ENERGY DERIVATIVES

Course Syllabus

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COURSE DESCRIPTION

This course provides an overview energy derivatives markets and the pricing of energy derivatives including forwards, futures, swaps, and options. We will begin by describing what futures and swap contracts are and how they are traded. We will then analyze how to price futures and swaps on energy commodities, and how the prices of these derivatives behave under varying market conditions. This will be followed by a description of the basics of option contracts. The course will then explore some simple no-arbitrage restrictions on the pricing of options. This will be followed by an analysis of two options pricing models, the binomial model and the Black model. The course will discuss in detail the assumptions underlying these models and the consequences of the violation of these assumptions. We will also discuss option risk, option hedging, exotic options and real options.

COURSE MATERIALS

You can download the overhead slides used in the lectures from my web page. You can also download the manuscript for my forthcoming book, /Structural Models of Commodity Price Dynamics/, which is a useful supplement for the mathematically-inclined.

GRADING

The grading for the course is based on up to five homeworks and a final. The homework counts for 33 percent of your grade; the final for the remaining 67 percent.

COURSE OUTLINE

/20 January-3 February. An Introduction to Energy Derivatives & Energy Trading. /In this week we will describe futures contracts, learn how they are traded, and analyze their purpose. We will examine concepts such as arbitrage, delivery, hedging, basis, basis risk, and clearing. There will also be an examination of the basics of energy trading, focusing on the transformations (over time, space, and form) in energy, and how trading can help maximize the value of these transformations. We will also analyze the pricing of contracts on precious metals as an introduction to arbitrage and as a standard of comparison to energy markets. We will also learn about the pricing of energy swaps. /Reading//: /

* /NYMEX Energy Products <http://www.bauer.uh.edu/spirrong/CME-EN_SalesBrochure.pdf>/
* /NYMEX Energy Hedging Brochure <http://www.bauer.uh.edu/spirrong/energyhedge.pdf> /
* /CME Price Risk Management Guide <http://www.bauer.uh.edu/spirrong/cme_grain_risk_management.pdf> /

* /CME Clearing Overview
<http://www.bauer.uh.edu/spirrong/clearing_brochure_release_102108.pdf>/
* /Pirrong WTI Hedging Performance Study
<http://www.bauer.uh.edu/downloads/Pirrong_WTI_Report_091116_Final.pdf>/
* /Purvin Gertz Crude Oil Fundamentals Study
<PurvinGertz_WTI_Benchmark_Study.pdf>/

/10 February. Storable Commodity Derivatives. /Many of the most important energy products, such as natural gas, crude oil, and products are storable. Understanding the behavior of forward curves for these commodities, and the dynamics of storables prices, requires an analysis of the optimal allocation of commodities over time. To gain this understanding, we will analyze the "theory of storage" and its implications for commodity futures pricing. We will discuss backwardation and contango, the determinants of the shape of energy forward curves, and the relation between the shape of the curve and the volatility of prices. We will also discuss how the actions of large traders can distort prices and price relations, and how this can impact hedgers in the marketplace.

· /Pirrong, "Squeezes, Corpses, and the Anti-Manipulation Provisions of the Commodity Exchange Act" (Regulation, 1994 <http://www.cato.org/pubs/regulation/regv17n4/v17n4-5.pdf>). /

· /Pirrong, "Energy Market Manipulation: Definition, Diagnosis,

and Deterrence" (Energy Law Journal, 2010).
<http://www.felj.org/docs/elj311/13-01-Pirrong-EnergyMarketManipulation-022510.pdf>/

/17 February. Hedging and Risk Measurement Basics./ This section will discuss how to use statistical methods to design variance minimizing hedges, and the implications of the theory of storage for hedge design and hedging effectiveness. I will also examine basic risk measurement methods, focusing on value at risk.//

/24 February. Non-Storable Commodity Derivatives and Credit Derivatives/. Recently, non-storable commodity derivatives have been introduced and exhibited rapid growth. These include derivatives on electricity and weather. This week we will discuss the pricing of such derivatives. Credit derivatives—contracts on the credit risk of corporations—are another major growth area. We will discuss the types of credit derivatives currently traded and their use.

/3 March. Speculation and Commodity Pricing/. Speculation is a controversial subject in commodity markets. We will examine the economics of speculation, and its effects on prices. We'll then consider the potential for speculation to distort prices, and the evidence relating to the effects of speculation. Finally, we will analyze the rationale for limits on speculation, notably position limits.

· /Pirrong, "No Theory? No Evidence? No Problem" (Regulation,

2010) <March%2020.%20Spring%20Break!>./

/10 March. Introduction to Options. /We will describe the basics of put and call options, and discuss briefly how puts and calls can be combined to create more elaborate payoff patterns. We will also examine the determinants of early exercise of American options. Finally, we will analyze put-call parity and other restrictions on option price relations. //

/NYMEX Brochures:/

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· /Options on Futures Basics <G66_Options_on_Fut2001.pdf>/

· /Hedging With Options Basics <AC-216_HedgersGuideNewBoilerplate.pdf>/

/Note! No Class on 17 March, 2011. Spring Break!/

/24-31 March. The Binomial Model. /In order to price options, it is necessary to utilize a model that characterizes how futures prices evolve over time. The binomial model is a simple and tractable example of such a model. We will describe the binomial model and show how to use it to price simple options. We will then extend the analysis to learn how to use the model to price options for which early exercise is

relevant.

/7-14 April. The Black Model. /Under certain assumptions the binomial model converges to the Black model. This model is the one most commonly used to price options. We will discuss the derivation of the model briefly, and then proceed to use it to price options. **

/21 April. Options Risks and Hedging—"The Greeks." / This week we will analyze how the Black model can be used to quantify options price risk. We will also discuss how to manage—hedge—options risks through dynamic trading strategies and how to replicate options using such strategies.

/28 April. Risk Measurement Revisited—VaR With Options/. Options introduce non-linearities that complicate risk measurement. This week we will discuss how to incorporate options into the VaR framework.

Take Home Final Exam Due 5 May, 2010/./

ABOUT YOUR INSTRUCTOR

I joined the UH faculty after spending 14 years teaching at the Michigan Business School, Graduate School of Business at the University of Chicago, the Olin School of Business at Washington University, and Oklahoma State University (where I held the Watson Family Chair in Commodity and Financial Risk management). I received my BA, MBA, and

Ph.D from Chicago. I primarily research subjects relating to derivatives markets (e.g., futures and options) and have consulted extensively with financial exchanges in the United States, Canada, and Germany. I have taught a wide variety of subjects, including risk management, derivatives pricing, investments, microeconomics, and industrial organization.