



If only I was a little bit better at this then I could buy one of these. Because it is not green I would just park it in my garage and use it only for driving to Vegas. I promise.

Options on Futures

... and the Aruba Options Model

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Homework 5

On Wednesday, October 22, during market hours, go to the course assignments page and do homework 5. It will only take about 15 minutes.

I am giving you \$5,000 and you will use it to buy a November put or call or straddle or strangle on either DIA or SPY.

I am giving you another \$5,000 to go to the CmeGroup web site to find the SPX S&P500 options on futures to buy a call or put on any November option for any December futures contract.

Turn in your results to me on Thursday, October 23, and then track your results until expiration.

Writing Covered Calls: The Aruba Options Model

Mudd Finance

The Aruba Options Model is the intellectual property of
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Question: If I buy 100 shares of common stock, then write an out-of-the-money covered call against it, what are some good proxies for calculating expected yield (1) if the stock price rises above the strike price and (2) if the option expires unexercised?

This question is answered by the Aruba Options Model.

Calculating the PEY

Mudd Finance

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$$PEY = \ln \left[\frac{(SPO \times N) - SFee}{((PPS - PO) \times N) + BFee} \right] \times \left(\frac{365}{Days} \right)$$

PEY = Projected Exercise Yield

SPO = Strike Price (of Option)

PPS = Purchase Price of Stock

PO = Price of Option

N = Number of Shares

SFee = Selling fees, typically of stock only

BFee = Buying fees, typically of stock purchase and fee for writing covered call.

Days = Number of days between the present and the day the option expires.

Model logic

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$$X_p = ((PPS - PO) \times N) + Bfee$$

The denominator, X_p , is the cost of the initial investment when buying a stock and writing a covered call against it. It is equal to the price per share minus the option price per share times the number of shares plus fees.

$$X_f = (SPO \times N) - SFee$$

The numerator X_f is the value of the investment if the option is called. It is equal to the strike price of the option (because the stock will be sold at that price) minus any fees.

The model shown again

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$$PEY = \ln \left[\frac{(SPO \times N) - SFee}{((PPS - PO) \times N) + BFee} \right] \times \left(\frac{365}{Days} \right)$$

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N = Number of Shares

SFee = Selling fees, typically of stock only

BFee = Buying fees, typically of stock purchase and fee for writing covered call.

Days = Number of days between the present and the day the option expires.

Calculating the UOY

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$$UOY = \ln \left(\frac{PPS \times N}{((PPS - PO) \times N) + Bfee} \right) \times \left(\frac{365}{Days} \right)$$

This yield is realized in the event that the option is not exercised and is only the yield on the uncalled option. Because the stock does not close above the strike price, the cash return to the option writer is the price of the option for which it was sold. The UOY does not take into account the possible capital gain or capital loss of the stock itself.

An example

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Buy 100 shares of IBM at 107, then sell a May 110 call for \$5.30. Suppose there are 48 days between now and the expiration date in May, and assume selling fees and buying fees to be \$25 and \$50:

$$PEY = \ln \left[\frac{(110 \times 100) - 25}{((107 - 5.30) \times 100) + 50} \right] \times \left(\frac{365}{48} \right) = 57.9\%$$

$$UOY = \ln \left[\frac{(107 \times 100) - 25}{((107 - 5.30) \times 100) + 50} \right] \times \left(\frac{365}{48} \right) = 36.8\%$$

Using Projected Option Yield Program to Calculate Yields

Option Yield Calculation Version 5.0 (July 5, 2001)	
Name of analyst:	
Date:	October 16, 2001
Stock	
Name:	IBM
Price of stock (PPS):	107.000
Symbol (optional):	IBM
Number of shares (N):	100
Buy Fees (BFee):	50.00
Sell Fees (SFee):	25.00
Option	
Strike price (SPO):	110.00
Month:	Oct
Price of option (PO):	5.375
Date of option expiration:	August 17, 2001
Results	
Contract days:	-60
Unexercised Option Yield (UOY):	-28.37%
Projected Exercise Yield (PEY):	-43.80%
Ordinary Yield - absolute:	4.66%
PEY - absolute:	7.20%

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... any further steps??

Yes. The Aruba model as shown here is merely useful for identifying a range of candidates from which we want to make a more refined selection.

In fact, we will want to

1. ... settle upon a useful volatility measure for the underlying stock,
2. ... build a stochastic model that allows us to simulate the time path of the stock,
3. ... add a Poisson distribution to the model,
4. ... run Monte Carlo simulations,
5. ... and weight the PEY and UOY for expected gains

But we need to learn more things. Meanwhile [do your homework](#) and select some candidates.

The expected value of the bet ...

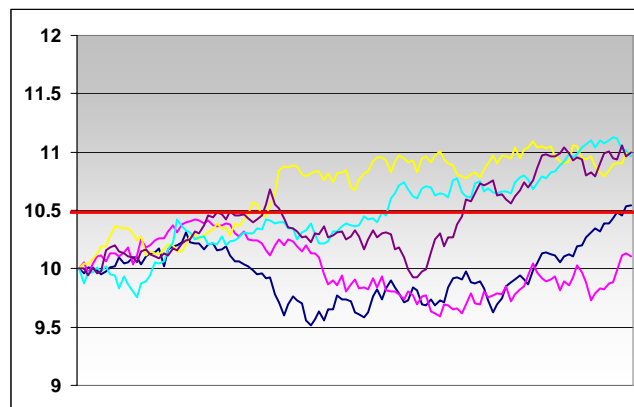
If we assume that the stock's growth rate (μ) over the short period of time is zero (or if we have used some statistical measure to give us a slightly positive μ), and if we assume that the option, if exercised, will be exercised at expiration, then we might be able to use our Monte Carlo simulation to estimate the expected value of the rate of return on our covered call. It will simply be

$$\text{Prob}_e(\text{PEY}) + (1 - \text{Prob}_e)(\text{UOY}) \text{ plus } \mu$$

Visual example of a Ito-Process Monte Carlo Simulation

Suppose our model told us to consider buying the stock at 10 and then write a 10.50 call for an attractive price.

This type of Monte Carlo simulation, if set up right, might give a good measure of the probability of ITM.



We will return to this homework after we learn Ito Processes and how to simulate them.

Your homework assignment

- **Part 1**
 - Use the Aruba model to evaluate 10 stocks for PEY and UOY.
 - Do the same for DIA and SPY for the nearest term calls that expire in 20 days or more.
 - Experiment with calls that are close to but out of the money.
 - Set high thresholds for candidates, like 40% UOY and 60% PEY.
 - Keep your model intact.
- **Part 2** (assigned in Module 3)
 - You will have to get daily data for one month for one of your stocks and SPY and recalculate daily volatility.
 - You will take the resulting numbers and run a Monte Carlo simulation of an Ito Process
 - You will use the results to get an Expected Value of your Aruba bet.



We are now inside the inner sanctum, where probability theory reigns supreme. Steve still hasn't shown up. I figured that maybe we could swap theories. I guess I'll head over to the B-Bar across the floor and find him there.

Maybe Tiffany will know where he is.

Options on Futures ... more exotica

Index Options

Index put and calls work exactly like stock puts and calls, except they are tied to a stock index of some kind. Most of these are traded on the Chicago Board Options Exchange (CBOE). See their site for the full list of CBOE options (extensive). AMEX also clears a lot of these. These are not the same as options on ETFs, although they perform about the same.

When you are buying or writing index options, you are playing the index.

They can be used for hedging if you own an index mutual fund.

CBOE S&P 500 Index Options

(SPX.X) S&P 500 INDEX							1,374.90
CALLS							
Symbol	Last	Bid	Ask	Vol	Open Int	Strike	
SXYLM	31.00	30.60	32.60	2	7,208	1,365	
SXYLN	27.80	27.20	28.20	307	28,574	1,370	
SXYLQ	25.00	24.10	36.10	1,678	60,445	1,375	
SXYLP	22.00	21.10	23.10	7,831	12,706	1,380	
PUTS							
Symbol	Last	Bid	Ask	Vol	Open Int	Strike	
SXYXM	15.30	14.60	16.20	2	7,657	1,365	
SXYXN	16.60	16.30	17.90	23	26,332	1,370	
SXYXQ	19.00	18.10	19.40	1,694	25,652	1,375	
SXYXP	20.00	20.10	21.70	9,022	4,001	1,380	

Near the money (yellow is itm), October 24, 2006.

Contract specs: \$100 multiplier, quoted in decimals, one point equals \$100. Also a mini-contract at 1/10 this value.

Options on futures contracts

Now that you understand both options (like call and put options) and futures (like crude oil futures) you have probably figured out what an option on a future is.

A call option on a **stock** gives you the right to buy the **stock** at the strike price on or before the expiration date.

A call option on a **future** gives you the right to buy the **future** at the strike price on or before the expiration date.

How are futures options settled?

When a **call** option is exercised, the holder acquires from the writer a **long** position in the underlying futures contract plus a cash amount equal to the excess of the futures price over the strike price (this is different from stocks).

When a **put** option is exercised, the holder acquires from the writer a **short** position in the underlying futures contract plus a cash amount equal to the excess of the strike price over the futures price.

A quotation for Crude Oil options

Crude Oil (NYM) 1,000 bbls; \$ per bbl						
Strike Price	Calls-Settle			Puts-Settle		
	Jun	Jly	Aug	Jun	Jly	Aug
2850		1.63	1.68	0.01	0.69	1.22
2900		1.33	1.43	0.01	0.89	1.47
2950	0.01	1.09	1.22		1.12	1.76
3000	0.01	0.88	1.03		1.44	
3050	0.01	0.70	0.86	0.87		
3100	0.01	0.54	0.72	1.29	2.09	2.75

CRUDE OIL, Light Sweet (NYM) 1,000 bbls, \$ per bbl				
	Open	Settle	Change	Open Int
June	29.73	29.32	-.041	59,346
July	29.65	29.44	-.021	121,145
Aug	29.1	28.96	-.012	44,082

What is the connection between the options contract above and the futures contract below?

An example (from the previous slide).

2950	0.01	1.09	1.22		1.12	1.76
July	29.65	29.44	-.021	121,145		

What is the highlighted option?

The July Crude oil futures contract is priced at \$29.44.

The July 2950 (meaning \$29.50 strike price) call is priced at \$1.09 per barrel. This means that you will pay \$1.09 per barrel or \$1,090 per contract for the right to buy the July futures contract (long, of course) for \$29.50 per barrel (\$29,500). This is a slightly-out-of-the money option.

Questions and Answers

Using the July 2950 call as an example:

2950	0.01	1.09	1.22		1.12	1.76
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Q: If I buy the crude oil futures call how much will I have to pay for it, and when?

A: It's just like a stock call. You pay \$1.09 per barrel times 1,000, or \$1,090, when you buy the call.

Q: Is there a margin account for these options, and is my profit and loss settled daily in my margin account like it is for the futures contract?

A: No! This is just like a stock call. You buy it for cash and if the future rises above the strike price it has value, if not it is worthless. (Like stocks, writing naked options requires margin).

Questions and Answers (continued)

Q: Who am I buying the call from?

A: Just like stocks, somebody wrote the call.

Q: If the call is in the money, can the call be exercised before the expiration date?

A: Yes, just like stocks.

Q: If I exercise my call and take delivery, do I take delivery of 1,000 barrels of crude oil.

A: Of course not. You take delivery of a July Crude Oil future, and whoever wrote that call has to "deliver" that futures contract. You also get cash equal to the future value minus the strike price. (Example follows)

Example of futures option delivery

2950	0.01	1.09	1.22	1.12	1.76
July	29.65	29.44	-.021	121,145	

Suppose you had bought the July 2950 futures contract call option (when that futures contract was priced at 29.44) and paid \$1.09 for it (\$1,090). Suppose on the date of expiration the futures contract is priced at 3100, which puts it in the money. How do you exercise?

Whoever wrote the option transfers ownership of the futures contract to you. You pay her no money. [Do you realize why you pay her no money? It's because of how options are settled]. You now own the option. She also pays you **\$1.50** (\$1,500), the difference between the strike price (**2950**) and the futures value (**3100**). You have effectively bought the option for 2950, although you paid **109** for that right (which means you really paid **3059**).

How would I use a futures option?

- ✓ Simply buy a call if you are speculating on a rise in the price of the futures contract.
- ✓ Buy a put if you are speculating on a fall in price of the futures contract.
- ✓ Write a covered call if you are long in a position to enhance yield.
- ✓ Write a covered put if you are short in a position to enhance yield.
- ✓ Buy a put to hedge a long future position.
- ✓ Buy a call to hedge a short future position.

A coffee hedging problem

A coffee grower in Columbia is concerned about the price of his crop, which he plans to harvest in September. The price of coffee has been very volatile in recent years and if it plunges between now and September far below current spot, he fears that he will be driven to bankruptcy. He anticipates being able to produce about 40,000 kilos of coffee.

How should he use the futures market to hedge his position?

1. What size contract (be careful about this)?
2. Which future on which market?
3. Long or short?
4. What is your initial margin?
5. Are you going to take or make delivery?

To solve this, the farmer would short 2 September contracts at 97.00 cents per pound. His position is about \$72,750.

The problem within a problem

We are still on the coffee problem. Given the contract that you have chosen for the coffee farmer above, and assuming that he has employed the futures contract that you recommend, what will happen to him if a crop freeze destroys his crop between now and September, and because of the freeze the price of coffee shoots up to USD \$1.75 per pound?

Is there any way that you can think of to hedge against this possibility – effectively hedging your hedge?

COFFEE (NYBOT)						
37,500 lbs, cents per lb.						
Strike	Calls-Settle			Puts-Settle		
	Price	Jly	Aug	Sep	Jly	Aug
90.0	6.14	10.59	12.69	2.45	3.63	5.75
92.5	4.80	9.32	11.66	3.60	4.85	7.20
95.0	3.90	8.19	10.78	5.20	6.20	8.80
97.5	3.05	7.50	10.00	6.85	8.00	10.50
100.0	2.40	6.55	9.25	8.69	9.53	12.23
105.0	1.60	5.40	8.15	12.87	13.36	16.09

What are our options here?
What should we do?