2008, which allows to rank them in a period where forecasting volatility would have been crucial.

Patrick Gagliardini (University of Lugano), and **Christian Gouriéroux** (University of Toronto and CREST). **Efficiency in Large Dynamic Panel Models with Common Factors**: This paper deals with efficient estimation in exchangeable nonlinear dynamic panel models with common unobservable factor. The specification accounts for both micro- and macro-dynamics, induced by the lagged individual observation and the common stochastic factor, respectively. For large cross-sectional dimension, and under a semi-parametric identification condition, we derive the efficiency bound and introduce efficient estimators for both the micro- and macro-parameters. In particular, we show that the fixed effects estimator of the micro-parameter is not only consistent, but also asymptotically efficient. The results are illustrated with the stochastic migration model for credit risk analysis.

Serge Darolles (Sociéte Générale and CREST), **Jean-Pierre Florens** (Toulouse School of Economics), Guillaume Simon (Sociéte Générale and Toulouse University). **Hedge Funds Durations : Endogeneity of Performance and Assets under Management**: The reporting of Hedge Fund performances in databases

is based on voluntary publication. This induces difficulties in measuring their true probability to fail or to stop reporting. A lot of studies have already tried to incorporate fund characteristics to explain this probability. The aim of this paper is to underline the importance of performance and assets under management to explain the duration of the lifetime of the fund, taking into account the potential endogeneity of those variables in the analysis of survivorship.

Federico Bandi (University of Chicago), **Valentina Corradi** (University of Warwick), Guillermo Moloche (University of Chicago). **Bandwidth Selection for Continuous Time Markov Processes**: We propose a theoretical approach to automated bandwidth choice for continuous-time Markov processes. We do so in the context of stationary and nonstationary processes of the recurrent kind. Because the rate of divergence of the process local time affects the rate of convergence of the functional estimates of the process moments, the nonstationary case, for which local time diverges at a generally unknown rate lower than T, is particularly delicate. The procedure consists of two steps. In the first stage, by invoking local gaussianity, we suggest an automated bandwidth selection method which maximizes the probability that the standardized data are a collection of normal draws. In the case of diffusions, for instance, this procedure selects a bandwidth which ensures consistency of the infinitesimal variance estimator but does not identify the drift function. Additionally, it does not ensure that the necessary rate conditions for asymptotic normality of the infinitesimal variance are violated. In the second stage, we propose tests of the hypothesis that the bandwidth is either "too small" or "too big" to satisfy all rate conditions. The suggested statistics rely on a simple randomized procedure based on the idea of conditional inference. Importantly, if the null is rejected, then the first-stage bandwidths are kept. Otherwise, the outcomes of the tests indicate whether we should select larger or smaller bandwidths. We study diffusion processes, jump-diffusion processes, as well as processes measured with error as is the case for stochastic volatility modelling by virtue of preliminary high-frequency spot variance estimates, for instance. The finite sample joint behavior of our automated bandwidth selection method, as well as that of the associated (second-step) randomized procedure, are studied via Monte Carlo simulation.

Andrew Patton (University of Oxford), Michela Verardo (London School of Economics). **Systematic Risk and Information Flows**: This paper investigates whether the systematic risk of a firm varies around firm-specific information flows. Previous studies assume that a stock's risk exposure remains constant during information flows, or varies at low frequencies with business cycle-type variables. We employ a new approach that uses intra-daily data and recent advances in econometric theory to obtain firm-level estimates of daily changes in beta for all 810 constituent companies of the S&P 500 index over the period 1995-2006. We then study the behavior of these systematic risk estimates around the dates of over 22,000 separate quarterly earnings announcements. We find that systematic risk on announcement dates increases by a statistically and economically significant amount, and declines on the post-announcement day, before reverting to its long-run average level. A simple model of investors' expectations formation using intermittent earnings announcements helps explain our empirical findings.

Yacine Aït-Sahalia (Princeton University), Jean Jacod (Université Pierre et Marie Curie). **Testing Whether Jumps Have Finite or Infinite Activity**: We propose statistical tests to discriminate between the finite and infinite activity of jumps in a semimartingale discretely observed at high frequency. The two statistics allow for a symmetric treatment of the problem: We can either take the null hypothesis to be finite activity, or infinite activity. When implemented on high frequency stock returns, both tests point towards the presence of infinite activity jumps in the data.

Rama Cont (Columbia University), **Cecilia Mancini** (Università di Firenze). **Nonparametric Tests for Analyzing the Fine Structure of Price Fluctuations**: We consider a semimartingale model where (the logarithm of) an asset price is modeled as the sum of a Lévy process and a general Brownian semimartingale. Using a nonparametric threshold estimator for the continuous component of the quadratic variation ("integrated variance"), we design - a test for the presence of a continuous component in the price process - a test for establishing whether the jump component has finite or infinite variation based on observations on a discrete time grid. Using simulations of stochastic models commonly used in finance, we confirm the performance of our tests and compare them with analogous tests constructed using multipower variation estimators of integrated variance. Finally, we apply our tests to investigate the fine structure of the DM/USD exchange rate process and of SPX futures prices. In both cases, our tests reveal the presence of a non-zero Brownian component, combined with a finite variation jump component.

Nour Meddahi (Toulouse School of Economics). **Expected Value Models: A New Approach**: Two approaches dominate the time series literature for modeling expected value models. The first one is based on observable variables and includes ARMA and GARCH models, while the second one is based on latent variables and includes state space and stochastic volatility (SV) models. The first approach is appealing because it allows one to compute conditional expectations (e.g., for forecasting purpose) and to use the Quasi Maximum Likelihood (QML) type of estimation. However, its main limitation is that it imposes some indirect restrictions that are not desirable. For instance a GARCH model, which captures volatility dynamics, imposes that some marginal moments are not bounded, which is a clear limitation of the model. In contrast, state-space models do not impose such restrictions and are more flexible. However, they do not allow one to compute conditional expectation given observable variables (rather than latent variables) and do not allow the use of QML techniques for inference purposes. The main contribution of this paper is to introduce a new approach that has the advantages of ARMA and state space models. The model we propose is a latent variable one where one can compute explicitly the conditional expectations of the variables of interest and, consequently, to use QML estimation. In other words, we bridge the gap between ARMA (or GARCH) and state space (SV) models. We apply our approach in two examples. In the first one, we deal with modeling volatility, i.e., we introduce a SV model and derive the first four conditional moments. This allows us to give a structural interpretation for the time varying effects of skewness and kurtosis recently highlighted by the literature. The second example deals with the dynamics of the Sharpe ratio.