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Balmy Miami Beach in Spring 2007. I wonder what this picture has to do with a lecture on credit swaps? Quite a bit actually.

Credit Swaps

...

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BS Homework checking examples

Annual Volatility							
Type	Stock	Strike	Volatility	Interest	Time	Option	Premium
Call	42	40	0.20	0.10	0.50	4.76	2.76
Put	42	40	0.20	0.10	0.50	0.81	0.81
Call	36	40	0.25	0.05	0.75	2.10	2.10
Put	36	40	0.25	0.05	0.75	4.63	0.63
Daily Volatility							
Type	Stock	Strike	Volatility	Interest	Time	Option	Premium
Call	110	100	0.05	0.00	4	10.95	0.95
Put	110	120	0.05	0.00	4	11.21	1.21
Call	100	115	0.06	0.05	16	4.45	4.45
Put	100	90	0.06	0.05	16	4.80	4.80

Old slide

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Today's news (literally) Nov 1 07

From Reuter's:

> Michael Raynes, the company's [Citigroup] head of structured credit, and Nestor Dominguez, co-head of its collateralised debt obligations segment, left the largest U.S. bank after the company posted its largest profit decline in three years, the Wall Street Journal said. [...]
>
> Earlier this month Citigroup said its third-quarter profit fell 57 percent as losses mounted from subprime and leveraged loans, fixed-income trading and its U.S. consumer business.

From CNN Money:

> **Citigroup downgraded at CIBC on concerns over need to raise capital; shares fall November 01, 2007: 08:20 AM EST NEW YORK, Nov. 1, 2007 (Thomson Financial delivered by Newstex) --**
>
> Citigroup (NYSE:C) was downgraded to sector underperformer from sector performer at CIBC World Markets, on the belief that the financial services giant will need to raise over $30 billion in capital in the near term through a dividend cut, asset sales, or a capital raise, or some combination.

At 7:32 PDT, **C** was down 2.98 to 38.38, from a 52-week high of 57. DJIA down 240.

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... but thankfully, responsible people are at the top

Bear CEO's Handling of Crisis Raises Issues - *Cayne on Golf Links, 10-Day Bridge Trip Amid Summer Turmoil* - Kate Kelley, **WSJ**, A1, Nov 1, 2007

> A crisis at **Bear Stearns** Cos. this summer came to a head in July. Two Bear hedge funds were hemorrhaging value. Investors were clamoring to get their money back. Lenders to the funds were demanding more collateral. Eventually, both funds collapsed.
>
> During 10 critical days of this crisis -- one of the worst in the securities firm's 84-year history -- Bear's chief executive wasn't near his Wall Street office. James Cayne was playing in a bridge tournament in Nashville, Tenn., without a cellphone or an email device. In one closely watched competition, his team placed in the top third.
>
> As Bear's fund meltdown was helping spark this year's mortgage-market and credit convulsions, Mr. Cayne at times missed key events. At a tense August conference call with investors, he left after a few opening words and listeners didn't know when he returned. In summer weeks, he typically left the office on Thursday afternoon and spent Friday at his New Jersey golf club, out of touch for stretches, according to associates and golf records. In the critical month of July, he spent 10 of the 21 workdays out of the office, either at the bridge event or golfing, according to golf, bridge and hotel records.

Personal prediction: When Cayne is fired because of this article, his severance pay will be more than HMC's entire endowment.

The company's corporate headquarters in New York

Bear's History: Roaring '20s, an Ace and a Hole

1923: Bear Stearns formed as a small stock-trading partnership

1933: Legendary Salim "Cy" Lewis joins firm from Salomon Brothers

1949: Alan "Ace" Greenberg joins the firm as a clerk, rises to CEO and dominates for decades. In 1988, Bear Stearns eventually prints 50-page booklet of his memos, "Memos from the Chairman," including a now-famous one on the need to save paper clips.

Oct. 29, 1985: Bear becomes one of the first publicly traded Wall Street firms, listing its stock on the New York Stock Exchange

1988: Moves headquarters from Wall Street area to midtown Manhattan

June 26, 2001: Mr. Greenberg resigns as chairman, title goes to James Cayne

2002: Completes a new 45-story headquarters near Grand Central Terminal

Early June 2007: Investors learn two Bear Stearns funds suffer losses on bad bets on subprime, kicking off the Wall Street subprime tumult. Stock begins to slide.

Aug. 1, 2007: Mr. Cayne fires Co-President Warren Spector

Fall 2007: Citic Securities, China's largest brokerage, agrees to invest $1 billion in Bear. The deal wasn't completed.

Jan. 8: Mr. Cayne relinquishes CEO post to Allan Schwartz

Friday: Bear announces it needed the support of J.P. Morgan Chase and the New York Fed. Stock plunges again.

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Bears Sterns Last Week of Trade 2008

Reading Hull

- Read chapter 23 first, but we will not have time to cover the Gaussian Cupola Model (alas) and will not cover convertible bonds.
- The read chapter 22 and again will not have time to cover the Gaussian Cupola Model (I may try to get to it after the exam), nor CreditVar. Everything else is pretty important. Pay attention to descriptions of credit ratings, default intensities, recovery rates, default probabilities, section 22.3 calculation of default probability estimates.
- *But* you will be glad to know that we are going to rely upon the lectures for this material.

Three types of Credit Swaps:

From the last lecture:

"*With bonds, the primary risk is the default risk of the bond or note*" for which we have

Credit Default Swaps

(Hull, Section 23.1 to 23.5)

"*With CDOs, the primary risk is default risk of individual mortgages (or credit cards) in the portfolio*" for which we have

CDO Derivatives, including Swaps

Synthetic CDOs

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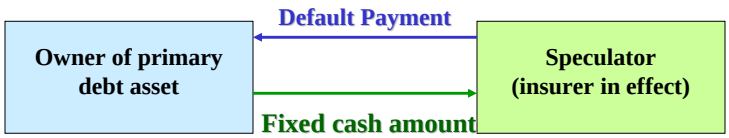
Credit Default Swaps (traditional)



The owner of the primary debt asset might hold a $10,000,000 A-rated 5-year note. There is some positive probability of default risk at some time in the note's life. Therefore, this party enters into a 5-year notional value credit swap with another party, who, in effect, is providing insurance against default.

The note-holder agrees to pay an annual fixed cash amount of, say, 75 basis points, or, $75,000. In turn, the swap holder will pay for the note-holder's loss (more details next slide) in the event of a default.

This is, in effect, an insurance premium that passes the default risk for asset-owner to speculator. **See Hull 23.1 for more detail.**

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More details ...

A swap payment event (whether default or something else) is usually called a *"**trigger event**."* In many credit derivatives (especially CDOs) the trigger event has a very complex legal definition defined somewhere in SEC documents related to the transaction or in trigger-event descriptions in indexed derivatives such as ABX derivatives.

There are also rating downgrade swaps, where the trigger event is a ratings downgrade.

In the case of this simple credit default, it will be the event that is legally defined as a default, which is when the issuer announces that they are unable to make further coupon payments on the liability.

For such securities there is typically a *"recovery rate"* because the value of the defaulted asset does not plunge to zero - instead it will plunge to a value like 20% of par value - because the defaulter may recovery from bankruptcy and resume payments or more likely there is some liquidation collateral.

Therefore the credit swap default payment that will be made *is equal to the value of an equivalent security with maturity remaining the same as the defaulted instrument, times one minus the recovery rate.* Often the default payment can be made by delivering a good asset of equivalent remaining maturity. (See Hull)

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Efficient Market Default Risk Swap Calculator for a 5-year Bond

Coupon Component

Risk Free Rate:	0.05			DPF:	0.0003	
Coupon Rate:	0.06					
Notional or Bond Value:	1					
Payments per year:	1					
Recovery Rate:	0.20					
Time:	1	2	3	4	5	
Default Probability:	0.0300	0.0303	0.0306	0.0309	0.0312	
Survival Probability:	0.9700	0.9397	0.9091	0.8782	0.8470	
Expected Payment:	0.0582	0.0564	0.0545	0.0527	0.0508	
Time Discount Factor:	0.9524	0.9070	0.8638	0.8227	0.7835	SUM:
PV of expected Payment:	0.0554	0.0511	0.0471	0.0433	0.0398	0.236856
No Default Payment:	0.0600	0.0600	0.0600	0.0600	0.0600	
PV of No Default Payment:	0.0571	0.0544	0.0518	0.0494	0.0470	0.259769
Coupon Spread:						0.022912

Redemption (Par) Value Component

Default Principal Recovery:	0.0240	0.0242	0.0245	0.0247	0.0250	
PV DPR:	0.0229	0.0220	0.0211	0.0203	0.0196	0.1059

Full redemption:	1
PV Full Redemption:	0.7835
Expected Redemption:	0.8470
PV Expected Redemption:	0.6636
PV ER plus PV DPR:	0.7695
Principal Value Spread:	0.013995

Present Value of No-Default CF:	1.0433
Present Value of Expected CF:	1.0064
Efficient Market Value of Swap:	0.0369

Go to the Excel file.

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What are we doing here?

We are taking the old bond formula to discount cashflow to present value,

$$MV = \sum_{i=1}^{n} \frac{C}{(1+r)^i} + \frac{Par}{(1+r)^n}$$

but we are discounting by the **risk-free rate**, which we assume to be the **LIBOR**, ***so*** we are not calculating the market value of the bond.

Likewise, we are adjusting the coupon payments and redemption value (par) for the probability of default at some time during the payment.

The spread between the PV of the bond when adjusted for default and what it would be if we were certain of no default will theoretically be the value an a **Credit Default Swap** in an efficient market.

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Subtleties

Do you understand (or will you understand) why this is not going to be 1.00 (or 100) if this is a newly issued bond?

Present Value of No-Default CF:	1.0433
Present Value of Expected CF:	1.0064
Efficient Market Value of Swap:	0.0369

Do you understand (or will you understand) why in an efficient market that is making accurate default probabilities that this is going to be very close to 1.00 (or 100) if this is a newly issued bond?

Important!!: In addition to explaining how swaps are priced, this explains how default risk is priced into bonds.

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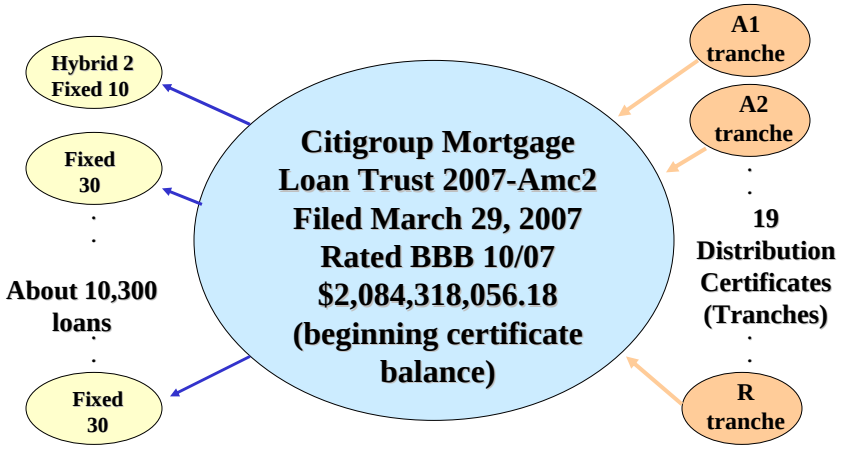
Cash Collateralized Debt Obligation



Multiple classes of investors through multiple certificate tranches, each with different payout (pass-through) rights and obligations, and more esoteric trigger events.

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The Amc2 Citicorp Tranche distribution

Citigroup Mortgage Loan Trust 2007-Amc2 - 10-D - For 9/25/07, As Of 10/4/07								
Table in Document 1 of 1 - 10-D - Periodic Distribution Report by an Asset-Backed Issuer								
		Certificate	Distribution Summary			Certificateholder	Summary (continued)	
	CUSIP	Record	Certificate	Beginning	Interest	Principal	Ending	Total
		Date	Pass-Throu	Certificate	Distribution	Distribution	Certificate	Distribution
			Rate	Balance			Balance	
	17311XAS	9/24/2007	5.65%	613,215,515.70	2,788,512.39	10,758,647.41	602,456,868.29	13,547,159.80
	17311XAT	9/24/2007	5.65%	145,634,518.15	662,252.74	2,117,251.18	143,517,266.96	2,779,503.92
	17311XAA	9/24/2007	5.59%	469,071,395.71	2,110,365.24	6,095,336.01	462,976,059.70	8,205,701.25
	17311XAB	9/24/2007	5.69%	330,788,000.00	1,514,871.21	0	330,788,000.00	1,514,871.21
	17311XAC	9/24/2007	5.76%	77,013,000.00	357,030.13	0	77,013,000.00	357,030.13
	17311XAD	9/24/2007	5.78%	72,745,000.00	338,415.80	0	72,745,000.00	338,415.80
	17311XAE	9/24/2007	5.80%	67,234,000.00	313,861.39	0	67,234,000.00	313,861.39
	17311XAF	9/24/2007	5.85%	38,577,000.00	181,638.73	0	38,577,000.00	181,638.73
	17311XAG	9/24/2007	5.98%	35,271,000.00	169,766.18	0	35,271,000.00	169,766.18
	17311XAH	9/24/2007	6.05%	33,066,000.00	161,017.64	0	33,066,000.00	161,017.64
	17311XAJ	9/24/2007	6.08%	31,963,000.00	156,418.93	0	31,963,000.00	156,418.93
	17311XAK	9/24/2007	6.66%	28,658,000.00	153,634.74	0	28,658,000.00	153,634.74
	17311XAL	9/24/2007	7.51%	25,350,000.00	153,258.35	0	25,350,000.00	153,258.35
	17311XAM	9/24/2007	8.01%	20,942,000.00	135,043.91	0	20,942,000.00	135,043.91
	17311XAU	9/24/2007	8.01%	25,351,000.00	163,475.22	0	25,351,000.00	163,475.22
	17311XAR	8/31/2007	0.00%	0	0	0	0	0
	17311XAN	8/31/2007	0.00%	69,438,526.62	1,804,760.95	0	69,438,526.62	1,804,760.95
	17311X9A	8/31/2007	0.00%	0	275,552.57	0	0	275,552.57
	17311XAP	8/31/2007	0.00%	100	152,206.88	0	100	152,206.88
	17311XAQ	8/31/2007	0.00%	0	0	0	0	0
Totals				2,084,318,056.18	11,592,083.00	18,971,234.60	2,065,346,821.57	30,563,317.60

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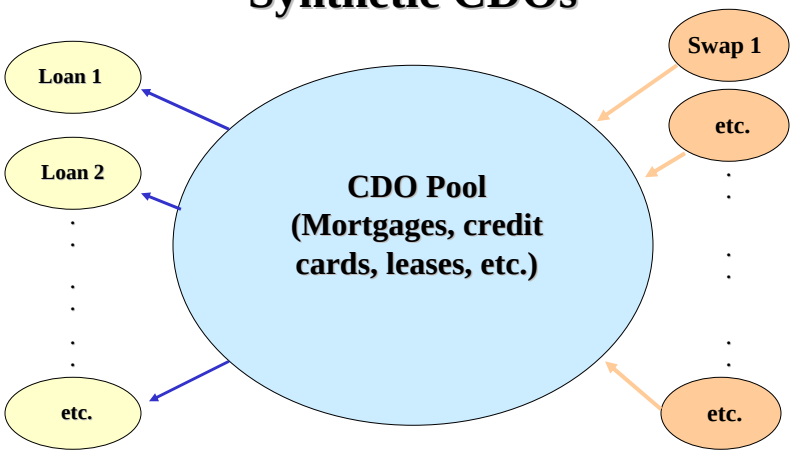
CDO Trigger Events or Threshold Events and their Payments

(This refers to both cash CDOs and synthetic CDOs):

Because it is made up of multiple assets, CDOs in their entirety will never default, only components, like individual mortgages. High default rates will cause a ratings downgrade of a CDO and will obviously reduce their value and the value of some or all of the tranches.

For example, a tranche swap on a CMO (mortgage) might be set up to anticipate interest payments and/or principal redemption payments from a mortgage pool, and that may be restricted to a subset of the loans (such as Alt/A only or a time slice, such as in the first year, or some combination of attributes). If the actual cashflow from the segment is a **shortfall** then the tranche will **pay** the pool and if a **surplus** will be **paid** by the pool:

Synthetic CDOs



The swaps may be tranches dedicated to loan quality, time periods, interest or principal, etc., and will have obligations as discussed on the previous slide.

Generic Value of any Tranche

$$V = \int_1^t p_\tau \left(1 - \lambda_\tau\right) e^{-(rfr)(\tau)}$$

Default rate

Using Hull's continuous approach, the generic value will equal the continuum of its expected cashflows (from whatever source, interest, principal from whomever pays, mortgage borrowers, credit card users), adjusted for the expected continuum of defaults if relevant, discounted by the risk-free-rate, usually the LIBOR.

Estimating cashflows and default rates

Many of the historical expected cashflow and default rates are determined by looking at historical averages in simple spreadsheets.

Teacher's comments on how this led to trouble in CDOs in 2007/2008.

From an article published on **August 11, 2003**, "*HSBC's Elder Statesman Sticks to his Thrifty Line*," in The Independent, by Katherine Griffiths, celebrating HSBCs (est. 1865) purchase of Household International, which would eventually drive HSBC to near-insolvency. HSBC was bailed out by the UK government on October 8, 2008:

There are apparently 150 PhDs at Household, who do nothing but try to predict what they call "the actuarial likelihood of how people are going to behave". The technique is so sophisticated, Sir John says, that they can predict how many loans will turn sour, within a 5 per cent margin of error.

Clearly, if the PhDs can apply their science to how Americans behave, it should also work for Brazilians, Mexicans, Indians and Chinese. This will mean HSBC will be able, for the first time, to lend money to customers all over the world, including those in countries where populations are growing fastest and where people often want a loan before saving or opening a current account. Lending, especially to those regarded as high risk, is also potentially far more profitable than current accounts and many other retail banking products.

"We are adding a brand new line of business in every country, so there are significant possibilities. We don't know how much yet, we just intuitively know it is there, though it will take time in the years ahead to develop," Sir John says.

The failure is found here ...

$$VAR\left[\sum_{i=1}^{n}\alpha_i x_i\right] = \sum_{i=1}^{n}\alpha_i^2 VAR(x_i) + 2\sum_{i=1}^{n-1}\sum_{j=(i-1)}^{n}\alpha_i\alpha_j COV(x_i, x_j)$$

The covariance is equal to the ***correlation coefficient*** of the two variables times the product of their sigmas. This coefficient has to be very low for true diversity or risk independence. But what happens when previously low correlations become robustly positive and the variables become ***interdependent***? And what happens if the ***volatility (sigmas) explode upward***? The diversity is lost, the risk compounds hugely, and a fortune is lost. This was the essential message of the failure of Long Term Capital, and again in 2007/2008.

How does the independence break down?

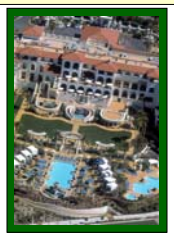
1. In market psychology, the affirmative adjective becomes a pejorative adjective: **global** (stock or bond) markets switch from implying diversity (Russia is not Argentina and has little connection) to connectivity (all bonds issued by underdeveloped countries are crap). Another example: **leveraged** bets (like carry trade) are wondrous in 2006, poisonous and essentially identical in 2008.
2. The populations implied by historical risk estimates change and nobody notices. Sub-prime borrowers in the 1990s were a much smaller and different (more reliable) population. They wear different colored hats.
3. Because of de-leveraging and margin calls during a crisis, all liquid assets become part of a big lump of assets that are sold down together. There is no independence

The AIG fiasco

AIG sold credit default swaps on many classes of financial assets, including CMOs. Apparently they treated the risk as an insurer might for earthquake insurance: collect copious amounts of cash and pray to high heaven that an earthquake doesn't happen. Of course, the earthquake in this case was sub-prime CMO interdependence.

The bailout of AIG (September 2008) not only arbitrarily effectively insured some CMOs and not others (AIG is not the only credit swapper out there) but will likely cost U.S. taxpayers more than $150 billion, and amount equal to a medium-sized annual budget deficit for the U.S. Government.

AIG executives celebrated the bailout by having a big weekend party at the St. Regis Monarch Resort in Southern California. Ocean view rooms start at $565. I've played golf there - wonderful experience.



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Jan 2009 Crude Contract (2008)

Interesting modeling question:

Is this movement from 70 to 145 to 40 in one year beyond explanation? Is this six-sigma, or four-sigma? Is this beyond the ability of any model to explain?

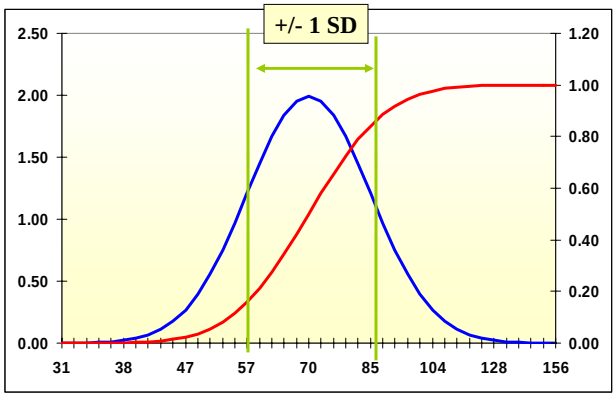
No.

The ingredients of an explanation ...

- Oil probably has a **price supply elasticity** of about 0.25 (inelastic) which implies a severe price reaction (4X%) to fluctuations in global oil demand.
- The global economy went from **robust expansion to severe contraction** in one year, which would explain a severe expansion, then contraction, in the price of oil.
  - ... but frankly, in the ranges of $40 to $140???
- With this kind of momentum movement in first one direction, then the opposite, one can expect **volatility** to rise, maybe to a multiple of its original value (we certainly saw that in stocks).
- So ...

If oil at $70 has an annual volatility of 0.20 ...

Value	Cumulative Probs	
46.9224	-2	0.0228
57.3112	-1	0.1587
70.0000	0	0.5000
85.4982	1	0.8413
104.4277	2	0.9772



The mapping shows the range of continuous growth rates for the price of oil, which is normal. The abscissa is transformed to the actual possible prices of oil, and is therefore log-normal. Look at the 1-sigma range of prices.

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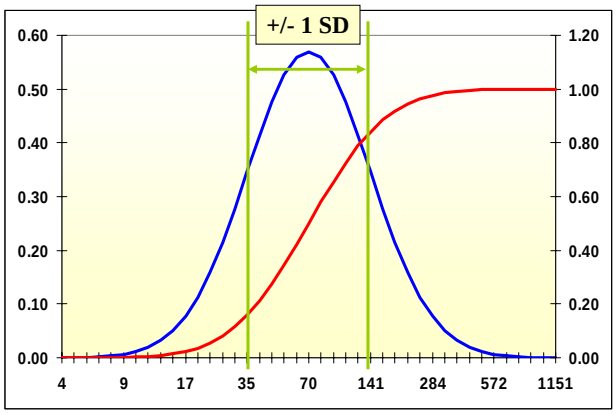
... but if that volatility balloons to 0.70

Value	Cumulative Probs	
17.2618	-2	0.0228
34.7610	-1	0.1587
70.0000	0	0.5000
140.9627	1	0.8413
283.8640	2	0.9772

A move from an annual volatility of 20% to 70% implies a move in the daily, observable volatility from 1% to 3.5%.



... the 1-sigma range for oil runs from $35 to $140. Look familiar?? Is this unexplainable or mysterious? No.

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... and by the way, oil is in full contango.

This is a 31% spread, far beyond any carry cost!

New York Mercantile Exchange (NYMEX)
Energy
CRUDE OIL (CL)

Download data | Analyze Chart

Market		Open	High	Low	Last	Change	Pct	Time
CL.F09	Jan 2009	43.40	44.20	43.15	43.15	-0.56	-1.28%	14:33
CL.G09	Feb 2009	46.10	46.40	44.60	44.60	-1.76	-3.78%	14:28
CL.H09	Mar 2009	46.80	46.80	46.80	46.80	-1.82	-4.07%	14:29
CL.J09	Apr 2009	50.25	50.25	50.25	50.25	-0.04	-0.08%	10:32
CL.K09	May 2009	77.15	77.15	77.15	51.64	+4.03	+7.80%	set 15:25
CL.M09	Jun 2009	54.20	54.20	54.15	52.78	+3.94	+7.46%	set 15:25
CL.N09	Jul 2009	59.58	59.58	59.58	53.76	+3.84	+7.14%	set 15:25
CL.Q09	Aug 2009	54.63	54.63	54.63	54.63	0.00	0.00%	09:42
CL.U09	Sep 2009	64.15	64.15	64.15	55.48	+3.59	+6.47%	set 15:25
CL.V09	Oct 2009	117.80	118.00	117.80	56.32	+3.50	+6.21%	set 15:25
CL.X09	Nov 2009	100.70	100.70	100.70	57.15	+3.41	+5.97%	set 15:25
CL.Z09	Dec 2009	60.25	60.25	60.00	57.98	+3.33	+5.74%	set 15:25
CL.F10	Jan 2010	61.35	61.35	60.80	58.78	+3.27	+5.56%	set 15:25

Source: ino.com

... and spreading more today!!

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Is quantitative risk analysis dead ... ?

... as has been recently suggested in editorials in The Wall Street Journal and elsewhere?

No.

There is really nothing wrong with the models, just how they were used. When using models (especially for risk analysis, like the 150 HSBC Ph.Ds) always at a minimum ask these questions:

1. What will happen if a key assumption breaks down?
2. What will happen if stable relationships between variables established from earlier times suddenly break down?
3. What will happen if a significant economic event comes along and disturbs or destroys former stable variables and relationships (such as volatility and independence)?
4. Models offer more than one message: ***sometimes the model is implying an inherent risk that is right there under your nose that you can't see.***

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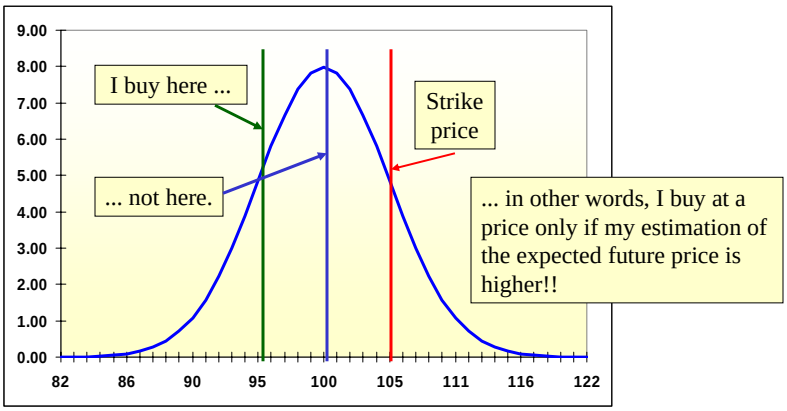
Fundamental lessons that I want you to remember from this class.

1. These models (and others I didn't show you) are good models and they are insightful and have strong explanatory power and some predictive power ...
2. ... but they must be used properly!!! ***They often have more than one message*** (like the risk example).
3. Risk assessment and general investment strategy must blend the objective with the subjective; use your models but also ***use your head and use common sense***.
4. Certain modeling assumptions allow you to build "perfect case" models, but because you are assuming something it doesn't mean that it is true!! Markets are not really Markov chains!! At some point you sometimes have to suspend the assumptions - in fact, if you realize that markets aren't perfect and prices are, hence, biased, this presents an *opportunity*.
5. ***Fundamental economics drives markets and prices*** (like oil). You must understand those economic forces to be a good investor. You can't hide behind an elaborate model and pretend the model is the world. It's not.

... you sometimes must suspend assumptions



When I buy a stock and write a covered call, do I assume that they expected future value of the stock is what I paid for it? No, because why would I pay attention to *when I take the position* if I believed that??