

# ECONOMETRICS OF COMMODITY AND ASSET PRICING

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The main objective of this course is to propose discrete time methods for pricing commodities and financial assets. These methods are based on four pillars, i) a financial pillar: the absence of arbitrage opportunity, ii) a mathematical pillar: the Laplace transform, iii) a probabilistic pillar: the affine processes, iv) a statistical pillar: the non-linear state-space models. The methods are first applied to commodity markets in order to price forward and futures contracts, taking into account the convenience yields. A modeling of spot and forward electricity prices is developed, as well as a simultaneous modeling of several commodity markets. Then the pricing methods are applied to various financial domains: sovereign and corporate bonds with possible switching regimes and/or zero lower bound spells, interest rate derivatives, default and illiquidity risks, quadratic and Wishart interest rate models, credit event pricing, option pricing including conditional heteroscedasticity or stochastic volatilities and/or switching regimes, simultaneous modeling of exchange rates, interest rates, stock index and international derivatives. The statistical problems of inference, filtering, smoothing and prediction are treated. All the methods are illustrated by applications based on real or simulated data.

## PLAN

### **AFFINE (or CAR) PROCESSES**

- Information in the Economy: the Factors
- Building Dynamic Models
- Properties of the Laplace Transform
- Affine or Car Processes

### **PRICING AND RISK NEUTRAL DYNAMICS**

- Stochastic Discount Factor: Equilibrium Approach
- Stochastic Discount Factor: Absence of Arbitrage Opportunity Approach
- Exponential Affine SDF
- The Risk Neutral Dynamics
- Typology of Econometric Asset Pricing Models

### **FORWARDS, FUTURES, DIVIDENDS, COMMODITIES, CONVENIENCE YIELDS**

- Pricing forward and futures contracts
- Convenience yields
- Seasonality

### **MODELING SPOT AND FORWARD ELECTRICITY PRICES**

- Characteristics of Electricity Markets (Spikes, Seasonality, Non Storability, Continuous Delivery)
- Direct Modeling of Spot and Forward Prices
- Application** to Spot and Forward Prices in the French Electricity Market

### **SIMULTANEOUS MODELING OF SEVERAL COMMODITY MARKETS**

- Backward Modeling
- Internal Consistency Constraints
- Switching Regime VAR Models in the Historical and Risk Neutral Worlds

### **ECONOMETRICS OF INTEREST RATE TERM STRUCTURE**

- Typology of term structure modeling strategies
- Affine term structure models (Gaussian, Gamma, Wishart)
- Inference
- Real term structure models

### **REGIME SWITCHING INTEREST RATE MODELS**

- Regime Switching and Default Free Bond Pricing:
- Application** to ECB Policy Rate

Regime Switching and Defaultable Bond Pricing:  
**Application** to Sovereign Yields in the Euro Zone  
Extensions: Sector Contagion, Credit Ratings

#### **ZERO LOWER BOUND INTEREST RATE MODELS**

ARG-Zero Processes  
Moments, Stationarity, Lift-off,  
VARG Processes  
Moments, VAR representations, Lift off  
Pricing  
**Application** to Japanese Interest Rates

#### **CREDIT RISK MODELS**

The Setup  
Term Structure of Corporate Rates  
Term Structure of “First to Default” Rates  
Credit VaR  
**Application** to simulated data

#### **QUADRATIC MODELS**

Quadratic Models and the Quadratic Kalman Filter  
Credit Risk and Illiquidity Risk  
**Application** to Interbank Rate, the Euribor-OIS spreads

#### **CREDIT EVENT PRICING**

Default event surprise  
Default Intensity, Pre-Intensity,  
Exogeneity, Contagion  
Pricing Individual and Joint Defaults  
**Applications** to the Credit Spread Puzzle and to Recursive Contagion

#### **OPTION PRICING**

Security Market Models  
Truncated Laplace Transforms  
Back Modeling of Switching Regimes  
Back Modeling of Stochastic Volatility Models  
Back Modeling of Switching GARCH Models  
Direct and backward Modeling of Conditionally Gaussian Dynamics  
Extensions: Spline and Conditionally Mixed Normal Models  
**Application** to ARCH models

#### **INTERNATIONAL MODELING**

Wishart Processes  
Joint Modeling of Several Term Structures, Exchange Rates and Market Indices  
Pricing Futures, Forwards, Swaps and Options Based on Several Markets  
**Application** to simulated data

#### **Appendix 1: QUANTITATIVE LATENT VARIABLE MODELS**

Definitions, Kalman Filtering, Kalman Smoothing, Estimations and Tests, First order Extended Kalman Filter (EKF1), Second order Extended Kalman Filter (EKF2), Unscented Filtering (UKF), Quadratic Kalman filter (QKF)

#### **Appendix 2: QUALITATIVE LATENT VARIABLE MODELS**

Markov Chain, Definition, Examples, Filtering, Smoothing, Likelihood, Kitagawa-Hamilton Algorithm, EM Algorithm, Stochastic Volatility Models, Prediction, Coding the State Variable, Parameterization of the transition matrix