



CMOs pay for this  
- problem is, you  
gotta pay them  
back!

# Collateralized Mortgage Obligations

... and their market, an introduction

(c) 2007-2008 Gary R. Evans. May not be used without the author's permission.

# The Homework

**Black-Scholes Option Price Calculator**  
European Options  
(annual volatility)

Stock Price:   
 Strike Price:   
 Annual Volatility:   
 Interest Rate:   
 Time:

Numerator:   
 Duration Volatility:   
 N(d1):   
 N(d2):

Option Price:   
 Option Premium:

**Black-Scholes Option Price Calculator**  
European Options  
(daily volatility)

Date Today:   
 Expiration Date:

Stock (C) Strike (P) Price:   
 Strike (C) Stock (P) Price:   
 Daily Volatility:   
 Interest Rate:   
 Time:

Numerator:   
 Duration Volatility:   
 N(d1):   
 N(d2):

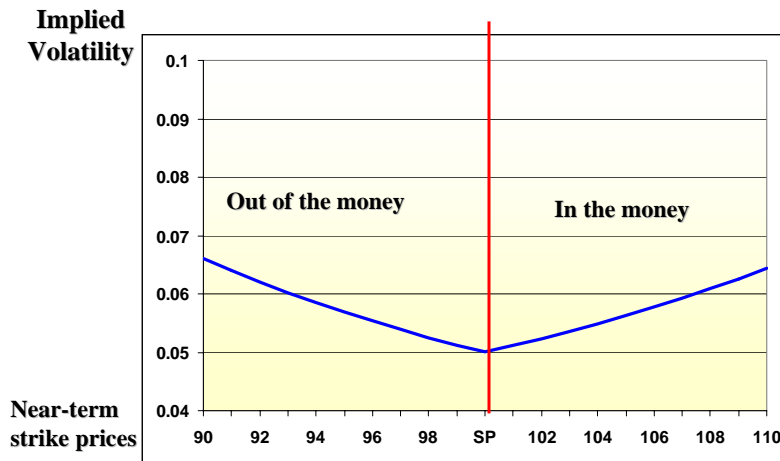
Option Price:   
 Option Premium:

## Teacher's notes on the current market

- Using BS on DIA options, one notes that the premiums on puts and calls atm are perfectly symmetric, but puts seem to have a larger premium than calls as you move otm.
- There are two momentum markets that are fully developed and near maturity right now:
  - Treasury securities (eventual TLT short play)
  - Volatility (there is volatility momentum now ... very dangerous)
- Markets are lead by economic expectations. Expectations for 2009, as bad as they are, continue to be readjusted downward, taking the market with them.
- You can't write covered calls in a market like this.

**Addendum:**

## The Implied Volatility Smile



Shown is an option chain with various strike prices where the 100 SP is at the money. Implied volatility from prices in this chain often produce a "smile," as shown.

## real estate and mortgage lending terms

Mudd Finance

<b>ALT-A</b>	A mortgage loan quality ranking that is one step below prime, sometimes because the borrower's FICO score is below a threshold like 680, or has provided incomplete income verification (if self-employed, for example).
<b>ARM (Adjustable Rate Mortgage)</b>	Adjustable Rate Mortgage: The mortgage interest rate will adjust after a certain period has elapsed to a rate linked to a variable rate like the LIBOR. Sometimes called a Variable Rate Mortgage (VRM).
<b>First Trust Deed</b>	The legal document associated with the primary large loan on a property, the first mortgage, typically has liquidation rights over higher trust deeds.
<b>Flipper</b>	A speculator who (typically) uses a <i>Subprime</i> loan to buy a home or condo while still being constructed with the home of reselling it for a profit upon its completion or shortly after its completion.
<b>FRM</b>	Fixed Rate Mortgage: The mortgage interest rate is fixed throughout the life of the loan.
<b>Home Equity Loan</b>	A general mortgage loan secured by a property on which a <i>First Trust Deed</i> already exists, associated with a <i>Second</i> (or later) <i>Trust Deed</i> .

## terms (cont)

Mudd Finance

<b>LTV (Loan to Value)</b>	The ratio of the principal value of a primary mortgage to the appraised value of the property. For example, a mortgage of \$300K against a home appraised at \$400K would have an <i>LTV</i> or 75%.
<b>Negative Amortization</b>	When a borrower makes a payment that is less than the payment required on the loan's long-term amortization schedule (such as paying less than the interest that is due on a payment-option loan) the resulting deficit is added to the principal balance of the loan.
<b>Payment Option ARM</b>	Allows the borrower to make a payment, typically for a few months only, below the long-term amortization payment for the loan. This payment can be below even the interest owed for the month. Such loans have <i>negative amortization</i> and severe <i>prepayment penalties</i> .
<b>PMI (Private Mortgage Insurance)</b>	Typically required on loans with less than 80% <i>LTV</i> or <i>Subprimes</i> this is an insurance payment that the borrower must pay to protect the lender in case of default. PMI rates are actuarially too high.
<b>Prepayment Penalty</b>	Always built into any mortgage offering <i>teaser rates</i> to protect the lender, assesses a penalty, sometimes very high, if the loan is paid off early in the life of the loan.

terms (cont)

<b>Prime</b>	The highest-grade mortgage loans, made to borrowers who have documented income and employment, have high FICO scores (above 680 for example), and typically are borrowing with a high (e.g. 80%) LTV (Loan-to-Value ratio).
<b>Second, Third, etc. Trust Deeds</b>	The legal documents associated with secondary and later loans on a property, typically <i>Home Equity Loans</i> .
<b>Subprime</b>	Mortgage loans, typically ARMS including 2/28s, made to borrowers who are not required to document income or employment history and very little of anything else. These were the root of the mortgage meltdown of 2007 and 2008. Typical FICO below 660.
<b>Teaser Rates</b>	A generic term that refers to the interest rate charged for an <i>ARM</i> if they are below market rates.
<b>VRM (Variable Rate Mortgage)</b>	Synonym for <i>ARM</i> .

ARMs (sometimes called VRMs)

<b>2/28</b>	A subprime (typically) ARM loan made with a very low teaser rate (e.g. 1%) that adjusts upward to a variable rate in a single step at the end of two years. These loans have negative amortization in the early years, require PMI, and severe prepayment penalties.
<b>5/25 or similar</b>	A more traditional ARM that starts with a low rate which graduates up to a variable market rate in a series of steps over a period of, say, five years. or seven years. There is no standard contract and terms depend upon what the lender offered. These will typically have negative amortization in the early years, will require PMI with less than 80% LTV, and prepayment penalties, although not as severe as a 2/28.
<b>Payment Option ARM</b>	One of the loans above that, in the early life of the loan, allows the borrower to choose the payment size, even if below the interest component of the payment. Automatically generates negative amortization and severe prepayment penalties, sometimes PMI.

**FRMs**

<b>15-year FRM</b>	A mortgage amortized at 15 years at a fixed rate, another industry standard. Monthly payments are higher than a 30-year FRM of course.
<b>10/30 etc. FRM</b>	A mortgage where payments are calculated as though amortized at 30 years (the payment would be the same as a 30-year FRM at the same rate) but principal due and payable at the end of 10 years. Interest rates will be a little lower than a 30-year FRM. Also offered in other maturities like 7/30
<b>80/10/10 etc. FRM</b>	A loan package where the borrower makes a 10% down payment, a first trust deed, typically a 30-year FRM, is borrowed equalling 20% of the purchase value of the home, and a second trust deed, which could be an ARM or an FRM of any duration, is made for another 10%. Used to get favorable terms on the first trust deed and to avoid PMI for a purchase with more than 80% LTV.

**CDO definitions**

<b>CDO (Collateralized Debt Obligation)</b>	Large pools of private investor debt funds (similar to notes and bonds) that are secured by debt assets of ultimate borrowers, like mortgages, credit card and installment credit receivables, leases, and so forth. Unlike notes and bonds, there are (typically) no pre-determined interest payments and no final principal redemption. Instead cash receipts to the pool from borrower debt payments, which are somewhat arbitrary, are passed through to the CDO investors.
<b>CMO (Collateralized Mortgage Obligation)</b>	Essentially a CDO that is dedicated to mortgages alone. The investment pool consists entirely of mortgages, typically mixed by maturity, risk, and type of mortgage.
<b>MBS etc.</b>	Mortgage Backed Securities (MBS), Obligations (MBO), Assets (MBA) are all generally synonyms for CMO.
<b>SIV (Structured Investment Vehicle)</b>	A type of CMO favored and marketed by banking groups like Citigroup, and a source of serious problems in 2007 and 2008. Banks package large portfolios of mortgages and fund them through the sale of asset-backed commercial paper and other relatively short-term debt obligations, securing the commercial paper with a bank line of credit. Fees for packing were large assets were not carried on the books of the banking groups.

## Subprime Loans

Subprime loans earned many headlines in early 2007 because of their soaring default rates. Subprime loans are loans that require virtually no documentation from the borrower - no income verification or other qualifying documentation listed on our earlier slide. These loans are almost always marketed with very low teaser rates that either step up to above market variable rates or to market rates after negative amortization. The teaser subprime loan will always have an expensive cashout penalty for the first few years (because the lenders are not stupid). Subprime loans are largely financed by mortgage pools and sold to buyers who otherwise would not qualify for a loan. It became clear in early 2007 that many truly unqualified borrowers and speculators had borrowed with subprime loans and, because real estate appreciation had stopped, they were unable to meet monthly payments when the loans stepped up. This guaranteed sizeable default and foreclosure rates in 2007, 2008, and 2009.

These loans nearly destroyed the U.S. economy.

## The legacy of mortgage financing

- Traditional until 1968 -
  - Mortgages largely financed by heavily-regulated financial institutions, largely banks and savings-and-loans (now gone) and other thrifts from depositor money, some government lending, some private mortgage pools.
- 1968 until late 1990s -
  - With FNMA in 1968 and Freddie Mac in 1970, mortgage financing shifted to MBSs sponsored by these agencies, still heavily regulated and emphasizing high-quality loans, with the gradual growth of private mortgage pools.
- 1990s to 2007 -
  - FNMA and Freddie Mac still powerhouses, banks still lend very heavily, and large growth in largely unregulated mortgage pools packaged as CMOs.

Old slide

Mudd Finance

## The Role of Freddie Mac

- Federal Home Loan Mortgage Corporation chartered by Congress in 1970.
- Authorized the sell securities and purchase mortgages, with U.S. Treasury authorized the buy Freddie Mac securities (as an implied "guarantee").
- Stock now traded as FRE.
- As of 9/30/2007, Freddie Mac had \$767 billion in debt funding mortgages, both variable and fixed, ranging from short term to 10 years.
- Will buy only "conforming loans" of good quality with mortgage value under \$417,000 (raised to \$729,500 in March 2008).

Old slide

Mudd Finance

## ... and Fannie Mae

- Originally created as a government agency in 1938, converted to the status as a government-sponsored mortgage secondary funding agency (like Freddie Mac) in 1968, now trades as FNM.
- Nearly identical in structure and purpose as Freddie Mac.
- As of September 2007, FNMA held or guaranteed \$2.3 trillion worth of mortgages.
- Portfolio has close to zero duration gap.
- Like Freddie Mac, only buys "conforming loans."
- Both Fannie Mae and Freddie Mac referred to in data as Government Sponsored Enterprise *GSE-backed mortgage pools* (and nobody knew what that meant until 2008).

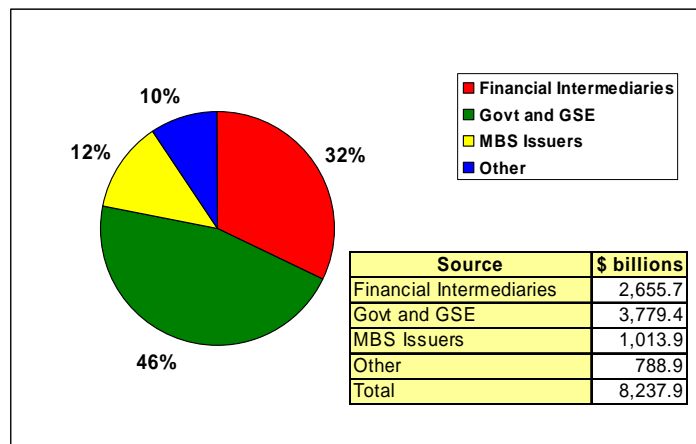
## Sequel: FNM and FRE Nationalized

On September 7, 2008, Fannie Mae and Freddie Mac were nationalized by the U.S. Treasury. Although these GSEs did not hold mortgage pools with sub-prime mortgages in their \$5 trillion portfolio, they did have some exposure to Alt-A and defaults were higher than projected on even prime mortgages. Consequently they had lost nearly \$15 billion combined in the first half of 2008.

The Treasury injected about \$100 billion in each GSE and received senior preferred stock and 20-year warrants to buy more equaling nearly 80% of equity value of each GSE.

This had the effect of providing direct Treasury backing of current and future liabilities of the GSE, although it requires each GSE to roll down their portfolios gradually to \$250 billion each (this is likely to be amended).

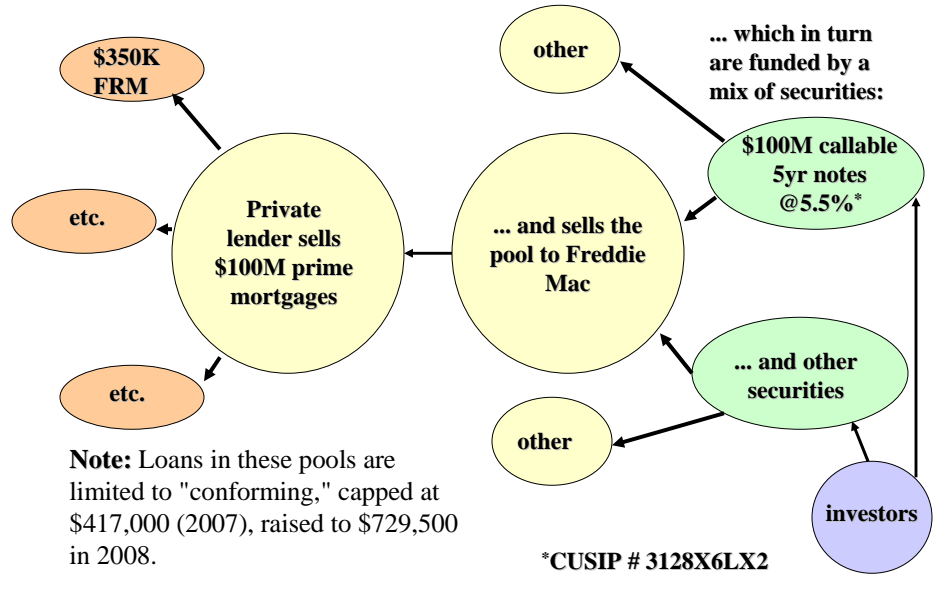
## Sources of Mortgage Lending 2006



Note: MBS issuers sell most of their paper to GSE. What is shown is net remaining.

Source: Federal Reserve Flow of Funds data.

## Freddie Mac Prime Mortgage Pools



## CMOs

- Many (most?) private lenders market a mix of loans, sometimes initially funding them with ABCP and similar short-term debt instruments, often secured with syndicated bank lines of credit.
- The loans are eventually (in a few months) packaged into CMOs with the intention of reselling them to longer term investors.
- "Conforming" loans (with balances below \$417,000, raised to \$729,500 in 2008, and of high quality) can be sold to government-sponsored mortgage pools Fannie Mae and Freddie Mac.
- Non-conforming loans must be sold to large-scale private investors.
- Most of the non-conforming CMOs are split into "tranches" and sold as pieces (see later slide for explanation)
- Credit derivatives exist that allow holders of the non-conforming CMOs to insure against default risk (see later slide for explanation).
- Non-conforming CMO packages, especially for Subprime loans, became the problem in 2007. ABCP dried up for them and they couldn't be sold.

## The life of a CMO

1. Using internal funds or money borrowed from ABCP or other sources, lender begins making loans.
2. After, say, 3 months, the loans are packaged into CMOs, called "loan trusts" by the SEC.
3. A Rule 424(b)(5) prospectus is filed with the SEC.
4. The CMO tranches are rated by Moody's, Fitch, and S&P based upon characteristics of the portfolio. The ratings are AAA, AA, A, BBB, BB, B, CCC (with +s and -s).
5. The CMO is sold directly or through tranches to multiple investors.
6. Credit derivatives (swaps) insuring against default and variable interest rates are created and traded.
7. SEC 10-Ds (periodic) are released describing portfolio status.

## How CMOs differ from Bonds

- |  |   |
|--|---|
| <ol style="list-style-type: none"> <li>1. Bonds and notes pay coupon interest and full principal value is redeemed at maturity.</li> <li>2. Value is discounted present value of future cashflow, which is known.</li> <li>3. Primary risk is default risk of the bond or note, absent in Treasuries.</li> </ol> | <ol style="list-style-type: none"> <li>1. CMOs pass on cashflow receipts from mortgages to investors, no coupons, no final redemption.</li> <li>2. Value is discounted present value of future cashflow, but that is <i>unknown</i>.</li> <li>3. Primary risk is default risk of <i>individual mortgages in the portfolio</i>, plus mis-pricing of assets because of errors in estimating cashflows.</li> </ol> |
|--|---|

## The role of Tranches in CMOs (and CDOs)

CDOs can be divided entirely into segments, called *tranches* in the literature but typically called *pass-through certificates* in the prospectuses that define them. The tranches are conduits for the cashflow generated by the CDO (from the mortgage pool in a CMO or credit card pool in a CDO) and they have rights to that cashflow as defined by the prospectus. Their value, although set by the market, should theoretically approximate the *discounted present value of the estimated cashflow* associated with the tranche.

These pass-through certificates are often classified as super, senior, super senior, and mezzanine certificates, which will be explained in a later slide.

These tranche arrangements are made to segment and allocate risk in the portfolio. They are very complicated derivatives and there is no limit to creative designs for their structure.

They are best learned by example, so let's look at a few.

## CMO pass-thru certificate (tranche) structure (simplified)

**Senior (or super senior): any additional default loss, rate AAA**

**Mezzanine 5: 5th 2% default losses, rated AA**

**Mezzanine 5: 4th 2% default losses, rated A**

**Mezzanine 5: 3rd 2% default losses, rated BB**

**Mezzanine 5: 2nd 2% default losses, rated B**

**Mezzanine 5: 1st 2% default losses, rated CCC**

10,000 mortgages, \$2 billion notional value.

Default loss is absorbed sequentially by the mezzanine tranches, insulating the larger senior tranche, allowing it to earn a AAA rating, *even if a large percentage of the portfolio is subprime.*

The intent was to sell off the mezzanines, which seldom happened.

Tranches typically had projected yields based on LIBOR + (see WaMu example).

Default losses on some of these hit 25%+.

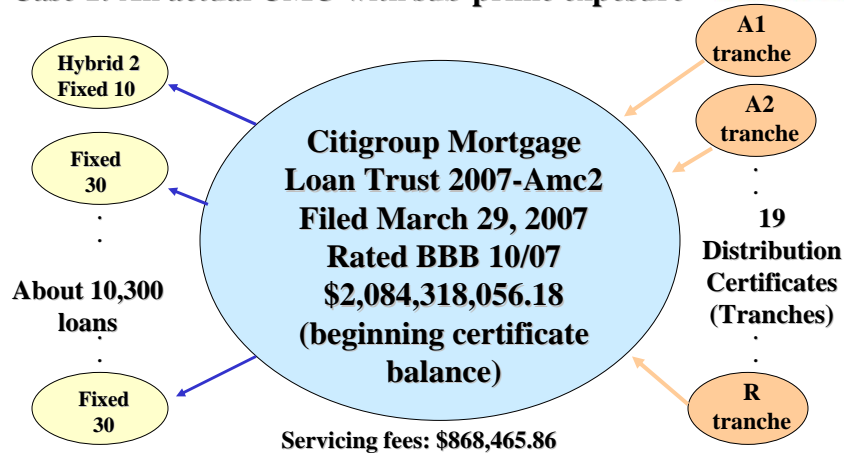
## CMO tranches and "mark to market"

CMO and CDO tranches can get very complicated. Not only are they typically divided according to risk classification, as shown on the earlier slide labeled Credit Risk Tranches, but also can be divided into "principal only" and "interest only" tranches, and also, effectively, restricted to time periods, as shown on the later slide labeled Duration Tranches.

Although tranche values are determined by the market, they will approximate the *present discounted value of the estimated cashflow streams of the tranche*. If loan defaults are higher than first estimated for the tranche, their value must decline must the estimated cashflow stream declines.

When the value of the CMO or CMO tranches decline because of rising default rates, publicly traded companies must "**mark to market**" (revalue) these securities and announce that. That became the economy-killing problem in 2007 and 2008. The disappearance of Countrywide, Bear-Sterns, Lehman Brothers, Washington Mutual, etc. had this as the root cause.

### Case 1: An actual CMO with sub-prime exposure Mudd Finance



Go to <http://www.secinfo.com/dqTm6.uT3.htm> and peruse the individual mortgages in this portfolio.

**Sources:** This loan is one of the constituents of ABX Index HE-A-07-2 maintained in [www.markit.com](http://www.markit.com). Some information from SEC various filings.

**Note:** \$380M (18%) of these loans were delinquent as of Sep 25, 2007.

## About the previous slide

- The 20 Distribution Certificates (Tranches) break down the loan portfolio into ratings (from AAA to BBB-), which in turn depend upon loan characteristics in that tranche, fixed versus variable, 1st vs. 2nd trust deeds, FICO scores (?) and so forth.
- About 20% of these loans were interest-only for 5 or 10 years.
- Average FICO score was 618!!
- Weighted LTV was 87%
- Average loan value was \$213,000 (a lot of second trust deeds)
- The loans were originated by Argent Mortgage Company
  - One of the largest sub-prime lenders in the U.S.
  - In July 07, State of Florida charges five Argent lenders with racketeering:  
see [http://www.fdle.state.fl.us/Press\\_Releases/20070719\\_Racketeering\\_Case.html](http://www.fdle.state.fl.us/Press_Releases/20070719_Racketeering_Case.html)
- If curious about more detail, see the (huge) prospectus at <http://www.secinfo.com/dqTm6.urj.htm>

## Case 2: A Troubled Washington Mutual CMO

- Prospectus dated March 22, 2007, WaMu Asset-backed Certificates, Series 2007 HE2 Trust.
- \$1,533,903 in sub-prime loans approximately.
- First and last scheduled payments: May 25, 2007 and April 25, 2037.
- 6,723 mortgage loans in the pool.
- Even before this CMO's tranches were offered, more than 12% of the mortgages had missed at least one payment.
- 75% of the loans were ARMs, 25% FRMs, 41% were balloon loans.
- 11% of the loans were interest only for 2, 3, or 5 years.
- Loans were classified into 2 Groups. Group I had average FICO of 618 (very low) and loan value \$191,873, Group 2, 646 and \$277,745. Lowest FICO score accepted was 500.
- Only 57% of these loans had full documentation.
- About 60% of the ARMS kick up in Jan/Feb 2009.
- As of March 2008, this CMO was rated CCC.

**WaMu Asset-Backed Pass-Through Certificates (Tranches) Series 2007 HE2 Trust**

Certificate Type (1)	S&P original ratings	Certificate Class	Approximate original certificate principal balance, thousands \$ (2)	Pass-through rates equal one-month Libor plus: (3)	Comments
Senior	AAA	I-A	491,550	0.260	The Senior Certificates are substantially protected from defaulting mortgages by the Mezzanine Certificates. They will generally earn the pass-through rates.
Senior	AAA	II-A1	357,425	0.110	
Senior	AAA	II-A2	125,322	0.190	
Senior	AAA	II-A3	199,414	0.250	
Senior	AAA	II-A4	117,955	0.360	
Mezzanine	AA+	M1	50,997	0.470	Excess interest from mortgages beyond the pass-thru rates go to the Mezzanine Certificates. Losses in excess of amounts covered by default swaps are allocated to the Mezzanine Certificates, starting with M9 first, then working down. M9 goes to zero principal balance, then M8, and so forth. (4)
Mezzanine	AA	M2	44,623	0.550	
Mezzanine	AA-	M3	27,092	0.750	
Mezzanine	A+	M4	23,905	1.350	
Mezzanine	A	M5	23,108	1.700	
Mezzanine	A-	M6	21,514	2.250	
Mezzanine	BBB+	M7	20,718	2.250	
Mezzanine	BBB	M8	12,749	2.250	
Mezzanine	BBB-	M9	17,531	2.250	

(1) All certificates in this CMO earn both interest and principal pass-through. A small number of non-offered certificates were part of this offering as well (mostly for taking care of the slop at the end when most mortgages have expired).

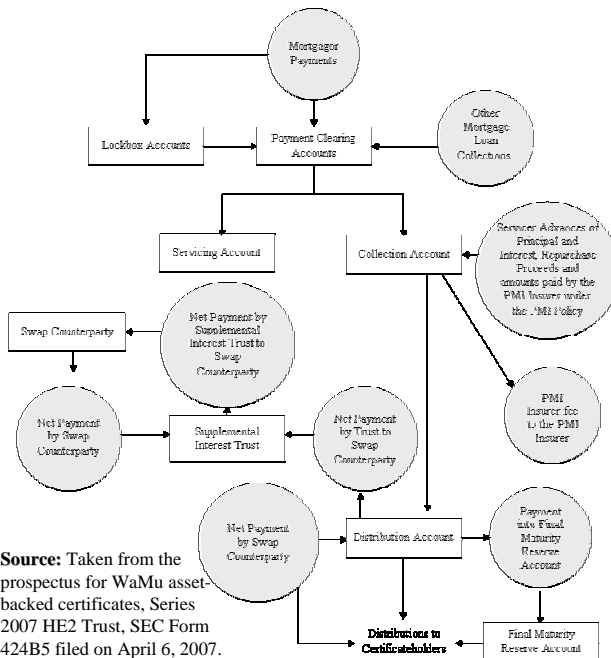
(2) Offered in minimum denominations of \$25,000 and any amount above that divisible by \$1,000.

(3) The actual rate earned includes these rates shown plus mortgage prepayments, including liquidations. Excess interest earned by the pool because of mortgage rates being higher than the pass-thru rates are paid to the Mezzanine Certificates. Default losses if applicable to the certificate type would reduce these of course. These rates are protected by LIBOR swaps. These rates increase when only 10% of the mortgage pool remains.

(4) The prospectus states that expected interest earned from mortgages will exceed the pass-through rates shown. This excess is paid to the Mezzanine Certificates, which makes them more valuable so long as there are not high default rates.

Source: Information was extracted from the prospectus for the CMO identified in the title, SEC form 424B5 filed April 6, 2007

**Mudd Finance**



Source: Taken from the prospectus for WaMu asset-backed certificates, Series 2007 HE2 Trust, SEC Form 424B5 filed on April 6, 2007.

This schematic from the WaMu CMO prospectus used as an example shows the complexity of the cashflow from the mortgage payment to the final distribution to the certificate holders. Theoretically, it is the present discounted value of this that determines the value of the tranche!

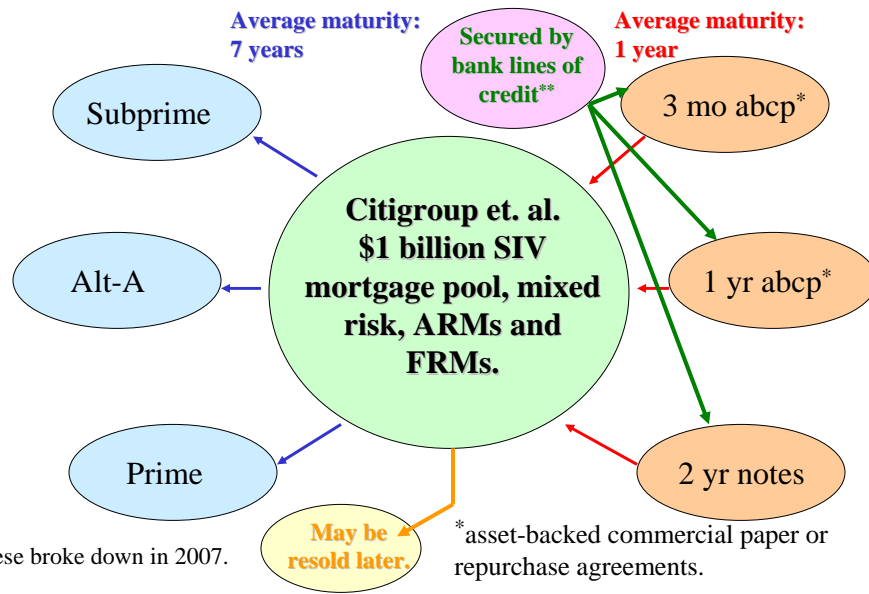
## About the WaMu tranches

... shown on the previous slide. The senior pass-through certificates are insulated from all but very high default rates. That's because default loan losses (from the mortgages in the CMO) are absorbed by the mezzanine certificates starting with the M9 certificate first. The full brunt of default loan losses are entirely born by the M9 certificate until its principal value falls to zero. Then additional loan losses are absorbed by M8, then M7, and so forth. Only when loan losses exceed about 16% of the full portfolio value do they begin to impact payouts to the senior certificates. ***It is for this reason that the senior certificates could be rated AAA, not because there are any AAA rated pools of mortgages in this CMO!*** This mortgage pool consists entirely of sub-prime loans, although the majority were assigned credit risk Premium A. [Therefore, this example is different than the tranches shown in the earlier slide labeled Credit Risk Tranches].

Although relatively safe, the senior certificates will earn only the pass-through rate shown on the chart, plus cash from early prepayments.

The mezzanine certificates will earn the pass-through rate *plus* excess interest earned from the mortgages above the pass-through rates for the other certificates.

## Typical SIV funding profile



## Key CMO variables affecting value

- ✓ 30/60/90/120 day delinquency rates
  - 60-day delinquency rate 7.7% Dec 2008 for all mortgages
  - For sub-prime and Alt-A, approaching 25%.
- ✓ Foreclosure rate
  - ✓ FICO profile
  - ✓ LTV
  - ✓ Income documented?
  - ✓ 1st or 2nd (or later) trust deeds
- ✓ Loan payoffs from home sales and refinancing

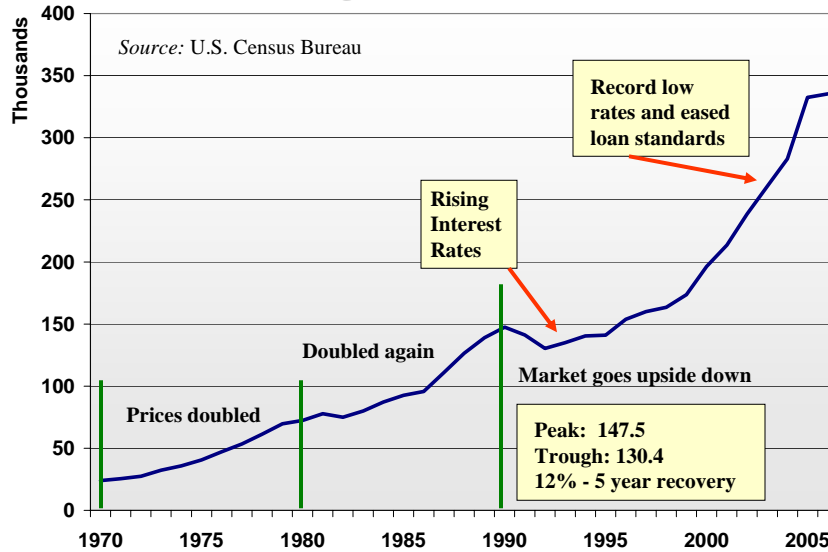
## The collapse of housing and parts of the CMO market in 2007

- Housing prices super-inflated, encouraging speculation
- Subprime market makes a very large number of poor loans (\$400 billion?)
- When Subprime variables rates kick up, tremendous rise in delinquencies and foreclosures.
- ABCP and other credit market sources dry up.
- FNMA et. al. can't help because loans capped at \$417K
- Prices begin their decline (on the day this lecture was given), news headline is that housing prices are falling at the highest pace since 1991, 5% for 10 cities.

from econ 104

Mudd Finance

## Western Region Median Price Single Unit Homes



## Going into summer 2007

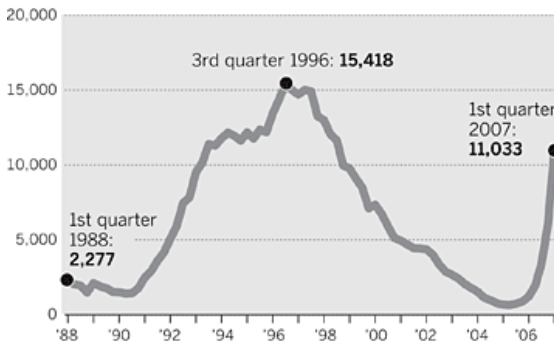
Mudd Finance

Added 10/29/2007: 3rd quarter was 24,209!

### Mortgage foreclosures

Home foreclosures are up sharply in California as many borrowers struggle to make higher payments on adjustable-rate mortgages.

Number of foreclosures statewide, quarterly data



Source: DataQuick Information Systems

Los Angeles Times

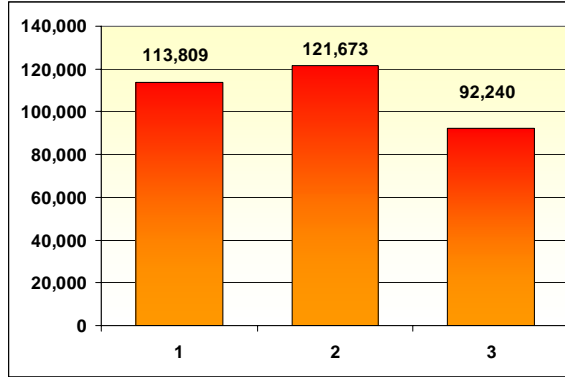
This graphic appeared in the *Los Angeles Times* on April 17, 2007. California foreclosures and default notices were heading toward record levels.

Aside from the general decline in affordability, this is almost entirely due to sub-prime, Alt-A, and Option ARMs (typically with refinance penalties) that were staircasing up to market rates or above from teaser rates.

This, of course, is adding to the inventory of unsold homes on the market.

## California Home Foreclosures 2008

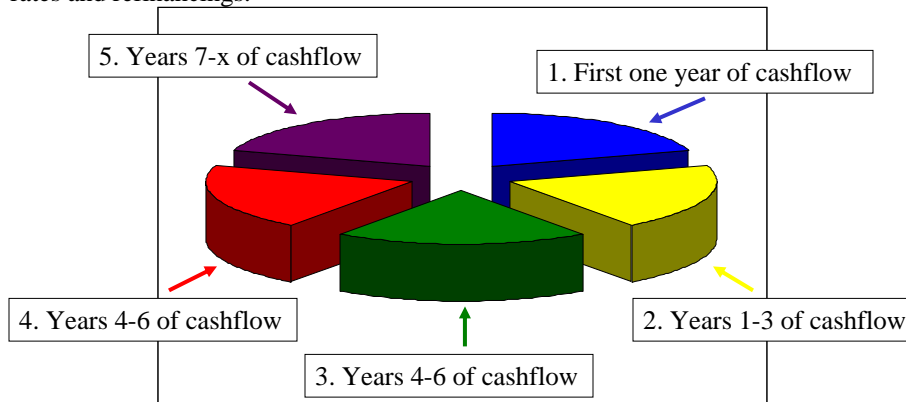
California Home Foreclosures	
Source: DataQuick	
2008 Q	
1	113,809
2	121,673
3	92,240
3rd quarter lower because of moratorium. Otherwise would have been about 2nd quarter level.	



## Memo: Duration Tranches

Note: The value of each tranche will be heavily impacted by default rates and refinancings.

A debt instrument divided into tranches:



The value of each?? Discounted projected (estimated) cashflow!