45-722
Finance Doctoral Seminar

Commodities

Mini 4 – 1999
Tuesday - Thursday
8:30-10:30AM
Room 318

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Course Home Page: http://sulawesi.gsia.cmu.edu/teach/phd722

DRAFT - 02/19/99 3:49 PM

° This is a draft. Please send me your suggestions

Overview

The common theme of this course is commodity pricing. Commodities are a traded asset and as such can be used to refine our theoretical and empirical understanding of asset pricing. They are also a large and growing part of the market.

Commodities markets are both an old and a new topic in financial economics. The terms contango and backwardation date back to the 1800’s and the London Metal exchanges. It is Keynes who first introduced the term “Normal Backwardation.” Much of the early markets regulation related to preventing corners, squeezes and other manipulation in commodity markets (You may recall the Hunt Brothers and silver in the 1980’s. One can also check out the current price increase in Cobalt.) More recently, commodities have re-emerged as an important and
interesting market. The “modern” history of commodities markets is tied to NYMEX’s introduction trading in Crude oil in 1986. This was right near the time that OPEC’s influence on oil prices was reduced. Although trading in other downstream energy commodities had been underway for a few years, it was the addition of the input crude-oil commodity that lead to an dramatic increase in trading volume. More recently, the volume in commodity trading has been driven by deregulation. Natural gas and electricity prices used to be regulated. Deregulation naturally leads to more price volatility and greater interest in traded securities related to the new market-based prices. <The NYMEX site has an interesting, short history of the New York Mercantile Exchange (NYMEX).> 

![Figure 3-4. Prices for Next Day On-Peak Spot Electricity Markets](image)

For example, ongoing deregulation in the electricity market is changing a once strictly regulated, low volatility, monopolistic industry into an open market with annual sales of over $250 billion. In particular, the de-coupling of power generation from power distribution has freed end-users, power generators, and power-marketer intermediaries to negotiate and contract directly with each other. A natural byproduct of this greater flexibility is a closer link between market prices and the underlying economics of supply and demand. June 1998 is a dramatic example of
this when peak-load electricity transacted at as high as $7,500 per megawatt hour at an active Midwest hub. More typical prices are $25-$50 per megawatt hour (see the FERC Report on the issue [59]). The possibility of such extreme price volatility leads naturally to a demand for OTC and exchange-traded derivative securities for risk management and/or speculation. The physical nature of these contracts makes leads to many interesting features and "embedded options." The new markets also raise interesting questions about the emergence and design of new markets.

The Plan
The Reading List and Schedule are organized into a few broad topics. We will begin the course with a "classical" view of commodity markets. In particular, we will look at the asset roll of commodities in a traditional "risk-return finance model. For example, in the section “Equilibrium Models - Risk-Return” we will look at the relationship between forward prices and future spot prices. Does the forward price “predict” the future spot price?

In the second portion of the course, “Derivative Prices,” we look at an options-based approach to commodity pricing. Like the Black-Scholes approach to equity options, we make some assumptions about the evolution of commodity spot prices and derive the no-arbitrage prices for commodity derivatives like forwards, futures and options. Unlike the classical equilibrium models, these no-arbitrage models are interested in the relation between prices at a given time. For example, they model the relation between today’s forward price and today’s spot price. As with any no-arbitrage approach, the specification of the evolution of the state variables is crucial. The common approach in commodity derivatives, is to specify the evolution of the spot price and a “convenience yield.” Two factors are necessary to explain the shape of the term-structure of forward prices (the forward curve).

The section on "Hedging and Metallgesellschaft" builds on the famous 1993 financial disaster of Metallgesellschaft (Germany’s 14th largest company) which almost went bankrupt with a strategy to hedge long-term positions in oil with a series of rolling short-term contracts. Most of the organized trading of financial contracts is in short-dated contracts (the shortest-term contract is often the most liquid). This section looks at the ability to hedge long-dated exposure using a dynamic trading strategy in short-term contracts. The properties of the “hedge ratio” of short-dated to long-dated contracts are important.

Unlike the classical risk-return models and the derivative models, the section on “Equilibrium Models - Storage” models the equilibrium spot
price from the underlying microeconomics of supply and demand. The two papers we focus on investigate the role of storage in equilibrium. Storage or inventory of commodities is closely related to a natural no-short-sell constraint. Unlike financial assets, commodities are physically consumed at some point in time. Sometimes, commodities behave like an asset in that through storage, value is transferred between periods. However, at other times commodities are an inefficient store of value since they are valued highly as consumption.

Equilibrium storage models focus on the embedded consumption timing option present in commodities. This is an example of the more general economic topic of Real Options. Physical irreversibility, like production, extraction, or physical investment affect the optimal investment and consumption and therefore influence asset prices.

**Required Text**
- None

**Background Books (Not required)**

**Useful Web Sites**
- See Course Home Page
  (These May not be that exhaustive – Yahoo does that for me)

**Paper Sources**
- You can obtain a copy from me. I will have a binder in my office that you can borrow. (Some of them may be at J-Store etc.)

**Prerequisite**
- The prerequisite for this course is Finance I (47-720) and/or permission.

**Format of Classes**
- This is a seminar-style course. As such we will read the papers and discuss them. I will do some lecturing, but much of the time we will engage in discussion. Rick tells me I can just pose a discussion question and sit there and stare at you until the awkward silence becomes too much and a discussion occurs.
You should read the paper before attending class. Typically this means you should have a solid understanding of the objective and results in the paper, be familiar with the notation and tried to work through a few of the steps. I realize that some papers are harder than others and that you may get stuck sooner.

**Evaluation**

- To be determined. Here is what I am thinking about...
  - Homework / Assignment questions. I am thinking about a couple of programming / numerical exercises that help you to work through the papers.
  - Brief Survey of a paper (or collection of papers) related to commodities. As you will note from the Reading List, there are many more interesting papers that we will not cover. This should consist of brief summary of the paper(s). In particular, you do not need to reproduce all the equations etc. The bulk of your report should consist of your consideration of the strengths, weakness and opportunities of the paper. The report should be about 5 to 10 pages.
  - General citizenship. As noted, this is a seminar and you cannot learn without being involved.
Schedule

- Please read the papers identified by the reference number before meeting. The reference refers to the Reading List. If you are uncertain about what to read, please let me know.
- I apologize in advance, I must reschedule two of the classes due to travel.

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<thead>
<tr>
<th>Topic / Paper</th>
<th>Ref</th>
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<tbody>
<tr>
<td>Equilibrium Models - Risk-Return</td>
<td>[1]</td>
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<td>One Period</td>
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<td>Multi-period Model</td>
<td>[2]</td>
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<td>Derivative Prices</td>
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<td>Brief introduction to Continuous time</td>
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<td>One, two factor models Schwartz (1997)</td>
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<td>Schwartz (1997) continued</td>
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<td>Spring BREAK</td>
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<td>Other factor Models - Smith and Schwartz (1998)</td>
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<td>Hedging and Metallgesellschaft</td>
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<td>Background on Metallgesellschaft</td>
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<td>[27]</td>
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<td>Hedging Long-Contracts with Short</td>
<td>[31]</td>
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<td>Ross (19xx)</td>
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<td>Equilibrium Models - Storage</td>
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<td>Deaton and Laroque</td>
<td>[37]</td>
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<td>Real Options</td>
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<td>Commodities and Production</td>
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<td>Litzenberger and Rabinowitz</td>
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<td>Hoover and Stegbemz</td>
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<td>Kogan</td>
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<td>Equilibrium and Myopia</td>
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<td>Lecture to be presented by Rafael Mendible</td>
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<td>One Final Topic</td>
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<td>“Trading Places” John Landis (D), Dan Aykroyd, Eddie Murphy (Snacks and Beverages included)</td>
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Reading List

This is not a comprehensive list.
I have tried to sort the papers into the broad themes we will be considering.
The detailed Schedule appears on Page 6

Equilibrium Models - Risk-Return


Empirical Facts about Commodities


**Derivative Prices**


[16] Steve Shreve’s Notes on Stochastic Calculus and Finance see: http://www.cscmu.edu/~chal/shreve.html


**Hedging and Metallgesellschaft**


**Equilibrium Models - Storage**


[38] Heinkel, R., M. Howe, and J. Hughes, "Commodity Convenience Yields as an Option Profit," Journal of Futures Markets, 10 (1990), 519-533.


Real Options


Electricity


**The Design of Commodities Markets**


More on Manipulation stuff and regulation / design??

**Multi-Commodities and Market Completeness**

To be added

**Information and Strategic**
