PHD COURSE “COMMODITY MARKETS AND DERIVATIVES”
NORWEGIAN UNIVERSITY IF SCIENCE AND TECHNOLOGY,
TRONDHEIM

To register for the course, please send an email to:
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Brief outline of the course:

- Commodity markets: overview, description and structure
- Commodity spot price models, their performance and calibration
- Forward curve modeling for commodities
- Modeling commodity price volatility
- Correlations/dependencies in commodity portfolios
- Modeling risk of a commodity portfolio
- Typical commodity derivatives (quanto, Asian, spread and basket options, volumetric and swing options, real options) and ways to price and hedge them
- Miscellaneous topics in commodity markets: exotic commodities (emission, weather, insurance, catastrophe, real estate derivatives); role of information, news and market fundamentals in commodity price formation.

Structure of the course and final assessment:

The course will encompass five full days of tuition. The first day will only consist of lectures; each subsequent day will consist of lectures and case study/problem solving sessions. Total of six lectures is planned, each lecture is four academic hours with breaks in between.

The case studies and working on problems should be done in pairs. For case studies, the students will need an access to a computer with internet connection (for data search and download) and a suitable implementation software, such as Matlab. An access to TR Datastream is strongly desirable. The case studies will end in writing short reports and small presentations by students. The course will end with a take-home written exam and the final assessment is done by combining the grade for the case studies (50%) with the grade for the exam (50%).

Detailed outline of the course:

Lecture 1

- Commodity markets: energy, agriculture, metals.
- Commodity trading: spot market, OTC forward market, commodity futures and exchanges.
- Central role of oil in energy markets. Brent and WTI markets and benchmarks: their structure, common features and differences.

Readings: [1], [3]

**Lecture 2**

- Commodity price features: seasonality, jumps, mean-reversion, excess volatility and kurtosis.
- Popular spot price models: GBM, mean-reversion, jump-diffusions and their properties.
- Calibration of the popular spot price models.
- Alternative models: state-space models, Levy processes, regime switching models, multifactor models.

Readings: [1], [2], [4], [5], [6], [7], [8], [10], [16], [17], [18], [19]

**Lecture 3**

- Role of futures markets and forward curves in commodities.
- Key features of commodity futures/forward prices.
- The central concept of the convenience yield and the theory of storage.
- Popular forward curve models: Gibson & Schwartz (1990), Schwartz (1997).
- Principal component analysis (PCA) of commodity forward curves.

Readings: [1], [2], [9], [10], [11], [12], [13], [14], [20], [21]

**Lecture 4**

- Empirical features of commodity price volatility and its term structure.
- GARCH, SV and multifactor volatility models for commodities.
- Building the implied volatility surface for commodity price volatility.
- Characterizing the dependence: correlation and cointegration in commodity markets.
- Financialization of commodities since 2007.
- Modeling of risk of commodity portfolios: PCA revisited.

Readings: [2], [32], [22], [23], [24], [25], [26], [14]

**Lecture 5**

- Asian, spread and basket options: Wakeman, Kirk, Vorst methods.
• GLN approach to basket and spread options, its extension to Asian and American options.
• Implied correlations from commodity spread options.
• Volumetric options: swing options in gas and electricity markets.
• Real options: oil exploration, power plants, gas storage.

Readings: [2], [27], [28], [29], [30]

Lecture 6

• Exotic commodities and underlyings: emissions, freight, weather, insurance, catastrophe, real estate, sport, art, wine, water. Their role as hedging and diversification instruments. Challenges with their modeling and valuation.
• Role of information, news and fundamentals in commodity price formation.

Readings: [31], [33], [34], [35]

Handouts:

Handouts will consist of: lecture slides, lecture notes written by S. Borovkova and copies of the key articles.

Problems:

Computational problems and exercises will be distributed among the participants during each lecture. These problems are meant to be solved during practical sessions and are similar to the exam questions.

Case studies:

Case studies will involve finding and collecting commodity price data, fitting and applying models discussed during the course, writing short reports that summarize the findings and presenting the results. The case studies will be done in pairs; each pair will receive an individual case study on the first day of the course. Possible subjects for the case studies are:

• Choosing and fitting an appropriate model to the spot price and/or volatility of a given commodity (e.g., corn, aluminum, coal).
• Risk modeling and VaR assessment of a given commodity portfolio.
• Application of the PCA to a given forward curve or a given commodity portfolio.
• Fitting the seasonal forward curve model to a given commodity futures curve.
• Investigating the dependencies (correlations, cointegration) within a given set of commodities.
• Implementing an option pricing model (e.g. for soybean crush spread option or a particular gas swing option) and valuation of these commodity options by means of this model.
• Inferring implied correlations between pairs of commodities from exchange-traded spread option prices.
• Investigating the role of news for a given commodity.

**Literature for the course:**

**Books: (not necessary, serve as supplementary/background material)**


**Articles: (not all necessary, the main materials and key references will be included in the handouts, the rest serve as supplementary/background material)**


