

Futures and Option Markets.

Derivative Markets. Risk Management in Financial Markets.

Peter Ritchken
Kenneth Walter Haber Professor
216-368-3849

Background Information

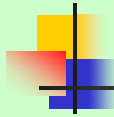
- **Why are there so many new financial products?**
 - Adjustable Rate Notes
 - Bonds with payouts linked to commodity prices
 - Dual currency bonds
 - Options with payouts linked to a time series average
 - Adjustable rate preferred stock
 - Crack spread swaps
 - Caps, floors, collars, swaptions, captions, floptions

Example

American Express: Adjustable Rate Preferred Stock (ARP)

- Perpetuity
- Payouts every quarter linked to
 - 6 month yield
 - 3 year yield
 - 10 year yield
- Cap on the payout, and a Floor on the payout.
- Management can call the ARP in at a predetermined price.

- Why does this product exist?
- Who would purchase it?
- How would you value it?
- Why did American Express issue this contract?



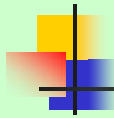
- Why have products become so complex?
- Are all these “additional” choices good for investors?

Peter Ritchken

Introduction

5

The Tokyo Disneyland Bond



- In 1999 Disney issued a \$100m 5 year earthquake bond.
- The bond had a payout linked to the magnitude and location of the earthquake.
 - Above 7.5 on Richter scale with 10km of theme park: bond is forgiven (payout =0)
 - Sliding scale of forgiveness: At 6.5, 25% of the principal is forgiven.
 - Other terms based on location (radius away from Theme park)

Peter Ritchken

Introduction

6



The Tokyo Disneyland Bond

- Coupon was set at LIBOR + 310 basis points.
- Why did Disney issue this bond?



BP Bond Issue

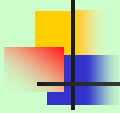
- BP invested in the Alaska pipeline. It was a large investment.
- They could issue straight debt with a fixed coupon.
- They could issue floating debt with a rate linked to LIBOR, for example.
- They issued a bond, with coupons linked to the price of oil.
- If oil went up, the coupons were increased (up to a maximum cap)
- If oil prices went down, coupons were decreased (down to a floor)

BP Bond Issue

- Why would BP issue such a bond?

Complexity of Products and Markets

- Why have products become more complex?



Completing the Market

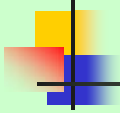
- Are more choices better?
- Preferences, Beliefs and Products.
- The number of new products has grown dramatically over the last two decades.
- Linear contracts and non linear contracts.
- Insurance related contracts
 - Contracts that pay out if stocks go up
 - Contracts that pay out if stocks go down
 - Contracts that pay out if stock prices are in an interval.



Derivatives

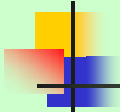
A derivative is an instrument whose value depends on the values of other more basic underlying variables.

An ounce of gold is not a derivative; it is a commodity with a value determined by the price of gold!



Derivatives: A Bet on Gold

- A contract that says the following:
 - If the price of gold in one year is above \$300 pay me \$1.
 - If the price is below \$250, I will pay you \$2.
 - Otherwise no money changes hand.
- Is this contract a derivative contract?
- Its value depends on something else
- This is a bet on the price moves of gold.
- In general derivatives can be viewed as bets on the price of something.



Derivatives: A Bet on Gold

- Bets are not necessarily bad.
- For example bets could provide insurance.

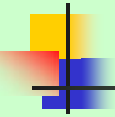
- Assume gold is trading at \$275.

- Who may be interested in buying the contract?
- Who may be interested in selling the contract?



Derivatives

- Note that for every buyer there is a seller.
- The number of bets outstanding at any point in time, is really equal to the number of paired transactions where one person is the buyer, the other the seller.
- The “buyer” is said to be long the contract.
- The seller is said to be “short” the contract.



Examples of Derivatives

- Futures and Forward Contracts
- Swaps
- Options
- Many other products



Ways Derivatives are Used

- To hedge risks
- To speculate (take a view on the future direction of the market)
- To lock in an arbitrage profit
- To change the nature of a liability
- To change the nature of an investment without incurring the costs of selling one portfolio and buying another



The world has become a risky place.


- Living is risky----Life Insurance
- Houses are risky---Fire Insurance
- Stock Markets are risky---
- Commodities are risky----
- Interest Rates are risky----
- Foreign Exchange is risky---
- Energy prices are volatile---

Financial Markets and Joe

- Joe works for a large firm. The firm raises money by issuing stocks and bonds in global markets
- The firm insures itself against adverse moves in currency, interest rates and commodity prices. This ensures that the firm is less likely to go bankrupt.
- Joe lives in tornado ally and insures his home. If the insurance company was completely local, it would not be able to pay claims if a disaster happened. By selling tornado risk in global markets the insurance company can pool with others.

Financial Markets and Joe

- Joe borrows money to buy a house. The bank sold the mortgage to other investors, freeing itself from interest rate and default risk, leaving that to others. Since the risk of the mortgage is borne by those willing to pay the higher price for it, Joe gets a lower mortgage rate.
- Joe's firm has given him an incentive package in the form of option contracts. This payout depends on the performance of the firm
- Joe invests in mutual funds that consist of a broad array of companies. This minimizes the risk exposure due to the collapse of any one company.



- Joe is in charge of a particular product that is new to the market. The product has a warranty. The warranty offers a money back guarantee for a six month period.
- Joe owns a life insurance policy, has medical insurance, and is considering insuring his investment portfolio. He is also thinking of entering into contracts that lock in the future price of his children's education.

Peter Ritchken

Introduction

21



- In sum Joe is involved in global markets, derivative contracting, and in placing many bets or insuring.

Peter Ritchken

Introduction

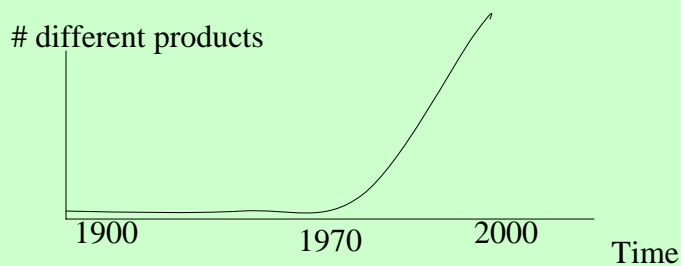
22

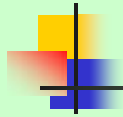
As an individual what risks should I bear?

- How do I choose which risks to bear, and which risks to hedge?
- How do I hedge the risks which I do not want to bear?
- Will I get ripped off when I insure against these risks?
- What maturity contracts should I purchase?
- Where do I get these contracts?
- Some risks are diversifiable, others are not. How do I price them?

The world has become risky!

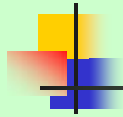
- Financial markets have responded to risk by offering innovative products
 - insurance products
 - hedging products
 - limited liability products





From the Firm's Perspective

- To what extent is my firm exposed to interest rates, FOREX, commodity price risk?
- What financial tools are available for managing these exposures?
- If my firm is exposed, how do I use the tools to manage the exposure?
- Should a firm hedge risk?
 - Can't the individual hedge more efficiently?
 - Examples



Reasons for the Firm to Hedge

- What would Miller and Modigliani say?
 - In a perfect market, Capital Structure Decisions do not really affect the value of the firm.
- We hedge to:
 - Reduce Taxes.
 - Reduce Costs of Distress.
 - Cheaper (transaction costs and size)
 - Special Information.
 - Market wants products that have low volatility.
- We will have more to say about this!



Regulation and Strategy

- An Ohio Widget Company
 - Should we hedge against FOREX risk?

Peter Ritchken

Introduction

27



Regulation and Strategy

- An Ohio Widget Company
 - Should we hedge against FOREX risk?
 - Should we hedge if we know our competitor is hedging?
 - Consequences of information disclosure?

Peter Ritchken

Introduction

28



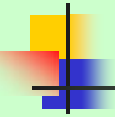
What will we learn?

- Futures, Forwards, Swaps, Options and Exotics.
 - How to Price
 - How to Hedge
 - How to Use Them
- How to transfer risk that you are not willing to bear, at a reasonable price.
- How not to get ripped off.
- How to ask the right questions, and use markets to your advantage.



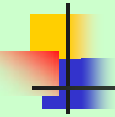
What will we learn?

- How to communicate the risk management needs faced by your firm, and to isolate the steps needed to solve the problem.
- To explain why certain products and strategies create value while others do not.
- To transcribe products designed by marketing, to hedging needs.
- To be able to perform risk management activities, to desks, books, product lines.



What will you learn?

- To understand how all corporate securities can be viewed as complex options, and to value them.
- To understand how option pricing theory can be used in capital budgeting and strategic planning.
- To understand the appropriate discount rates to use for cash flows in capital budgeting.
- To appreciate how flexibility in projects and financial instruments can be valued.
- To better understand why complex products exist.
- To understand a day in the life of a trader and a financial engineer.



Examples of Derivatives

- Contracts on:
 - Stock
 - Bonds
 - FOREX
 - Commodities
 - Interest rates
 - Indices
 - Weather
 - Political election outcomes
 - Pollution
 - credits.



Futures Contracts

- A futures contract is an agreement to buy or sell an asset at a certain time in the future for a certain price
- By contrast in a spot contract there is an agreement to buy or sell the asset immediately (or within a very short period of time)



Exchanges Trading Futures

- Chicago Board of Trade
- Chicago Mercantile Exchange
- LIFFE (London)
- Eurex (Europe)
- BM&F (Sao Paulo, Brazil)
- TIFFE (Tokyo)
- and many more



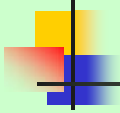
Futures Price

- The futures prices for a particular contract is the price at which you agree to buy or sell
- It is determined by supply and demand in the same way as a spot price



Electronic Trading

- Traditionally futures contracts have been traded using the open outcry system where traders physically meet on the floor of the exchange
- Increasingly this is being replaced by electronic trading where a computer matches buyers and sellers



Examples of Futures Contracts

Agreement to:

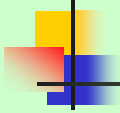
- buy 100 oz. of gold for \$400/oz. in December (NYMEX)
- sell £62,500 for 1.5000 \$/£ in March (CME)
- sell 1,000 bbl. of oil for \$60/bbl. in April (NYMEX)



Terminology

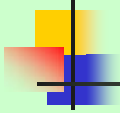
- The party that has agreed to buy has a long position
- The party that has agreed to sell has a short position

Example

- 
- January: an investor enters into a long futures contract on COMEX to buy 100 oz of gold for \$300 per oz. in April
 - April: the price of gold is \$315 per oz

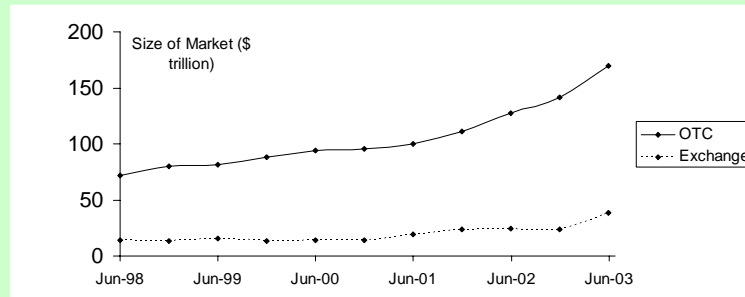
What is the investor's profit?

Over-the Counter Markets

- 
- The over-the counter market is an important alternative to exchanges.
 - It is a telephone and computer-linked network of dealers who do not physically meet.
 - Trades are usually between financial institutions, corporate treasurers, and fund managers.

Size of OTC and Exchange Markets

(Figure 1.2, Page 4)



Source: Bank for International Settlements. Chart shows total principal amounts for OTC market and value of underlying assets for exchange market

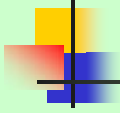
Forward Contracts

- Forward contracts are similar to futures except that they trade in the over-the-counter market
- Forward contracts are popular on currencies and interest rates



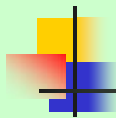
Foreign Exchange Quotes for GBP

	Bid	Offer
Spot	1.6281	1.6285
1-month forward	1.6248	1.6253
3-month forward	1.6187	1.6192
6-month forward	1.6094	1.6100



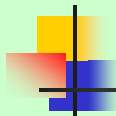
Options

- A call option is an option to buy a certain asset by a certain date for a certain price (the strike price)
- A put option is an option to sell a certain asset by a certain date for a certain price (the strike price)



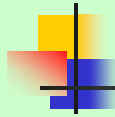
American vs European Options

- An American option can be exercised at any time during its life
- A European option can be exercised only at maturity



Intel Option Prices (May 29, 2003; Stock Price=20.83);

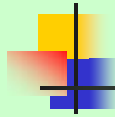
Strike Price	June Call	July Call	Oct Call	June Put	July Put	Oct Put
20.00	1.25	1.60	2.40	0.45	0.85	1.50
22.50	0.20	0.45	1.15	1.85	2.20	2.85



Payout of a Call Option

- At the expiration date the profit of a call option is:
- $\text{Max}(0, S(T)-X)$
- Example: $S(T) = 105$; $X = 100$.
- You have the right to buy at 100. This right is worth \$5.

- What would happen if you could buy the right (option) for \$4, for \$6....



Payout of a Put Option

- At the expiration date the profit of a put option is:
- $\text{Max}(0, X-S(T))$
- Example: $S(T) = 100$; $X = 105$.
- You have the right to sell at 105. This right is worth \$5.

- What would happen if you could buy the right (option) for \$4, for \$6....



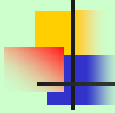
Exchanges Trading Options

- Chicago Board Options Exchange
- American Stock Exchange
- Philadelphia Stock Exchange
- Pacific Exchange
- LIFFE (London)
- Eurex (Europe)
- and many more (see list at end of book)



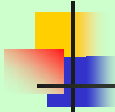
Options vs Futures/Forwards

- A futures/forward contract gives the holder the obligation to buy or sell at a certain price
- An option gives the holder the right to buy or sell at a certain price



A day in the Life of a Financial Engineer

- A firm builds 4 townhouses a year. They townhouses are presold at fixed prices. So the profit of the firm depends on holding costs down.
- Assume the largest uncertainty is lumber prices.
- Further assume the firm buys lumber at the beginning of each quarter at prices $S(1)$, $S(2)$, $S(3)$ and $S(4)$.
- Viewed from date 0, the Cost of lumber is uncertain and given by
- $C = S(1) + S(2) + S(3) + S(4)$



A day in the Life of a Financial Engineer

- $C = S(1) + S(2) + S(3) + S(4)$
- The budget for lumber is given by $B = \$400,000$
- Hopefully, $C < B$
- The firm is concerned that lumber prices might rise and blow away their profit margin

- What are their alternatives?

Strategy 1

- Buy all the lumber they need today and store it.
- Cost = $4S(0)$

Strategy 2

- Enter into 4 forward contracts that lock into the price of lumber for delivery on the required dates.

Strategy 3

- Buy four consecutive option contracts with a fixed strike price?
 - Buy calls or puts
 - What is the point of this strategy?
- $\text{Cost} = \text{Min}(S(1), X) + \text{Min}(S(2), X) + \text{Min}(S(3), X) + \text{Min}(S(4), X)$
- Maximum the firm pays is $4X$

Strategy 4

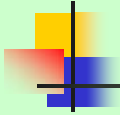
- Concerned about blowing the budget.
Concerned that $S(1) + S(2) + S(3) + S(4) < B$

Get a contract that pays out the excess:

$$\begin{aligned}\text{Payout} &= \text{Max}(0, S(1) + S(2) + S(3) + S(4) - B) \\ &= 4\text{Max}(0, (S(1) + S(2) + S(3) + S(4))/4 - B/4) \\ &= 4\text{Max}(0, \text{Average} - X)\end{aligned}$$

Where $X = B/4 = 100,000$ dollars.

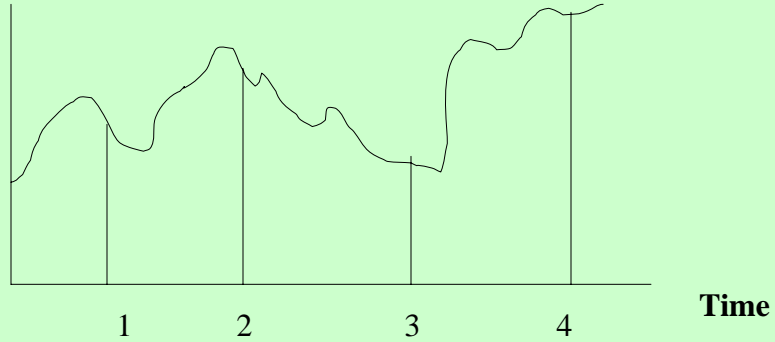
-



An Example of an Exotic Claim

- Average Rate Options

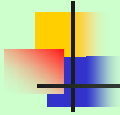
Price



Peter Ritchken

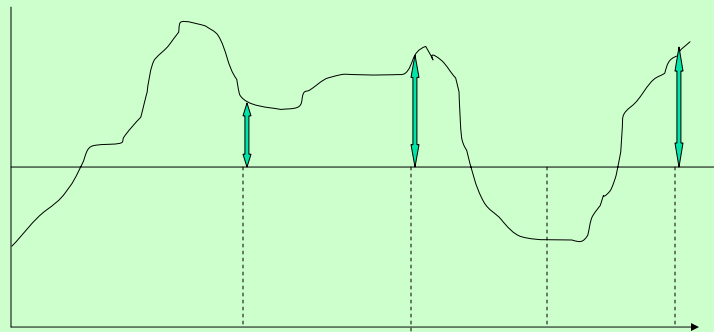
Introduction

57



Hedge Price Appreciation by Buying 4 Call Options

- $\text{Cost} = C(0;1) + C(0;2) + C(0;3) + C(0;4)$



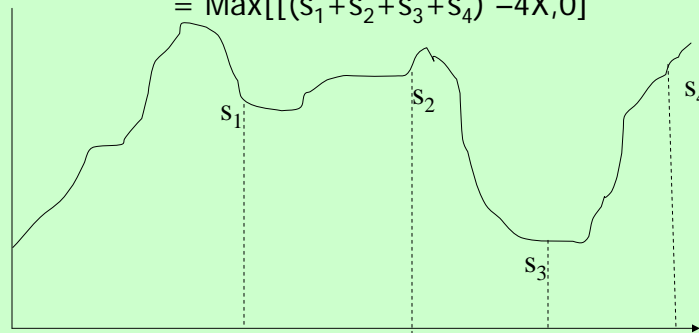
Peter Ritchken

Introduction

58

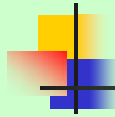
Hedge Price Appreciation by Buying 4 Options on the Average

- Payout = $4\text{Max}[(s_1+s_2+s_3+s_4)/4 - X, 0]$
= $\text{Max}[(s_1+s_2+s_3+s_4) - 4X, 0]$

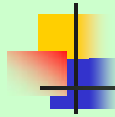


Comparison of Strategies

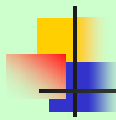
- Which strategy provides the most protection?
- Which strategy protects the budget?
- Which strategy is the cheapest?



- A financial engineer (consultant) will be able to analyze these alternatives (and others) and make recommendations to the firm.
- This requires being able to value derivatives and being able to establish risk profiles for each alternative.

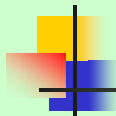
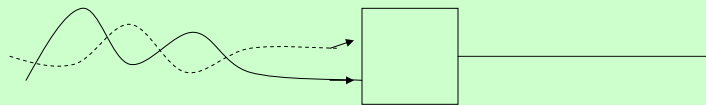


- The valuation tools we look at in this class are helpful in many cases where there is managerial flexibility.



Capital Budgeting and Real Options

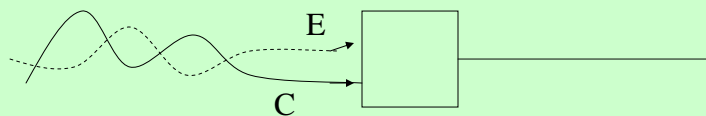
- Valuing a Flexible Manufacturing System.



Valuing a Flexible Manufacturing System

In each period you have the option to switch from Electricity to Coal and vice versa.

$$\text{Min}[E,C] = E - \text{Max}[0,E-C]$$

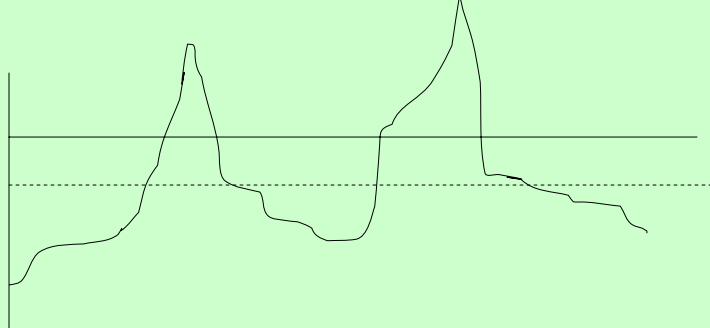


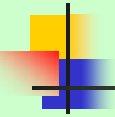
Capital Budgeting and Real Options

- Valuing a Flexible Manufacturing System.
- Valuing Excess Capacity.
- Valuing the Option to Abandon
- Valuing the Option to Expand
- Valuing the Option to Defer.

Valuing a Peaking Unit

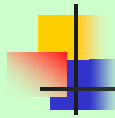
- Use the machine when prices exceed X.





- Each day, you look at the price of electricity. If it exceeds X , use the machine; if not don't use it. The profit for each date t is:
- $\text{Max}[0, S(t)-X]$
- But this is the payout of a call-option with strike X and maturity t .
- So the value of the peaking unit equals the value of a portfolio of call options, one for each time period.
- So, if we can value a call option, we can value a peaking unit.

Peter Ritchken Introduction 67

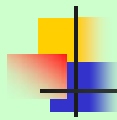


Background Material 1

- Interest Rates, Bond Prices and Discount Factors

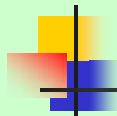
$$1 \rightarrow (1 + \frac{r}{n})^{nT}$$
$$1 \rightarrow e^{rT}$$
$$P(0, T) \rightarrow \$1$$
$$P(0, T) = e^{-rT}$$

Peter Ritchken Introduction 68



Example

- r is 6% continuously compounded.
- $T = 0.25$ year.
- $P(0,T) = \exp(-rT) = \exp(-0.06/4) = 0.985$
 - The Present Value of \$1 is \$0.985
 - Buy 0.985 bonds.



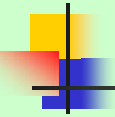
Background Material 2: The Law of One Price

- Two investments that generate exactly the same cash flows at the same times, should be priced the same.
- If they were not, what would you do?
 - Buy the cheap.
 - Sell the expensive
 - Pocket the difference.
- We will use this idea, over and over again!



Arbitrage Example

- A stock price is quoted as £100 in London and \$172 in New York
- The current exchange rate is 1.7500
- What is the arbitrage opportunity?



Gold: An Arbitrage Opportunity?

- Suppose that:
 - The spot price of gold is US\$390
 - The quoted 1-year futures price of gold is US\$425
 - The 1-year US\$ interest rate is 5% per annum
 - No income or storage costs for gold
- Is there an arbitrage opportunity?



Summary

- Welcome to the wide variety of Derivatives
- Looked at the need for complex (nonlinear contracts)
- Looked at some examples which illustrate hedging and financial engineering.
- Briefly discussed futures and options.
- Set the stage for the semester.