Week 10 – Securitization

MIT Sloan School of Management

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Outline

- Securitization overview
- Restructuring credit risk
  - CDO structures
  - Effect of default correlation
- Mortgages and MBS
  - Products and structures
  - Prepayment risk
  - Pricing

What is Asset Securitization?

Asset securitization is **the process of collecting and pooling financial assets (e.g., loans), and then selling securities backed by the cash flows from the asset pools**.

These securities are often called "**asset-backed securities**" because each pool is backed by specific collateral assets, with no recourse to the issuers of those underlying assets.

What Types of Assets are Securitized?

Over time the variety of assets securitized has expanded

The largest and oldest segment of the market is for conventional residential mortgages

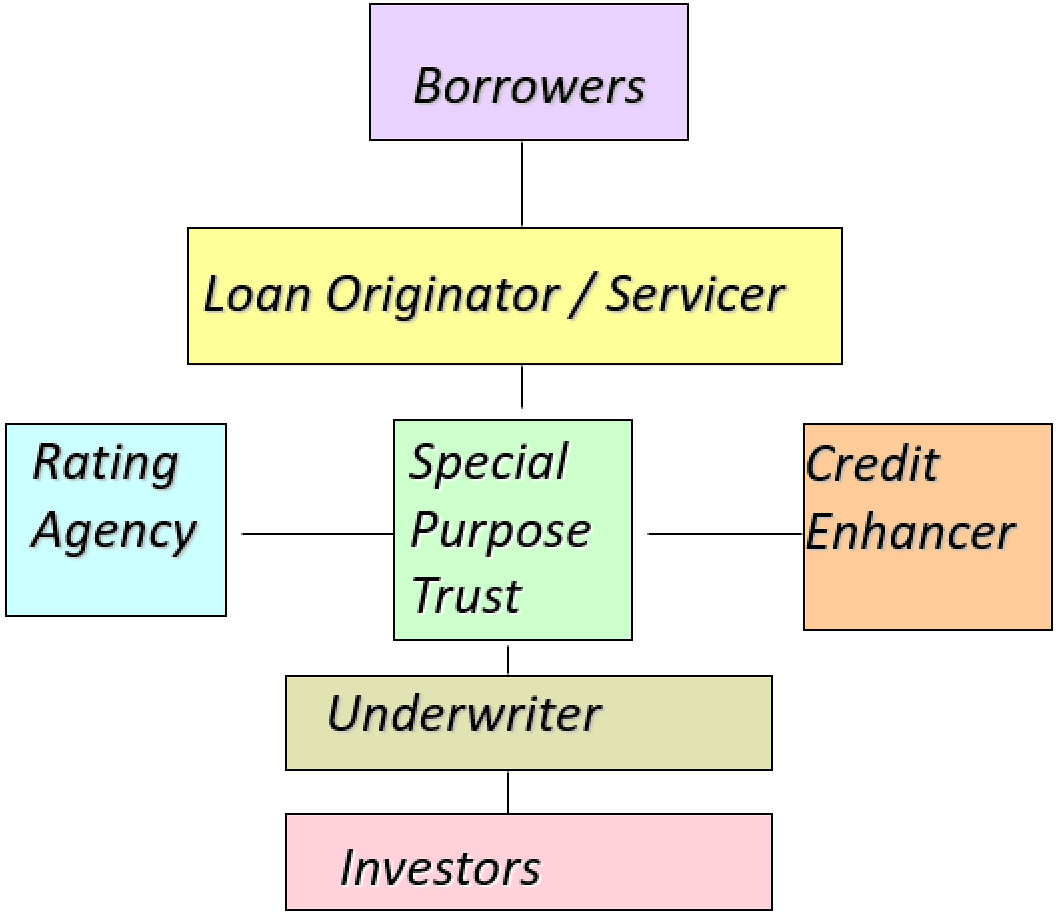
Some popular categories are:

- Real estate: MBS (RMBS and CMBS), CMO/REMICs
- Loans: CLOs
- Debt: CDOs

Examples of underlying assets include:

home equity loans	**junk bonds**	**student loans**
boat loans	**second mortgages**	**SBA loans**
credit card loans	**auto loans**	**lease receivables**
senior bank loans	**third world debt**	

Creating Asset-Backed Securities



What caused the growth of securitization?

- **Efficiency**
  - e.g., allows for wider risk sharing and risk restructuring.

- **Regulatory avoidance or incentives**
  - e.g., restructuring or removing assets from the balance sheet can reduce capital requirements

Potential advantages over traditional bank lending

- **Cost Efficiencies:** Specialization in the credit process
- **Liquidity**: Securitization can convert illiquid individual loans or debt instruments into liquid marketable securities
- **Information**: With securitization, the financial market determines value, possibly frequently
- **Funding Sources**: Securitization can turn a market with only local investors into a market with national or global investors
- **Options Available to Borrowers and Lenders**: Securitization leads to a broader range of terms and rates for borrowers and lenders, and facilitates diversification
  - Redistributes credit, interest rate and prepayment risk, ideally to those best able to manage each risk, hence lower total borrowing costs

Securitization can also create new problems

- Adverse selection
  - Are the lowest quality loans securitized?
- Moral hazard
  - Do banks and other originators screen and monitor borrowers less if they sell the loans?
- Model risk
  - Complex structures are difficult to price
    - E.g., correlation misspecification
- Some pieces of complex structures can be very illiquid

Restructuring credit risk

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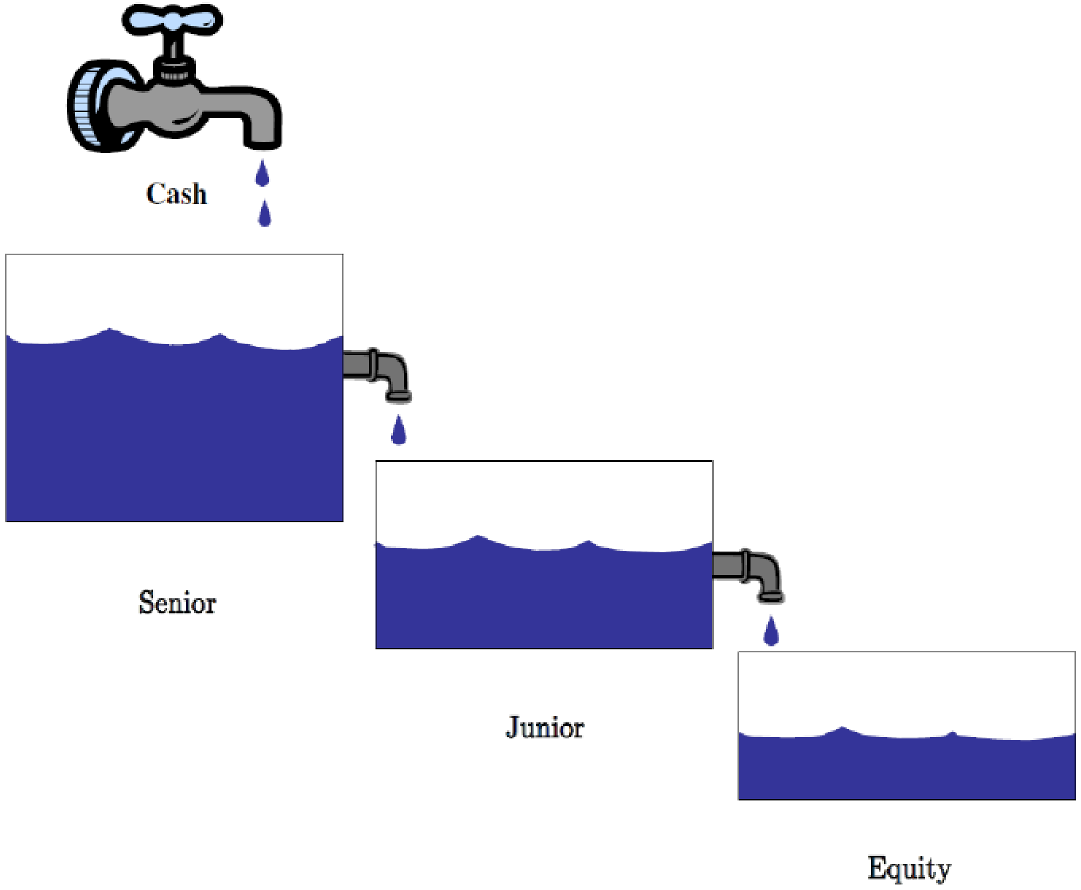
Collateralized debt obligations (CDOs)

A popular structured product with embedded credit derivatives

Pools together debt securities from different issuers and then specifies rules for passing cash flows to various “tranches”

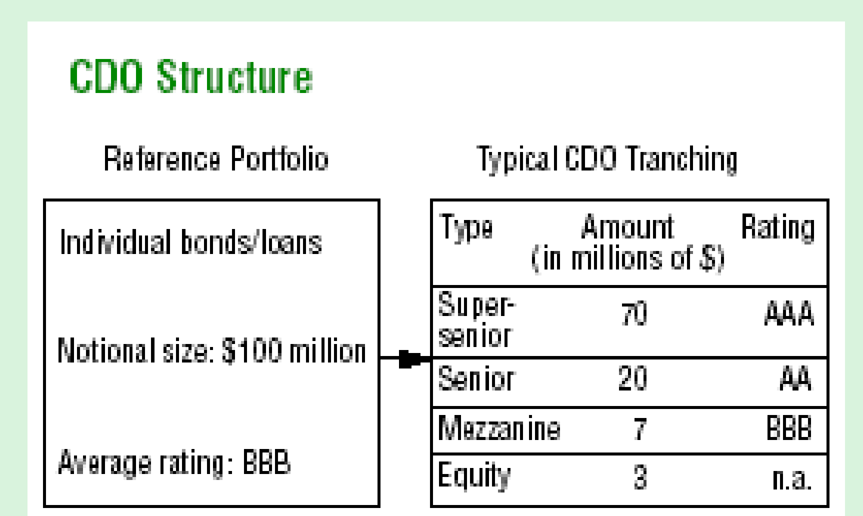


Example of tranching

- **Equity Tranche** $= [0\% - 3\%]$ of notional
  - Credit losses up to 3% of the portfolio notional hit the equity tranche
  - This the most credit risky tranche
- **Mezzanine Tranche** $= [3\% - 7\%]$
  - Credit losses hit this tranche only if they are above 3% of notional
  - Maximum loss is 7% of notional
- Other Standardized Tranches $= [7\% - 10\%], [10\% - 15\%], [15\% - 30\%]$
- **Super Senior Tranche** $= [30\% - 100\%]$ of notional

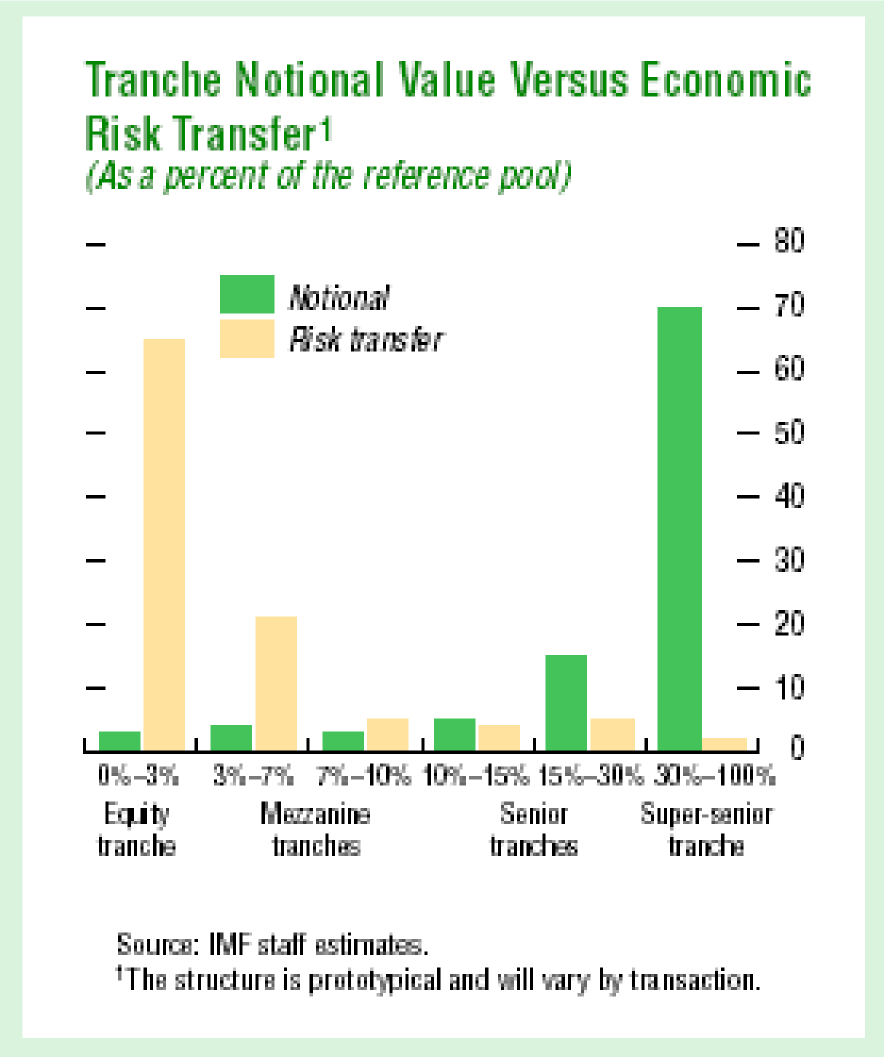
Cash flow restructuring

- Pooled cash flows from debt repayments are restructured into different classes of claims called **“tranches”**
  - Some tranches are structured to be safe and predictable
  - Others have much more unpredictable cash flows and can be tricky to value



Source: IMF

Tranching results in significant risk restructuring



Alternatives for redistributing credit risk

- In this CDO example, credit risk is transferred to **subordinated tranches** or to equity holders
  - This is a form of "**over-collateralization**"
- Alternatively, credit risk may be covered with a **guarantee from a "credit enhancer"**
  - Types of **private credit enhancement**:
    - (a) pool insurance from an insurance company
    - (b) a bank letter of credit
  - **Government credit enhancement:**
    - Federal, state and local gov't entities provide credit enhancement to support certain private activities
      - E.g., Fannie Mae and Freddie Mac guarantee mortgages

CDOs and default correlation

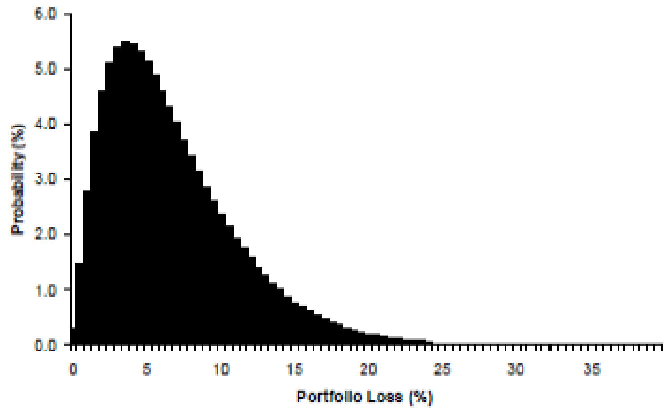
- Investment in CDOs implies a speculative position on the default correlation across the bonds in the portfolio of credits

- To understand the types of risks that such an investments would imply, we need to understand how differences in default correlation affect the expected losses in each tranche
  - For instance, assume the default correlation across all the names in a portfolio is one (i.e. perfect correlation)
  - Then the default risk in the equity tranche would be as high as in senior tranche

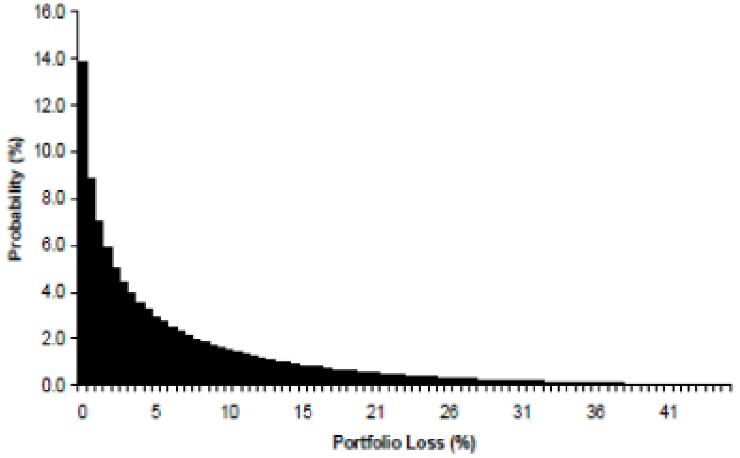
- How does the portfolio loss distribution depend on the correlation across assets?
  - We can perform a simulation exercise
  - Assume a portfolio with 100 names, each with probability of default = 14%
  - Let's assume that the correlation across defaults is 15%, 40% or 100%

Effect of correlation on loss distributions

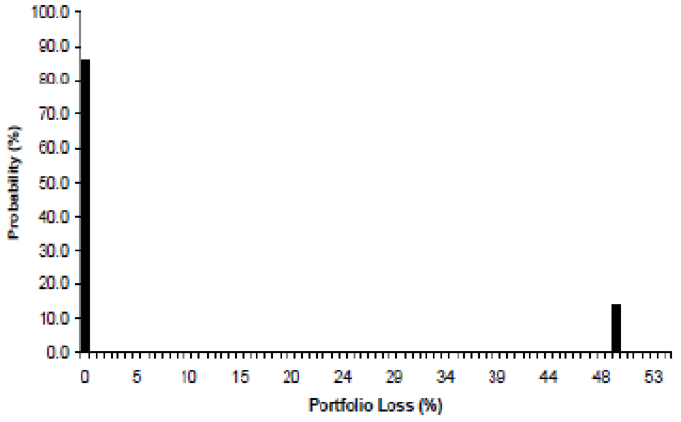
The Loss Distribution for a Portfolio of 100 Assets with a Default Correlation of 15%. Each Asset Has a 6-Year Default Probability of 14% and a Recovery Rate of 50%.



The Loss Distribution for a Portfolio of 100 Assets Each with a 40% Default Correlation



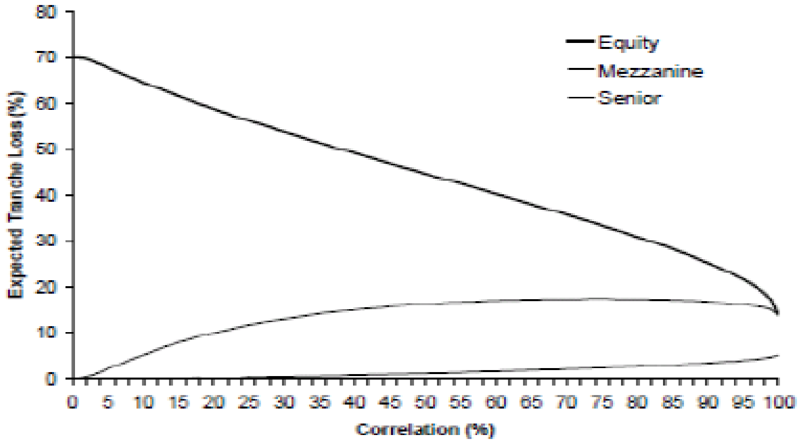
The Loss Distribution for a Portfolio of 100 Assets with a 100% Default Correlation



CDOs and default correlation

- As the correlation increases, the tail of the loss distribution become heavier
- This implies that it becomes relatively more likely that losses able to hit the Baa tranche will be reached
- In the limit, as mentioned, when correlation = 100%, if default occurs, it will affect both the Mezzanine and Senior tranches

5. The Percentage Expected Loss of Each of the Tranches of the Portfolio as a Function of the Default Correlation Between the Assets in the Collateral Pool



- An investor in the equity tranche is **"long correlation"**
- An investor in the senior tranches is **"short correlation"**

Example: Effects of default correlation on value

- Consider a simple CDO based on two notes
  - Note: probabilities are risk neutral so that price is found discounting expected discounted cash flow at risk-free rate.

- Both notes are zero-coupon and have one-year maturities:

  Note 1: \$100 principal; 50% expected recovery rate (or \$50); price = \$95

  Note 2: \$200 principal; 40% expected recovery rate (or \$80); price = \$179.5

- Assuming the one-year LIBOR rate is 2 percent, then the (risk-neutral) probability of default, pi, for each note i is:

  Note 1: $\frac{1}{1.02}(\$50 p_1 + \$100(1-p_1)) = \$95 \Rightarrow p_1 = 6.2\%$

  Note 2: $\frac{1}{1.02}(\$80 p_2 + \$200(1-p_2)) = \$179.5 \Rightarrow p_2 = 14.1\%$

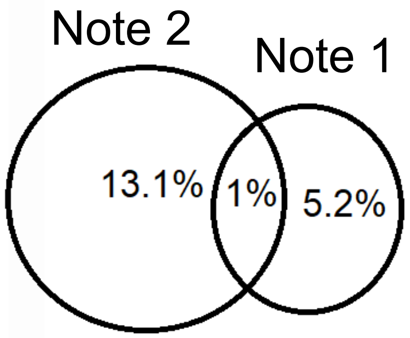
Example continued

Assume that the probability of both notes defaulting at the same time is 1 percent:

- The probability of *only* note 1 defaulting is 5.2 percent (6.2 – 1),
- The probability of *only* note 2 defaulting is 13.1 percent (14.1 – 1),
- The probability of neither note defaulting is 80.7 percent (100 – (13.1 + 5.2 + 1)).

Assume the $300 CDO is divided into three tranches:

- the senior tranche ($220 of principal),
- the mezzanine tranche ($60 of principal),
- the junior tranche ($20 principal).



For each tranche, the expected payouts under each default scenario can be calculated.

Example continued

				expected payouts in each default scenario		
	probability of scenario (%)	total payout		senior tranche	mezzanine tranche	junior tranche
Default Scenario						
No default	80.7	$300		.807 x $220 = $177.5	.807 x $60 = $48.4	.807 x $20 = $16.1
Note 1 defaults alone	5.2	$250		.052 x $220 = $11.4	.052 x $30 = $1.6	.052 x $0 = $0
Note 2 defaults alone	13.1	$180		.131 x $180 = $23.6	.131 x $0 = $0	.131 x $0 = $0
Both default	1	$130		.01 x $130 = $1.3	.01 x $0 = $0	.01 x $0 = $0
			Expected payout E*	$213.80	$50	$16.10
			Present value E*/1.02	$209.60	$49	$15.80
			Yield	220/209.6-1 = 4.9%	60/49-1 = 22.4%	20/15.8 - 1 = 26.6%

Example continued

How would the payouts change if default correlation increased?

- In this example, the probability of both notes defaulting together would increase to over 1 percent.
- Correspondingly the probability of no default would also increase as the probabilities of the two notes defaulting separately decreased.
- Default scenarios 1 and 4 would be more likely, and default scenarios 2 and 3 would be less likely.
- As default correlation increases, the value of the most subordinated tranche (i.e., the equity and junior tranches) increases, and the value of the most senior tranches decreases.

Example continued

Assume probability of both notes defaulting at same time is now 3 percent:

- The probability of *only* note 1 defaulting is 3.2 percent (6.2 – 3),
- The probability of *only* note 2 defaulting is 11.1 percent (14.1 – 3),
- The probability of neither note defaulting is 82.7 percent (100 – (11.1 + 3.2 + 3)).

Again assume the $300 CDO is divided into three tranches:

- the senior tranche ($220 of principal),
- the mezzanine tranche ($60 of principal),
- the junior tranche ($20 principal).

Example continued

	probability of scenario (%)	total payout		expected payouts in each default scenario senior tranche	mezzanine tranche	junior tranche
Default Scenario						
No default	82.7	$300		.827 x $220 = $181.9	.827 x $60 = $49.6	.827 x $20 = $16.54
Note 1 defaults alone	0.032	$250		.032 x $220 = $7.0	.032 x $30 = $0.96	.032 x $0 = $0
Note 2 defaults alone	0.111	$180		.111 x $180 = $20.0	.111 x $0 = $0	.111 x $0 = $0
Both default	0.03	$130		.03 x $130 = $3.9	.03 x $0 = $0	.01 x $0 = $0
			Expected payout E*	$212.86	$50.58	$16.54
			Present value E*/1.02	$208.69	$49.59	$16.22
			Yield	220/208.69-1 = 5.42%	60/49.59-1 = 21%	20/16.22 - 1 = 21.34%

This demonstrates that when correlations increase, the expected payout on senior tranches tends to fall, whereas the expected payout on the junior tranches tends to rise.

This has led some to conclude that unexpectedly high default correlations is what caused senior MBSs to suffer unexpected losses during the 2008 financial crisis

Mortgages and MBS

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Key features of the mortgage market

Basics

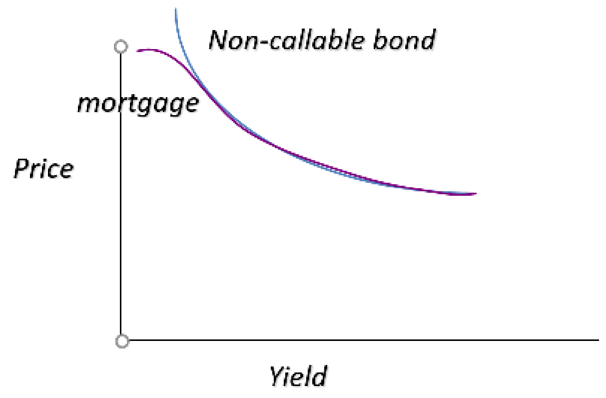
- A **mortgage** is **a loan collateralized with real estate** (most often residential housing or commercial property)
  - Focus here is on residential market
- There are a number of **payment options**:
  - **fixed rate** and **adjustable rate** are the most common in the U.S.
    - 30-year fixed rate mortgages are the most popular, followed by 15-year fixed rate mortgages
    - Other types include interest only, 5/1, 5/25…
- By law, conforming residential mortgages can be prepaid without penalty at any time in most states.
- Many mortgages in the U.S. are financed through securitization. Others are held by banks. Most U.S. mortgages are guaranteed against default risk by a gov't agency.

Mortgage Risk

There are several types of risks for investors in mortgages or in mortgage-backed securities:

- credit risk
  - Mitigated by collateralization
  - Often absorbed by a government or private guarantor
- interest rate risk
- prepayment risk
  - when rates fall, prepayment speeds up
- extension risk
  - when rates rise, prepayment slows
- liquidity risk

Recall that prepayment risk creates negative convexity



Typical steps in a mortgage securitization

1. A commercial bank, mortgage broker or thrift **originates** the mortgage loan
2. The originator sells the loan to the securitizer, that **creates a security backed by a pool of similar mortgages**
3. The securitizer absorbs credit risk by **guaranteeing timely payment of principal and interest**
4. The securitizer contracts the right to service the loans to a servicing company if they are not retained by the originator
5. The securitizer **sells the asset-backed securities to the market**

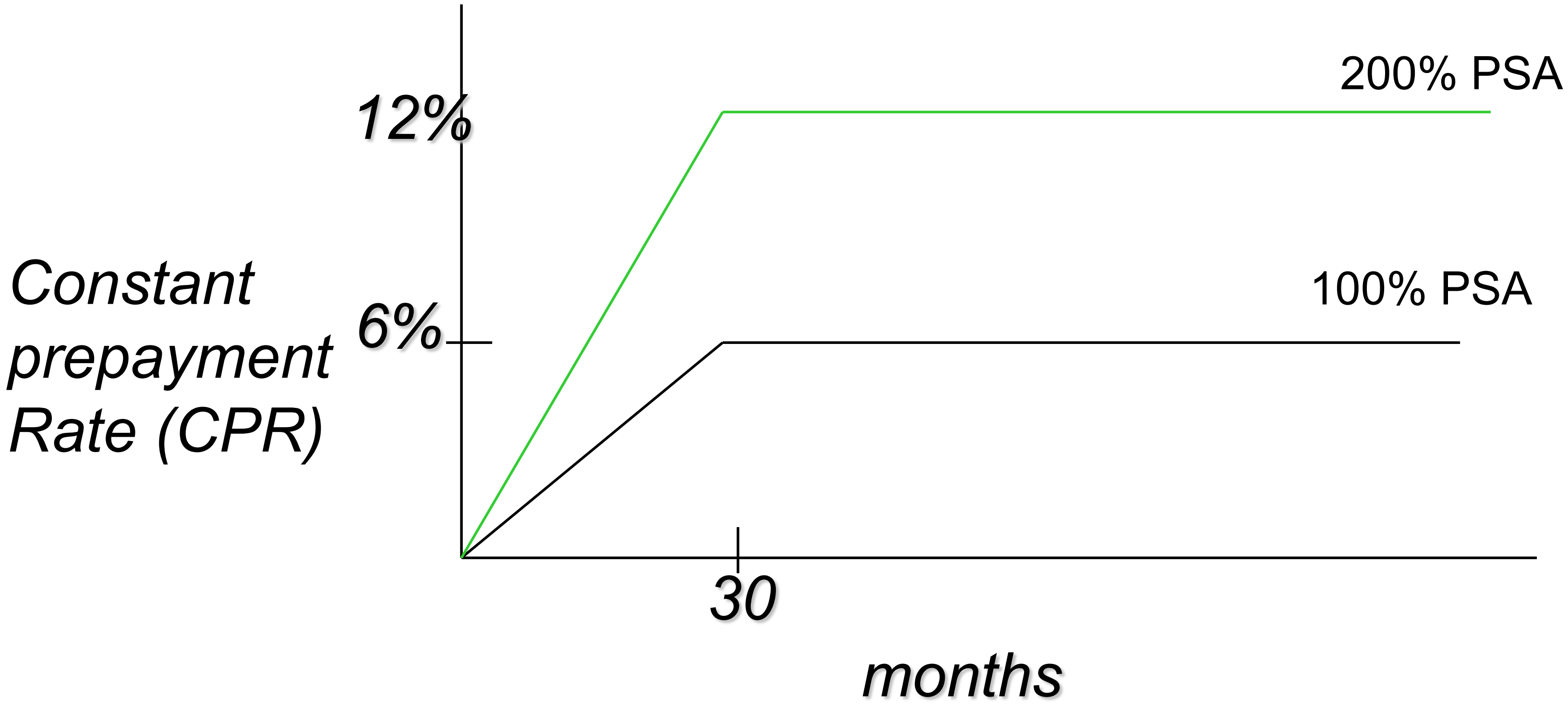
Price Determination

- As for any security, price is the present value of expected future cash flows, discounted at appropriate risk-adjusted rate(s)
- For MBS, due to the prepayment option and the complexity of some of the securities, cash flows and can be challenging to model
- Identifying the appropriate risk-adjusted discount rate is also tricky
  - A derivatives pricing approach is useful for valuing default and prepayment options
- A **critical input** into projecting cash flows is modeling **prepayment behavior**

Prepayment models for MBS

- Quantifying prepayment has evolved from using simple models to more complex models…
  - Constant Prepayment Rate (CPR) and Single Monthly Mortality (SMM)
  - Public Securities Association (PSA) Model
    - An important tool for communication
- **State of the art**: Proprietary econometric prepayment models
  - Statistical estimates based on historical experience
  - Function of observables: e.g., loan size, interest rates, loan age, credit score, LTV, location, etc.
  - Competing hazard models
  - Beware of parameter instability
  - Contrast with optimal prepayment

The PSA prepayment model



PSA is used to communicate about what realized cash flows will look like under alternative assumptions for prepayment rates

MBS products

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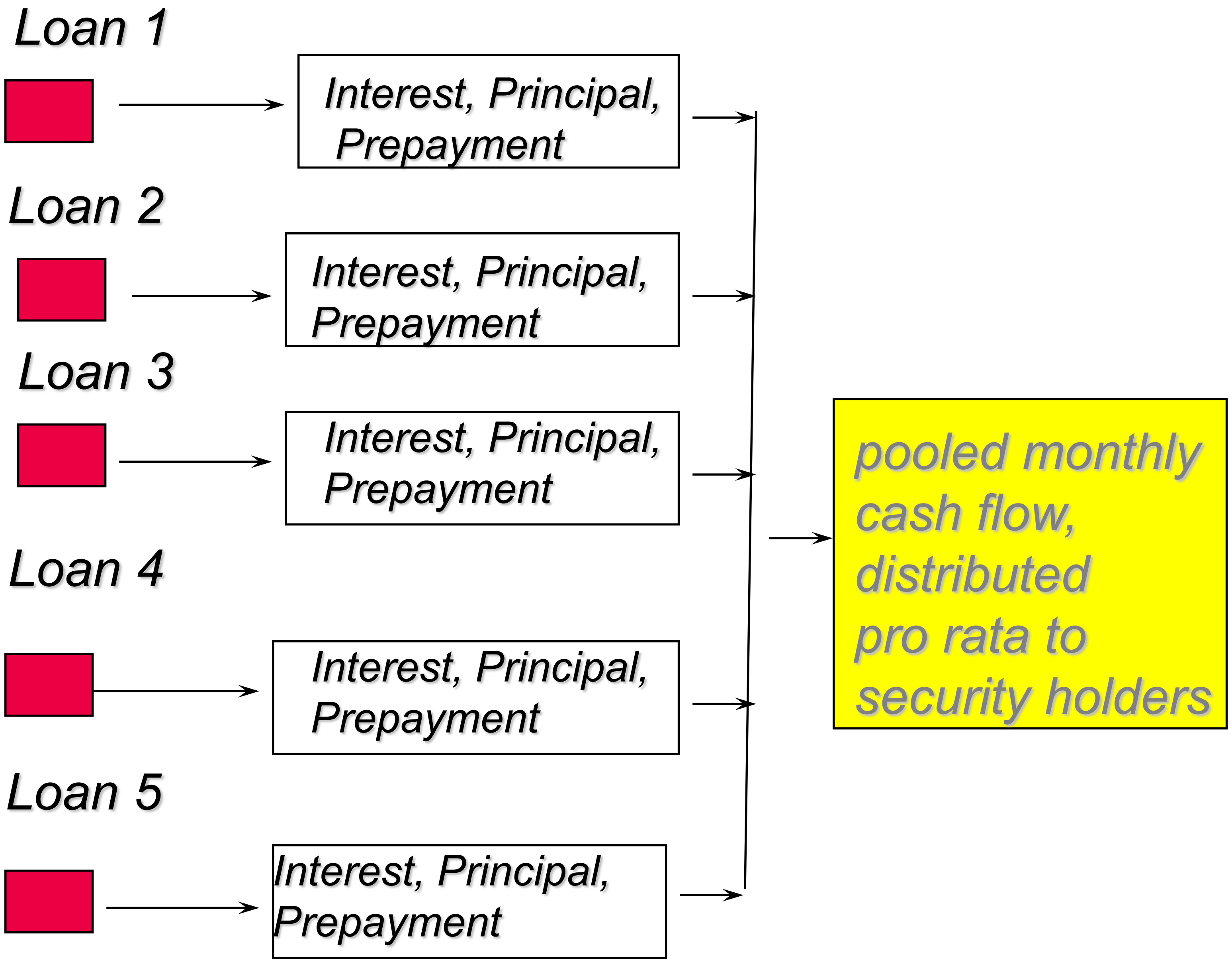
Pass-through securities

- Structure of mortgage pass-through securities
  - Created in 1968.
  - Cash flows from a group of mortgages are pooled and distributed in equal proportions (pro rata) to all investors.
  - Repayment of principal is generally guaranteed
  - A benefit is diversification: lower risk and hence more predictable payment stream than from individual mortgages.
    - Easier to price than individual mortgages
    - More liquidity than individual mortgages



Each loan is $200,000
Total loans is $1 million

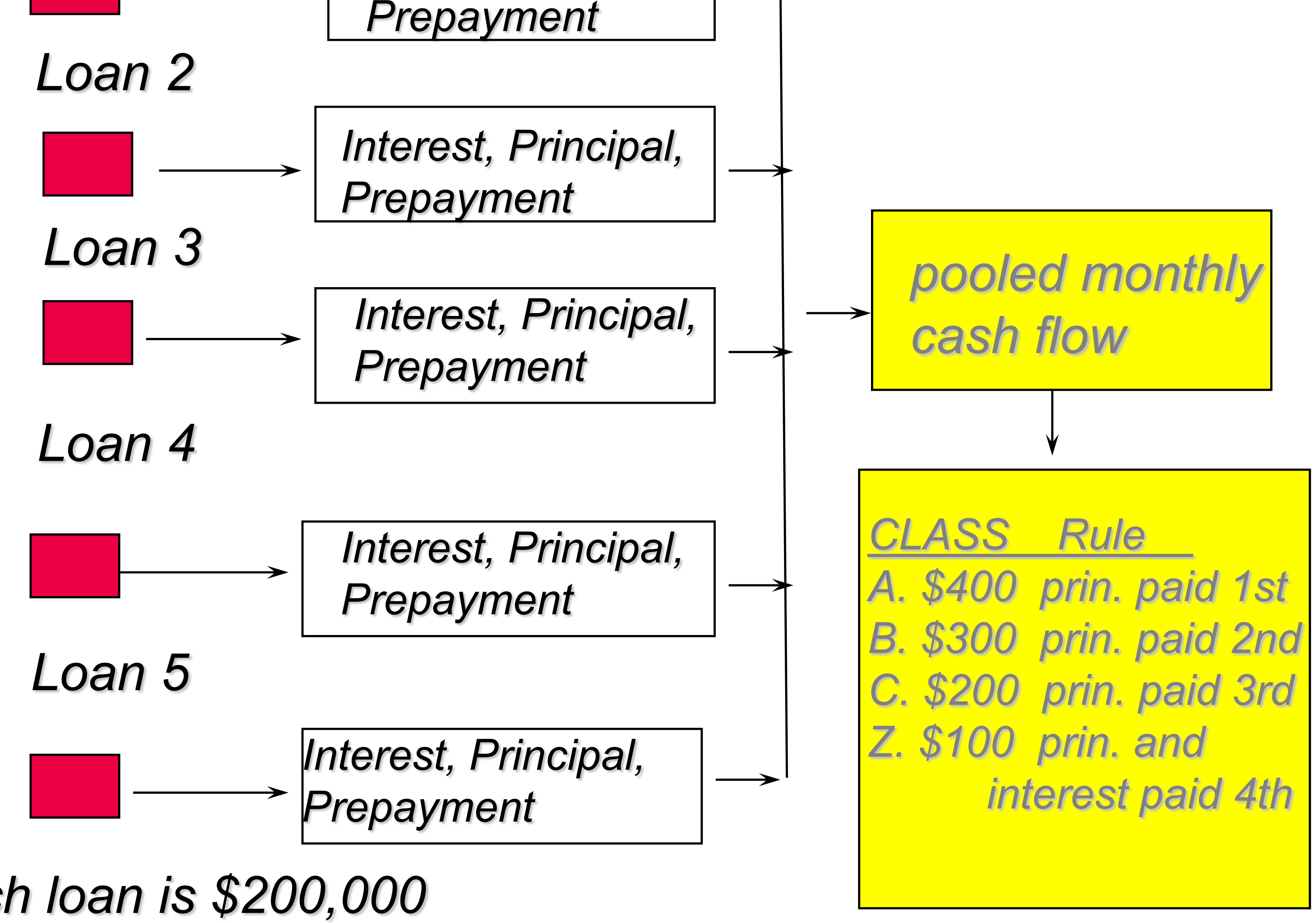
Collateralized Mortgage Obligations (CMOs)

- These were invented to further tailor the risk associated with mortgage-backed securities by assigning cash flows to various classes of bondholders (tranches).
- First issued by Freddie Mac in 1983.

- Common types of CMO securities include:
  - Sequential Pay
  - Planned Amortization Class (PAC)
  - Targeted Amortization Class (TAC)
  - Support Class
  - Floater
  - Inverse Floater

  - Within each CMO structure, tranches can vary enormously in their risk and liquidity.

Example of sequential pay structure



Each loan is $200,000
Total loans is $1 million

IOs and POs

An IO pays only interest, based on a notional principal amount.

What happens when rates fall?

- As principal is prepaid, interest on principal falls
- In certain interest rate ranges, the IO loses value
  - What does this imply about the effective duration of an IO?

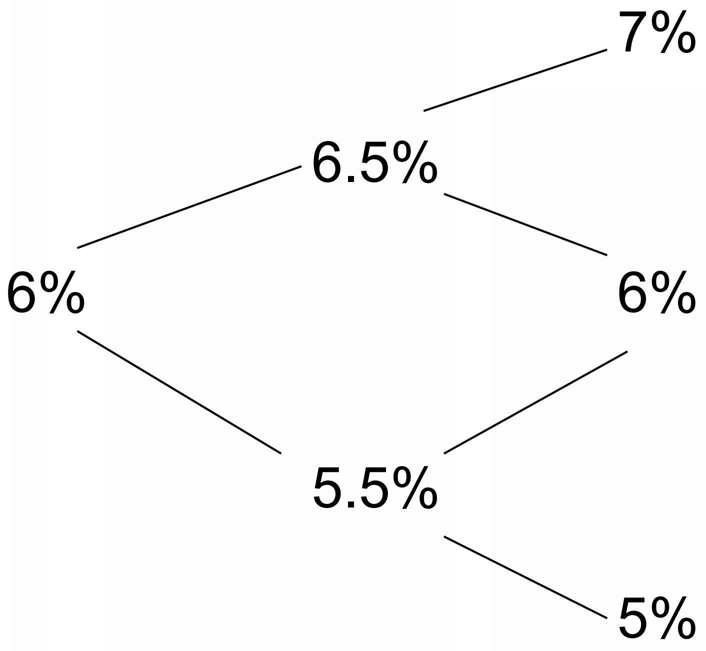
A PO pays only principal.

What happens when rates rise?

- The discounted value of the PO falls for a given payment pattern.
- The discounted value of the PO falls further because principal payments are delayed.
  - What does this imply about the effective duration of a PO?

Example: Estimating Mortgage-backed Security Prices

Assume that your interest rate model is represented in tree form, and predicts the following process for risk-free rates (all paths assumed equally likely):



Assume that your prepayment model generates the following cash flows from an MBS, corresponding to the four equally likely interest rate paths:

6.0%	*6.5%*	*7.0%*	*(up, up)*
$100	$100	$100	
6.0%	*6.5%*	*6.0%*	*(up, down)*
$100	$100	$104	
6.0%	*5.5%*	*6.0%*	*(down, up)*
$100	$150	$50	
6.0%	*5.5%*	*5.0%*	*(down, down)*
$100	$150	$58	

each path is equally likely (because of the assumption that pr(up) = pr(down) = .5).

Assume investors require a spread of .25% over the risk-free rate as a compensation for mortgage risk.

Then the possible paths that will be used for discounting can be written as:

6.25%	*6.75%*	*7.25%*	*(up, up)*
$100	$100	$100	
6.25%	*6.75%*	*6.25%*	*(up, down)*
$100	$100	$104	
6.25%	*5.75%*	*6.25%*	*(down, up)*
$100	$150	$50	
6.25%	*5.75%*	*5.25%*	*(down, down)*
$100	$150	$58	

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The maximum price you would be willing to pay for this security is found by discounting along each path and averaging:

$$\frac{100}{1.0625}+\frac{100}{(1.0625)(1.0675)}+\frac{100}{(1.0625)(1.0675)(1.0725)}$$

= 264.49

$$\frac{100}{1.0625}+\frac{100}{(1.0625)(1.0675)}+\frac{104}{(1.0625)(1.0675)(1.0625)}$$

= 268.58

$$\frac{100}{1.0625}+\frac{150}{(1.0625)(1.0575)}+\frac{50}{(1.0625)(1.0575)(1.0625)}$$

= 269.50

$$\frac{100}{1.0625}+\frac{150}{(1.0625)(1.0575)}+\frac{58}{(1.0625)(1.0575)(1.0525)}$$

= 276.66. **The average = $269.81 = price!**

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Thank you and good luck!

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