OPTIONS and FUTURES
Lecture 1: Foundation

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- applications

- big ideas

- derivatives market players

- strategy examples

Derivatives pricing theory is useful for...

- trading marketed options and futures (of course)
- pricing corporate claims like convertibles and warrants
- pricing or choosing when to exercise employee stock options (ESOs)
- valuing contract terms (e.g. an option to renew a lease)
- choosing a mortgage (evaluating the refinancing option)
- risk management
- designing dynamic investment strategies
- capital budgeting taking into account decisions in future contingencies
- extracting market expectations from quoted prices (e.g. implied volatilities)
- speculating on economic events
- ...and more

Some definitions

- derivative security ... a contract whose value derives from (depends on) something else

- underlying ... what the value depends on, for example,

  - a commodity price (e.g. oil, gold, wheat, orange juice, electricity)
  - an exchange rate (e.g. yen-dollar, euro-yen)
  - a security price (e.g. IBM common stock, Treasury Bond)
  - a stock index (e.g. S&P 500)
  - other economic factors (e.g. inflation or GDP)

- arbitrage ("arb") ... a strategy generating profit without any downside, a money pump

Some reasons for derivative trades

- hedging ... using derivatives to offset risk (insurance)

- risk management ... evaluation and management of risks

- speculation ... taking on a derivative position to bet on market moves

- market making ... trading to profit from providing liquidity

- liquidity trade ... a trade not based on useful proprietary information, often a sale to generate cash

- informed trade ... a trade based on useful proprietary information

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Some examples of derivatives

- forward contract ... a firm commitment to buy at a future date at a fixed price

- futures contract ... like a forward contract, but marked to market daily

- call option ... the buyer of the option has the right, but not the obligation, to buy in the future at a fixed price

- put option ... the buyer of the option has the right, but not the obligation, to sell in the future at a fixed price

- European option ... option can be exercised at maturity only

- American option ... option can be exercised anytime before maturity

- lookback option ... option based on price path, e.g. average price over time

- up-and-out (resp. down-and-out) option ... option that disappears when the underlying hits an upper (resp. a lower) boundary.

- up-and-in (resp. down-and-in) option ... option that becomes active when the underlying hits an upper (resp. a lower) boundary.

In-class exercise: put and call option value

Today is the maturity date of put and call options written on Microsoft. Today, the market price of Microsoft is $27.30.

What is the value of a put with a strike price of $27.00?

What is the value of a call with a strike price of $27.00?

What is the value of a put with a strike price of $27.50?

What is the value of a call with a strike price of $27.50?

More examples of derivatives

- Swap ... agreement to swap one cash flow stream for another

- Swaption ... option to enter a swap at a fixed price in the future

- ESOP ... Employee Stock Option Plan

- real option ... option embedded in the operations of a firm (many examples)

- tax timing option ... real option motivated by the tax code

- reload option ... a particular type of employee stock option

- call provision ... option to pay off a corporate bond early

- pension liability ... what is owed to participants in an pension plan

- collateralized mortgage obligation ... claim to part or all of the cash flows thrown off by a pool of mortgages

- credit derivative ... option providing insurance against a specified list of possible default events

- convertible bond ... corporate bond that can be converted to equity at the option of the buyer

Some big ideas

- More is better than less.

- Buy cheap.

- Sell expensive.

- Hedge and borrow or lend to convert a profit opportunity into an arb..

- Absence of arbitrage is usually an accurate assumption.

- Be skeptical if you think you found an arb.

Story about a profit opportunity (hedging example)

High grade copper trades today in the spot market at $1.30 a pound. We can make a private deal to buy 100,000 pounds of scrap copper in the spot market for $90,000 ($0.90 per pound), and at a cost of $0.30 a pound today (including transportation and all other costs) a smelter will convert the scrap to high-grade copper to be delivered six months from now.

A naive calculation makes this seem like a good deal: $1.30 - 0.90 -0.30 = $0.10. However, how do we make sure this is a good deal? How do we structure the deal so we do not take on a huge amount of risk?

Cash flows from buying and smelting the copper

time	now	six months out
purchase	($90K)	-
scrap	scrap Cu +100K lbs.	
refining	scrap Cu (100K) lbs.	high grade Cu +100K lbs.
copper	($30K)	-
sell refined	-	high grade Cu (100K) lbs.
copper spot	-	unknown price/lb × +100K
net	($120K)	unknown price/lb × +100K

Looking at this, it is not so obvious that this is a good deal. We don't know what the price of copper will be six months from now. We could probably build some sophisticated model predicting what the price will be, but that would still leave us with the possibility of a big loss if prices fall. Also, we are not experts on the copper market and we may miss something important that is known to sophisticated participants. Derivatives give us a better path.

Hedging

Selling copper forward (instead of selling later in the spot market) is a way of removing the price risk. A forward contract commits to trade in the future. The date ("maturity"), quantity, and price ("forward price") are constants dictated by the forward contract. In our example, suppose we find out that the 6-month forward price of copper is \$1.25/pound. This is disappointing; market participants expect that prices will fall over the next six months. Using the forward contract to eliminate the price risk we have:

time	now	six months out
purchase	(\$90K)	-
scrap	scrap Cu +100K lbs.	
refining	scrap Cu (100K) lbs.	high grade Cu +100K lbs.
copper	(\$30K)	-
sell refined	-	high grade Cu (100K) lbs.
copper forward	-	\$125K
net	(\$120K)	\$125K

Financing

We need cash to buy the scrap and pay for refining: proceeds from selling the refined copper will only come in six months time. We shop for a loan and find best offer against the copper has a 5% rate (straight interest), implying a rate of $5\% \times 6 \div 12 = 2.5\%$ over 6 months. With borrowing we have

time	now	six months out
purchase	($90K)	-
scrap	scrap Cu +100K	
refining	scrap Cu (100K) lbs.	high grade Cu +100K lbs.
copper	($30K)	-
sell refined	-	high grade Cu (100K) lbs.
copper forward	-	$125K
borrowing	$120K	($123K)
net	-	$2K

The hedging and financing have converted the profit opportunity into an arb (arbitrage). The next step is skepticism: have we omitted any legal costs or fees? Is our counterparty for the forward contract a good credit? Is $2K enough to compensate us for our time?

The bad news

At this point, it may seem that we have arrived at a very cheerful state of affairs: after a few simple calculations we buy and sell and pocket cash. Unfortunately, things are not so easy.

- Absence of arbitrage is the norm.

- Most arbs still involve some risk-taking.

- Many smart people are looking for arbs; finding simple arbs is especially rare.

For finance scholars, our theory usually assumes there is no arbitrage, and assets are fairly priced. When our theory is wrong, we do not feel so bad, because then we can make money by trading.

In-class exercise

Suppose that the spot price for high-grade copper is $1.25/pound, that the 6-month forward price for high-grade copper is $1.35/pound, and that the cost of storing copper for 6 months is $0.03/pound, payable in advance. Assume that we can borrow at straight interest of 5%/year (=2.5% over 6 months). Set up the cash flows from a candiate arbitrage from storing copper at a scale of 100,000 pounds. Is it a good deal?

time	now	six months out
buy Cu spot		
store Cu for 6 months		
sell Cu forward		
borrow		
net		

Wrap-up

Big ideas!

- More is better than less.

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- Sell expensive.

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- Be skeptical if you think you found an arb.