Mortgage loans and mortgage-backed securities

Mortgages

- A mortgage loan is a loan secured by the collateral of some specific real estate property which obliges the borrower to make a predetermined series of payments.

- A mortgage design is a specification of the interest rate, term of the mortgage, and manner in which the borrowed funds are repaid.

- Mortgage originator (original lender) can either

  - hold the mortgage in their portfolio
  - sell the mortgage to an investor or
  - use the mortgage as collateral for the issuance of a security (mortgage backed security).

Contract rate (interest rate on a mortgage loan)

Contract rate is greater than the yield on a Treasury security of comparable maturity. The spread reflects

- costs of collection
- costs associated with default (not eliminated despite the collateral)
- poorer liquidity
- uncertainty concerning the timing of the cash flow.

Fixed rate, level payment, fully amortized mortgage

- The borrower pays interest and repays principal in equal instalments over an agreed upon period of time (term of the mortgage). The frequency of payment is typically monthly.

- The servicing fee is a portion of the mortgage rate. The interest rate that the investor receives is called the *net coupon*.

Growing equity mortgages

- It is a fixed-rate mortgage whose monthly mortgage payments increase over time.

Amortization schedule for a level-payment fixed-rate mortgage

Mortgage loan:	\$100,000
Mortgage rate:	8.125%
Monthly payment:	\$747.50
Term of loan:	30 years (360 months)

$$\text{monthly payment} = \text{mortgage balance}\left[\frac{i(1+i)^n}{(1+i)^n - 1}\right]$$

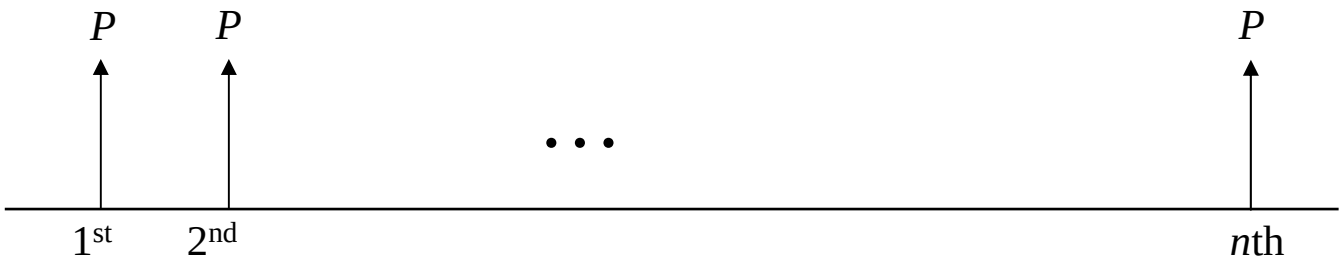
where i is the simple monthly interest rate.

Example

$n = 360$, mortgage balance = \$100,000, $i = 0.08125/12$.

Mortgage payment = \$742.50.

Proof of the mortgage formula



$$P[(1+i)^{n-1}+(1+i)^{n-2}+\cdots+1]=M(1+i)^{n}$$

extend one extra period:

$$P[(1+i)^{n}+(1+i)^{n-1}+\cdots+(1+i)]=M(1+i)^{n+1}.$$

Subtract the two terms:

$$P[(1+i)^{n}-1]=Mi(1+i)^{n}$$

so that

$$P=\frac{Mi(1+i)^{n+1}}{(1+i)^{n}-1}.$$

Month	Beginning Mortgage Balance	Monthly Payment	Monthly Interest	Principal Repayment
1	100,000.00	742.50	677.08	65.41
2	99,934.59	742.50	676.64	65.86
3	99,868.73	742.50	676.19	66.30
⋮	⋮	⋮	⋮	⋮
358	2,197.66	742.50	14.88	727.62
359	1,470.05	742.50	9.95	732.54
360	737.50	742.50	4.99	737.50

- Interest portion declines and repayment portion increases.

Adjustable rate mortgages

The mortgage rate is reset periodically in accordance with some chosen reference rate.

Other terms

- Rate caps limit the amount that the contract rate may increase or decrease at the reset date.

- A lifetime cap sets the maximum contract rate over the term of the loan.

Prepayment

Payments made in excess of the scheduled principal repayments. The amount and timing of the cash flows from the repayments are not known with certainty.

- Sale of a home
- Market rates fall below the contract rate
- Failure to meet the mortgage obligations

Factors affecting prepayment behaviors

1. Prevailing mortgage rate – the current level of mortgage rates relative to the borrower's contract rate.
   - The spread should be wide enough to cover the costs

2. Path history of rate spread is important
   – depends on whether there have been prior opportunities to refinance since the underlying mortgages were originated.

3. Presence of prepayment penalty.

4. Macroeconomic factors e.g. growing economy results in a rise in personal income and in opportunities for worker migration.

5. Seasonal factor: Home buying increases in the Spring and reaches a peak in the late Summer. Since there are delays in passing through prepayments, the peak may not be observed until early Fall.

Interest rate path dependence

Prepayment burnout – Prepayments are path dependent since this month's prepayment rate depends on whether there have been prior opportunities to refinance once the underlying mortgages were originated.

Example – path of interest rates in the past 3 years

First path: $11\% \rightarrow 8\% \rightarrow 13\% \rightarrow 8\%$

Second path: $11\% \rightarrow 12\% \rightarrow 13\% \rightarrow 8\%$

More refinancing occurs now when the interest rates follow the second path.

Prepayment models

Describes the expected prepayments on the underlying pool of mortgages at time *t* in terms of the yield curve at time *t* and other relevant variables.

– predicted from an analysis of historical data.

Example

Weekly report “Spread Talk” published by the Prudential Securities

- provides 6-month, 1-year and long-term prepayment projections assuming different amounts of shift in interest rates.

Mortgage-backed securities are securities backed by a pool of mortgage loans.

1. Mortgage passthrough securities;

2. Collateralized mortgage obligations;

3. Stripped mortgage-backed securities.

The last two types are called *derivative mortgage-backed* securities since they are created from the first type.

MBS versus fixed income investments

- Virtually no default risk since the mortgages in a pool are guaranteed by a government related agency, such as GNMA (Government National Mortgage Association) or FNMA (Federal National Mortgage Association).
- Prepayment risk

  Prepayment privileges given to the householder to put the mortgage back to the lender at its face value.

How is the Option-adjusted-spread (OAS) determined?

- OSA analysis evaluates the cash flows for an MBS based on thousands of different interest rate scenarios. Starting with certain prepayment assumptions, each different interest rate path is converted into a prepayment scenario. For example, if market rates drop 100 bps, what percentage of borrowers will refinance in a given month.
- A value for the security is derived by discounting the theoretical cash flows to the present and averaging them.

Numerical techniques: lattice tree to generate the various interest rate scenarios.

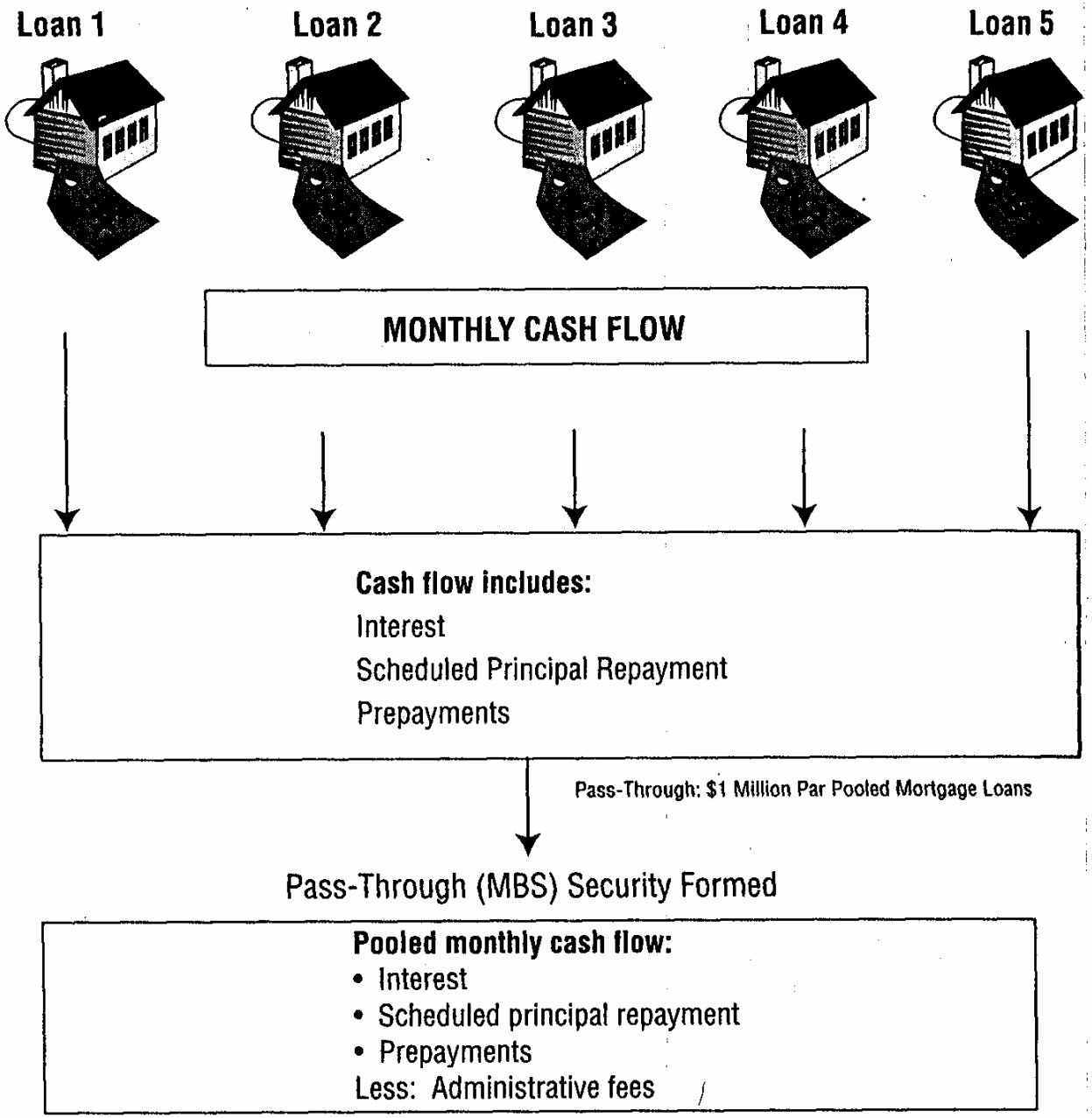
Mortgage passthrough securities

- A mortgage passthrough security is a security created when one or more holders of mortgages form a pool of mortgages and sell shares or participation certificates in the pool.

- The cash flows consists of monthly mortgage payments representing interest, the scheduled repayment of principal, and any prepayments.

- Payments are made to security holders each month. The monthly cash flows for a passthrough are less than the monthly cash flows of the underlying mortgages by an amount equal to servicing and other fees.

- Not all of the mortgages that are included in the pool that are securitized have the same mortgage rate and the same maturity. A weighted average coupon rate and a weighted average maturity are determined.



How a Pass-Through Security Is Created

Senior / subordinated structures

- The subordinated class is the first-loss piece absorbing all losses on the underlying collateral, thus protecting the senior class.

- The senior class is giving up yield to the subordinated class holders.

Example

$100 million deal divided into

$92.25 million senior class

$7.75 million subordinated class

Suppose there is $10 million of losses, the subordinated class experiences $7.75 million of losses (100% loss) and the senior class experiences a loss of $2.25 million (2.4% = $2.25 / $92.25 loss).

Contraction risk

Suppose an investor buys a 10% coupon Ginnie Mae at a time when mortgages are 10%. What would be the impact on prepayments if mortgage rates decline to 6%.

- The price of an option free bond will rise, but in the case of passthrough security the rise in price is less because there is a higher prepayment. The upside price potential is truncated due to prepayments. The cash flows from prepayments are reinvested at a lower rate.

Expansion risk

What happen if the mortgage rates rise to 15%?

- The price of the passthrough, like the price of any bond, will decline.

- It declines more because the higher rates will tend to slow down the rate of prepayment, in effect increasing the amount invested at the coupon rate, which is lower than the market rate.

Collateralized mortgage obligations

A collateralized mortgage obligation is a debt instrument collateralized by mortgage passthrough certificates. The cash flows (interest and principal) are directed to different bond classes, called tranches so as to mitigate different forms of prepayment risk.

This is known as

"distribution based on the waterfall".

Remarks

- The creation of a CMO *cannot eliminate prepayment risk*. It can only redistribute prepayment risk among different classes of bond holders.

- CMO class has a different coupon rate from that for the underlying collateral, resulting in instruments that have varying risk-return characteristics that fit the needs of fixed-income investors.

- Suppose investors have different preferred maturities, so they should be willing to pay different prices for securities of different expected maturities.

Sequential-pay tranches

Total par value of $400 million

Tranche	Par amount	coupon rate (%)
A	$194,500,000.00	7.5
B	$36,000,000.00	7.5
C	$96,500,000.00	7.5
D	$73,000,000.00	7.5
	$400,000,000.00	

Rules

- Tranche A receives all the principal payments until the entire principal amount owed to that bond class, $194,500,000 is paid off; then tranche B begins to receive principal and continues to do so until it is paid the entire $36,000,000.
- Each tranche receive interest on the respective class's outstanding balance

Five-Tranche Sequential-Pay Structure with Floater, Inverse Floater, and Accrual Bond Classes*

Tranche	Par Amount	Coupon Rate (%)
A	$194,500,000.00	7.50
B	$36,000,000.00	7.50
FL	$72,375,000.00	1-month LIBOR + 0.50
IFL	$24,125,000.00	28.50 – 3 × (1-month LIBOR)
Z (accrual)	$73,000,000.00	7.50
	$400,000,000.00	

* The interest for the *accural tranche* would accrue and be added to the principal balance (like zero-coupon bond). The interest that would have been paid to the accural bond class is used to speed up pay down of the principal balance of earlier bond classes.

Payment rules

For disbursement of principal payments:

- Disburse principal payments to tranche A until it is paid off completely.
- After tranche A is paid off completely, disburse principal payments to tranche B until it is paid off completely.
- After tranche B is paid off completely, disburse principal payments to tranches FL and IFL until they are paid off completely.
- The principal payments between tranches FL and IFL should be made in the following way: 75% to tranche FL and 25% to tranche IFL.
- After tranches FL and IFL are paid off completely, disburse principal payments to tranche Z until the original principal balance plus accrued interest is paid off completely.

Payment rules

For payment of periodic coupon interest:

- Disburse periodic coupon interest to tranches A, B, FL, and IFL on the basis of the amount of principal outstanding at the beginning of the period.

- For tranche Z, accrue the interest based on the principal plus accrued interest in the preceding period.

- The interest for tranche Z is to be paid to the earlier tranches as a principal paydown.

- There is a cap on FL and a floor on IFL. The maximum coupon rate for FL is 10% ; the minimum coupon rate for IFL is 0%. The factor 3 in IFL is called the coupon leverage.

Why CMO are popular?

1. The CMO converts a long-term monthly payment instrument into a series of semi-annual payments, which are bond-like securities with short, intermediate and long maturities.

2. The multiple-maturity structure reduces the degree of uncertainty of cash flows for any particular maturity class, and provides the longer maturity classes with limited call protection. This is because shorter tranches absorb the initial burden of excess principal repayments.

3. Investors are attracted by the broader range of investment maturities made possible by the CMO structure. For example, insurance companies purchase heavily in the 4-6 year life tranche. Pension funds have been active in the longer tranche sector.

4. Credit quality
   The high quality of the collateral (GNMA etc.) along with the protective structure of the trust, enables these securities to generally carry the highest investment grade credit rating.

5. Yield
   Offer investors attractive yield premiums over Treasury and even some corporate bonds.

6. Event risk
   CMO are essentially free from default risk. They are also free from events that cause price fluctuations in the corporate world.

Valuation of the tranches

CMO is the unbundling of traditional mortgage-backed securities into short tranche cash flows and long tranche cash flows. The market yield of a bundled bond is the weighted average of the yields for the two tranches.

- Steeper yield curves (wider spread between the long-term and short-term interest rates) and greater prepayment risk enhance the value of of the CMO security relative to the comparable GNMA (Government National Mortgage Association) pass-through.

- Each 100 basis points increase in the steepness of the yield curve is found to provide 14 basis points increase in CMO's weighted yield

Stripped mortgage backed securities

They are created by altering the distribution of principal and interest from a pro rata distribution to an unequal distribution. For example, all the interest is allocated to the *IO class* (interest only) and all the principal to the *PO class* (principal only).

- PO securities are purchased at a substantial discount from par value. The faster the prepayments, the higher the yield the investor will realize.

- IO investors want prepayments to be slow. This is because when prepayments are made, the outstanding principal declines, and less dollar interest is received.

Five Tranche Sequential Pay with an Accrual Tranche and an Interest-Only Tranche

Tranche	Par Amount	Coupon rate (%)
A	$194,500,000.00	6.00
B	$36,000,000.00	6.50
C	$96,500,000.00	7.00
Z	$73,000,000.00	7.25
IO	$52,566,667 (notional)	7.50
	$400,000,000.00	

For the IO class, there is no par amount. The amount shown is the amount on which the interest payments will be determined. This is called the notional amount.

Notional amount for 7.5% IO

$$= \frac{\text{tranches par value} \times \text{excess interest}}{0.075}.$$

Tranche	*Par Amount*	*Excess Interest (%)*	*Notional Amount for a 7.5% Coupon Rate IO*
A	$194,500,000.00	1.50	$38,900,000
B	$36,000,000.00	1.00	$4,800,000
C	$96,500,000.00	0.50	$6,433,333
Z	$73,000,000.00	0.25	$2,433,333
	Notional amount for 7.5% IO		$52,566,667

Payment rules

For payment of periodic coupon interest:

- Disburse periodic coupon interest to tranches A, B, and C on the basis of the amount of principal outstanding at the beginning of the period. For tranche Z, accrue the interest based on the principal plus accrued interest in the preceding period. The interest for tranche Z is to be paid to the earlier tranches as a principal pay down. Disburse periodic interest to the IO tranche based on the notional amount at the beginning of the period.

Payment rules

For disbursement of principal payments:

- Disburse principal payments to tranche A until it is paid off completely.
- After tranche A is paid off completely, disburse principal payments to tranche B until it is paid off completely.
- After tranche B is paid off completely, disburse principal payments to tranche C until it is paid off completely.
- After tranche C is paid off completely, disburse principal payments to tranche Z until the original principal balance plus accrued interest is paid off completely.

Impact of mortgage rates

IO in stripped mortgage back securities

- The value increases monotonically with rate increase since interest payments increase.

PO in stripped mortgage backed securities

- The value decreases monotonically with rate increase since future cash flows to be received has less present value.

Valuing MBS using Monte Carlo simulation

- Generate random interest rate paths by taking as input today's term structure of interest rates and a volatility assumption.
- Prepayments are projected by feeding the refinancing rate and loan characteristics into a prepayment model. Given the projected prepayments, the cash flow along an interest rate path can be determined.

  The simulation works by generating many scenarios of future interest rate paths. An estimate of the value of the MBS is the average of the sample values over many simulation trials.