NEW ECONOMIC SCHOOL
Masters in Energy Economics

Energy Risk Management

Module 4, 2017-18 academic year
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Course information
Course website:
Instructor's office hours:
Class Time:
Room Number:
TAs:

Course description
The goal of the course is to introduce students to the broad and complex field of risk management as applied to the energy industry. The body of knowledge covered in the course builds on the prior student knowledge of energy commodities (crude oil, natural gas, petroleum products, coal, and electricity) and their fundamentals, derivative securities (futures, options, and swaps) as well as statistical and modeling skills. The course looks at multiple risks and risk factors, including market, credit, operational, and liquidity risks, and introduces the main tools and techniques that risk managers use to measure and manage these risks, applied either to commodity positions or to physical assets. The holistic approach to risk management is addressed in the context of Enterprise Risk Management (ERM). The course follows the basics of the body of knowledge required for the Energy Risk Professional (ERP) certification administered by Global Association of Risk Professionals (GARP). Given the very intense nature of the course (half-module), the course will emphasize breadth over depth.

Upon completing the course, you should be able to:
a. List and discuss the main risks facing an energy organization
b. Evaluate the risk of financial positions and physical investments
c. Design basic hedging strategies with energy / weather derivatives
d. Apply basic modeling and simulations skills to valuing energy derivatives
e. Apply basic option pricing framework to managing physical asset risk
f. Apply basic Value at Risk (VaR) framework to measuring risk
g. Apply basic counterparty default risk framework to valuing energy loans
h. Articulate the basic propositions of the ERM framework
i. Appreciate the impact of regulation on energy risk management

Course requirements, grading, and attendance policies
Attendance is mandatory. Some of the material discussed in class is borrowed from multiple sources, all of which are impossible to provide as required reading. Hence, attendance and taking detailed notes are critical to getting a good grasp of the material.

The prerequisites for the course are *Global Petroleum & Gas Market Economics*, and *Derivatives*.

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Your performance in the course will be evaluated as follows:

Class participation	30%
Final Project	70%

We will perform exercises and conduct discussions in class. You will be required to participate by answering questions and / or commenting. The participation will account for 30% of the course grade. I will assign a project at the end of the course, to be completed within two weeks after the last day of class. The project will account for the remaining 70%.

Course contents

The main format of the course will be lecture. However, you will be expected to participate by doing class exercises and participating in discussions. The tentative course schedule is below.

Day 1 (3 hours): Energy Risk Management: Introduction
1. Market, credit, liquidity, and operational risk
2. Hedging: determinants and impact on firm value
3. Physical Infrastructure (storage, transportation, conversion)
4. Energy trading operation, energy exchanges, and trading regulation

Day 2 (3 hours): Price Risk: Linear
1. Specifics of energy price behavior
2. Modeling spot prices and forward curves (convenience yield)
3. Basis risk
4. Linear hedge contracts (futures and swaps): strategies

Day 3 (3 hours): Price Risk: Nonlinear
1. Modeling volatilities (SMA, EMWA, GARCH)
2. Nonlinear hedge contracts (options): strategies
3. Risk of physical assets (real options, swing options)

Day 4 (3 hours): Value at Risk
1. Value at Risk (VaR) and expected shortfall
2. Historical and Monte Carlo simulations
3. Backtesting, stress testing

Day 5 (3 hours): Credit Risk, Operational Risk, ERM
1. Counterparty default risk (default probability, loss given default, credit default swaps)
2. Energy lending
3. Operational Risk
4. ERM framework

Final Project (Graded)

The details of the project to be released on the last day of the course.

Sample exercises solved in class (Participation Graded)

1. Price an ATM swing option to take delivery of natural gas over 4 weeks with weekly increments of 10,000 MMBtu each. The total volume to be taken over the whole month should be no less than 10,000 MMBtu and no more than 30,000 MMBtu. If no delivery is taken, a

penalty of $0.5 per MMBtu ($5,000 total) will apply. Assume the strike price to be $4.00 per MMBtu, the interest rate 2% per annum, and the volatility of the futures price to be a constant 0.4 per year.

2. Refer to the provided historical price series for a hypothetical commodity. The futures price is currently 63. You have a long position in one unit of the commodity. Knowing nothing about this commodity other than past price history, you notice the following option contracts (calls and puts) trading on the underlying futures. Strike prices = [50, 53, 56, 59, 62, 65, 68, 71]. Each option contract has exactly one year to expiration. Calculate the annualized volatility of daily return on the underlying price. Assuming constant volatility and given interest rate of 0.5% per annum, calculate the premiums of the call and the put options above using the Black-Scholes model. Calculate the delta of each option. Next, design a (roughly) zero-cost collar hedging strategy, picking the call and the put of your choice. Using the historical price series, simulate the distribution of the underlying price on the next trading day. Simulate the distribution of your portfolio value (the call + the put + the underlying) on the next trading day. Finally, estimate the one-day Value at Risk at the 99% confidence level for your portfolio per unit of commodity.

3. Given the following information on an energy bond:

Maturity	U.S. Treasury Par Yields	Unconditional risk-neutral default probability, p_t	Loss given default, %
1	4.63	1.25%	65
2	4.90	1.75%	65
3	5.05	2.50%	65
TOTAL			

Price the 3-year CDS on the bond with a par value 100.

4. Given the following example of electricity futures prices, and assuming you entered the contract at F=72, what is the marked-to-market value of the contract on 05/31/06 and the delta of the contract?

Example: observed as of 05/31/06

A single day's worth of on-peak power delivery
(5 X 16 contract to sell 25.00 MW per hour, 16 hours per day)

Leg #	Expiration Date	Payment Date	Discount Factor	# Days in Leg	First Delivery	Last Delivery	Average Forward	Average Discount
1	06/30/06	08/07/06	0.9978	1	07/03/06	07/03/06	66.1733	0.9989

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5. An option's payoffs depend on the average of prices over a period of time. That is, payoff for a call is max(avg(F) – K),0) and payoff for a put is max(K – avg(F),0). Explain the advantages of this option relative to an American option, and provide an example of its use in energy trading.

Course materials

The required textbooks for this course are:
John Hull, Risk Management and Financial Institutions 4th Edition
Dragana Pilipovic, Energy Risk: Valuing and Managing Energy Derivatives, 2nd edition

The optional book is: *Vincent Kaminski, Energy Markets*

Academic Integrity Policy

Cheating, plagiarism, and any other violations of academic ethics at NES are not tolerated.