Mortgage-Backed Sector of the Bond Market

LEARNING OUTCOMES

1. Mortgage Loan:
    a. cash flow characteristics of a fixed-rate,
    b. level payment, and
    c. fully amortized mortgage loan;
2. Mortgage Passthrough Securities:
    a. investment characteristics,
    b. payment characteristics, and
    c. risks;
3. Prepayment amount calculation on a mortgage passthrough security for a month, given the single monthly mortality rate;
4. Compare the conditional prepayment rate (CPR) with the Public Securities Association (PSA) prepayment benchmark;
5. Explain why the average life of a mortgage-backed security is more relevant than the security's maturity;
6. Explain factors that affect prepayments and the types of prepayment risks;
7. Explain how a collateralized mortgage obligation (CMO) is created and how it provides a better matching of assets and liabilities for institutional investors;
8. Distinguish among the sequential pay tranche, the accrual tranche, the planned amortization class tranche, and the support tranche in a CMO;
9. Evaluate the risk characteristics and relative performance of each type of CMO tranche, given changes in the interest rate environment;
10. Explain investment characteristics of **stripped mortgage-backed securities**;
11. Compare agency and nonagency mortgage-backed securities;
12. Compare credit risk analysis of commercial and residential nonagency mortgage-backed securities;
13. Describe the basic structure of a commercial mortgage-backed security (CMBS), and explain the ways in which a CMBS investor may realize call protection at the loan level and by means of the CMBS structure.

Mortgage-Backed Sector of the Bond Market

- Four **important features** of fixed-rate, level payment, fully **amortized mortgage:**

1. The amount of the principal payment increases as time passes.
2. The amount of interest decreases as time passes.
3. The servicing fee also declines as time passes.
4. The ability of the borrower to prepay results in **prepayment risk**. Prepayments reduces the amount of interest the lender receives over the life of the mortgage and cause the principal to be repaid sooner.

Example: A 30-year, $500,000 level payment, fully amortized mortgage with a fixed rate of 12%. Calculate the monthly payment and prepare an amortization schedule for the first three months.

Example: Calculating a mortgage payment

Consider a 30-year, $500,000 level payment, fully amortized mortgage with a fixed rate of 12%. Calculate the monthly payment and prepare an amortization schedule for the first three months.

Answer:

The monthly payment is $5,143.06:

N = 360; I/Y = 1.0 (12/12); PV = –500,000; FV = 0; CPT → PMT = 5,143.06

With reference to the partial amortization schedule in the figure below, the portion of the first payment that represents interest is $5,000.00 (0.01 × $500,000). The remainder of the payment, $143.06 ($5,143.06 – $5,000.00), goes toward the reduction of principal. The portion of the second payment that represents interest is $4,998.57 (0.01 × $499,856.94). The remaining $144.49 ($5,143.06 – $4,998.57) goes toward the further reduction of principal.

Mortgage-Backed Sector of the Bond Market

Monthly Amortization Schedule for a 30-Year, $500,000 Mortgage Loan at 12%

Payment Number	*Initial Principal*	*Monthly Payment*	*Interest Component*	*Reduction of Principal*	*Outstanding Principal*
1	$500,000.00	$5,143.06	$5,000.00	$143.06	$499,856.94
2	499,856.94	5,143.06	4,998.57	144.49	499,712.45
3	499,712.45	5,143.06	4,997.12	145.94	499,566.51

Notice that the monthly interest charge is based on the beginning-of-period outstanding principal. As time passes, the proportion of the monthly payment that represents interest decreases, and, since the payment is level, the proportion that goes toward the repayment of principal increases. This process continues until the outstanding principal reaches zero and the loan is paid in full.

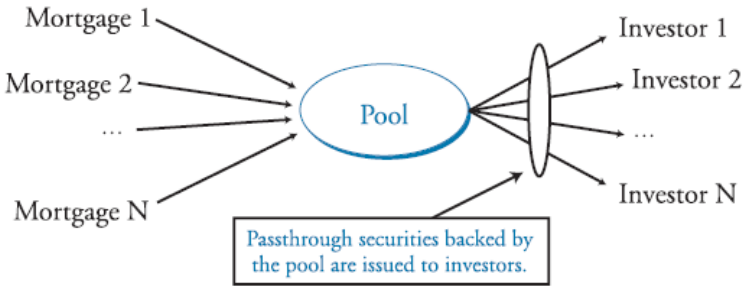
- Scheduled Amortization = Scheduled Principal Repayment
- Prepayments = Payments in excess of the required monthly amount
- Prepayment Risk = prepayments will reduce the amount of interest the lender receives over the life of the loan.
- The likelihood of Prepayment Risk actually occurring is very real.

Mortgage-Backed Sector of the Bond Market

➢ **Mortgage Passthrough Securities:** *investment characteristics, payment characteristics, & risks*

- A claim against a pool of mortgages. Any number of mortgages may be used to form the pool, and any mortgage included in the pool is referred to as a securitized mortgage.

Mortgage Passthrough Cash Flow



- **Weighted Average Maturity (WAM)** of the pool = the weighted average of all the mortgages in the pool, each weighted by the relative outstanding mortgage balance to the value of the entire pool.
- **Weighted Average Coupon (WAC)** of the pool = the weighted average of the mortgage rates in the pool.
- The coupon rate on the passthrough (called ***Passthrough Rates***) < the average coupon rate of the underlying mortgages
- **Securitization** = passthrough securities are traded in the secondary market that effectively convert illiquid mortgages into liquid securities

Agency Passthrough Securities in the U.S.

1. ***Ginnie Mae***. Issued by the Government National Mortgage Association (GNMA), an agency of the U.S. government under the Department of Housing and Urban Development. Thus, its guarantee is backed by the full faith and credit of the U.S. government, and there is no credit risk.
2. ***Freddie Mac***. Issued by the Federal Home Loan Mortgage Corporation (FHLMC).
3. ***Fannie Mae***. Issued by the Federal National Mortgage Association (FNMA).

Note that FHLMC and FNMA are not truly government agencies, but *government-sponsored enterprises* originally created by the U.S. government. Thus, a guarantee from Freddie or Fannie is not backed by the full faith of the U.S. government, but they are considered to be of very high credit quality. The most important characteristic of passthrough securities is their

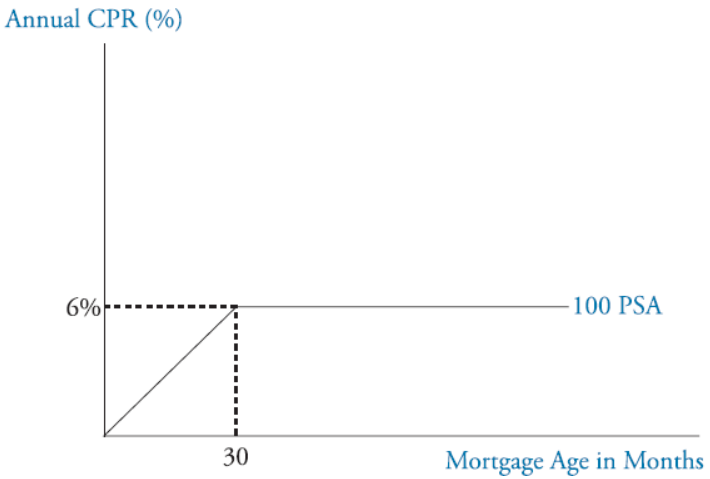
prepayment risk.

➢ The **Cnditional Prepayment Rate** (**CPR**) with the **Public Securities Association** (**PSA**) prepayment benchmark.

- CPR = the annual rate at which a mortgage pool balance is assumed to be prepaid during the life of the pool.
- A mortgage pool's CPR is a function of past prepayment rates and expected future economic conditions.
- The Single Monthly Mortality Rate (**SMM**)a monthly prepayment rate of CPR using the following formula:

$$(1 - CPR) = (1 - SMM)^{12}; \quad \text{Equivalently,} \quad SMM = 1 - (1 - CPR)^{\frac{1}{12}}$$

- The PSA prepayment benchmark assumes that the monthly prepayment rate for a mortgage pool increases as it ages, or becomes seasoned. The PSA benchmark is expressed as a monthly series of CPRs.



- $CPR(x\ month) = \left(\frac{x}{30}\right)6\%$, if $x \leq 30$;
- $CPR(x\ month) = 6\%$, if if $x > 30$

- A particular pool of mortgages may exhibit prepayment rates faster or slower than 100% PSA, depending on the current level of interest rates and the coupon rate of the issue.
- A 50% PSA refers to one-half of the CPR prescribed by 100% PSA, and
- 200% PSA refers to two times the CPR called for by 100% PSA.

Example: Computing the SMM

Compute the CPR and SMM for the 5th and 25th months, assuming 100 PSA and 150 PSA.

Answer:

Assuming 100 PSA:

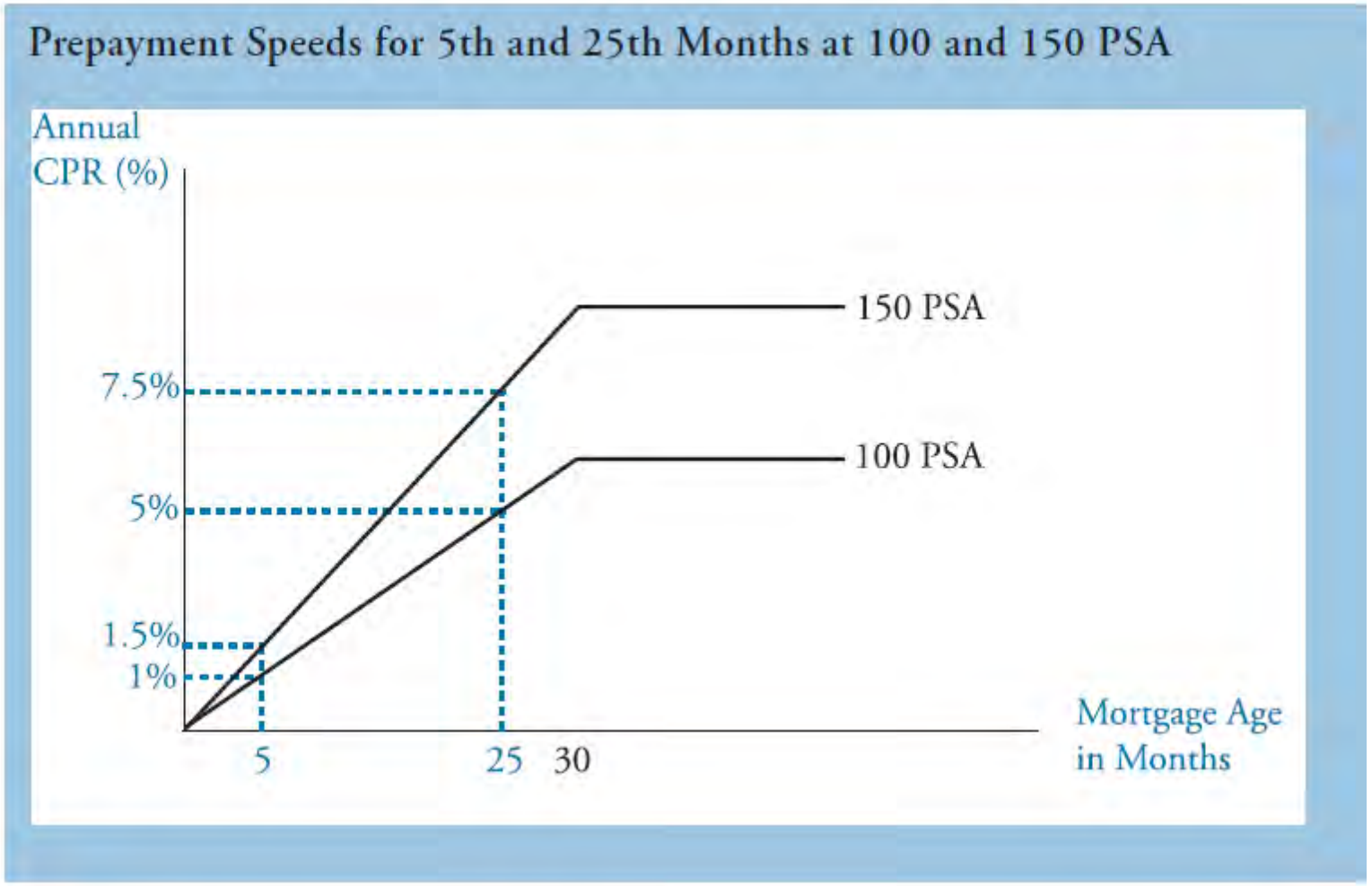
$$\text{CPR}(\text{month } 5) = 5 \times 0.2\% = 1\%$$
$$100 \text{ PSA} = 1 \times 0.01 = 0.01$$
$$\text{SMM} = 1 - (1 - 0.01)^{1/12} = 0.000837$$

$$\text{CPR}(\text{month } 25) = 25 \times 0.2\% = 5\%$$
$$100 \text{ PSA} = 1 \times 0.05 = 0.05$$
$$\text{SMM} = 1 - (1 - 0.05)^{1/12} = 0.004265$$

Assuming 150 PSA:

$$\text{CPR}(\text{month } 5) = 5 \times 0.2\% = 1\%$$
$$150 \text{ PSA} = 1.5 \times 0.01 = 0.015$$
$$\text{SMM} = 1 - (1 - 0.015)^{1/12} = 0.001259$$

$$\text{CPR}(\text{month } 25) = 25 \times 0.2\% = 5\%$$
$$150 \text{ PSA} = 1.5 \times 0.05 = 0.075$$
$$\text{SMM} = 1 - (1 - 0.075)^{1/12} = 0.006476$$


Prepayment Speeds for 5th and 25th Months at 100 and 150 PSA
Annual
CPR (%)
150 PSA
100 PSA
7.5%
5%
1.5%
1%
5
25
30
Mortgage Age
in Months

➢ Calculate the Prepayment Amount

The estimated prepayment for any month m can be expressed as:

Prepayment_m = SMM_m x (mortgage balance at beginning of month *m* – scheduled principal payment for month *m*)

Example: Calculating prepayment amount

Assume that you have invested in a mortgage pool with a $100,000 principal balance outstanding at the beginning of the 25th month. The scheduled monthly principal payment for month 25 is $28.61. Borrowing from the previous example, the CPR and SMM, assuming 100 PSA, are 5% and 0.4265%, respectively. Compute the prepayment for the 25th month.

Answer:

This means that 0.4265% of the pool balance, less scheduled payments, will be prepaid this month. So the estimated prepayment amount is:

$$\text{Prepayment}_{25} = (0.004265)(\$100{,}000 - \$28.61) = \$426.38$$

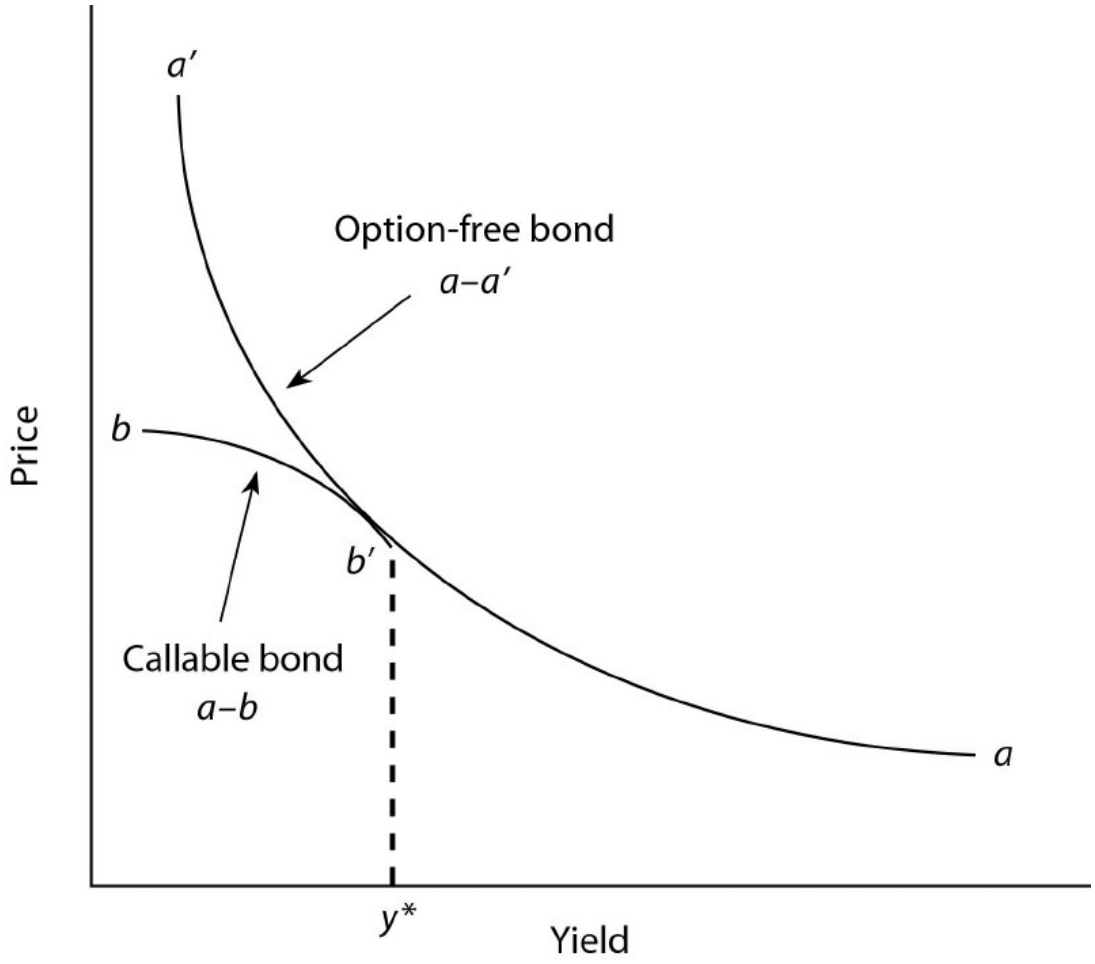
➢ **The Factors that affect prepayments**:

1. ***Prevailing mortgage rates*** affect prepayments by influencing the:
   a. *Spread between the current mortgage rate and the original mortgage rate*. This is the most important factor. If a homeowner is holding a high interest rate mortgage and current mortgage rates fall, the incentive to refinance is large.
   b. *Path of mortgage rates*. The path that mortgage rates follow on their way to the current level will affect prepayments today. Consider a mortgage pool that was formed when rates were 12%, then interest rates dropped to 9%, rose to 12%, and then dropped again to 9%. Many homeowners will have refinanced when interest rates dipped the first time. On the second occurrence of 9% interest rates, most homeowners in the pool who were able to refinance would have already taken advantage of the opportunity. This tendency is called refinancing burnout.

2. ***Housing turnover*** increases as rates fall and housing becomes more affordable. This increases refinancing and prepayments. Housing turnover is also higher when economic growth is higher. As the level of general economic activity rises, personal income increases, and workers move to pursue career opportunities. The result is an increase in housing turnover and mortgage prepayments.

3. Two particular ***characteristics of the underlying mortgages*** also affect the level of prepayments: seasoning (i.e., the age of the loan) and property location. Prepayments are low for new mortgages but increase as the loan seasons (the PSA benchmark reflects this idea). Local economics also influence prepayments, which tend to be faster in some parts of the country and slower in others.

Negative Convexity



➢ Types of Prepayment Risk

1. ***Contraction Risk*** refers to the shortening of the expected life of the mortgage pool due to falling interest rates and higher prepayment rates. There are two undesirable consequences for passthrough investors when interest rates decline:

   a. First, MBS exhibit **negative convexity** as rates decline due to the embedded call option granting the mortgage borrower the right to prepay. Hence, the upside price potential of passthrough securities is restricted, because investors receive principal sooner than expected (like a callable bond).

   b. The second undesirable outcome is **reinvestment rate risk**. Declining interest rates stimulate prepayments resulting in the earlier-than-expected receipt of principal. This means that investors are faced with having to reinvest at relatively lower rates.

2. ***Extension risk*** is associated with interest rate increases and falling prepayment rates. Bond prices typically fall when interest rates rise. With passthroughs, the accompanying decrease in prepayments compounds this price decline, because the timing of the passthrough cash flows is extended further than originally expected (i.e., the duration of the bond is extended). This is undesirable for mortgage investors, particularly short-term investors, because they would prefer to recapture their principal as soon as possible and reinvest at the current higher rates. Essentially, investors' capital must remain invested at the lower rate.

➢ Collateralized Mortgage Obligation (CMO)

- *Demand* for CMO ← Institutional investors have varying degrees of concern about exposure to prepayment risk. Some are primarily concerned with extension risk, while others want to minimize exposure to contraction risk.

- The ability to partition and distribute the cash flows generated by a mortgage pool into different risk packages has led to the creation of collateralized mortgage obligations (CMOs).

- CMO securities can be more closely matched to the unique asset/liability needs of institutional investors and investment managers. It is because CMOs are securities issued against passthrough securities (i.e., they are securities secured by other securities) for which the cash flows have been reallocated to different bond classes called tranches, each having a different claim against the cash flows of the mortgage passthroughs or pool from which they were derived. Each CMO tranche represents a different mixture of contraction and extension risk.

➢ Sequential Pay CMO

To illustrate, consider a simple CMO structure with two tranches in which both tranches receive interest payments at a specified coupon rate, but all principal payments are directed to tranche one until it is completely amortized (the *short tranche*). Principal payments would then accrue to Tranche 2 until it was fully amortized and the underlying pool was exhausted.

Contraction and extension risk still exist with this structure, but they have been redistributed to some extent between the two tranches. The *short tranche*, which matures first, offers investors relatively more protection against extension risk. The other tranche provides relatively more protection against contraction risk.

Sequential Pay CMO Structure (prepayment speed = 150 PSA)

CMO Structure

Tranche	*Outstanding Par Value*	*Coupon Rate*
A	$200,000,000	8.50%
B	50,000,000	8.50%

Month	*Beginning Principal Balance*	*Principal Payment*	*Interest*	*Total Cash Flow = Principal Plus Interest*
1	$250,000,000	$391,128	$1,770,833	$2,161,961
2	249,608,872	454,790	1,768,063	2,222,853
3	249,154,082	518,304	1,764,841	2,283,145
4	248,635,778	581,620	1,761,170	2,342,790
5	248,054,157	644,690	1,757,050	2,401,741
183	$51,491,678	$545,153	$364,733	$909,886
184	50,946,525	540,831	360,871	901,702
185	50,405,694	536,542	357,040	893,582
186	49,869,152	532,287	353,240	885,526
187	49,336,866	528,065	349,469	877,534

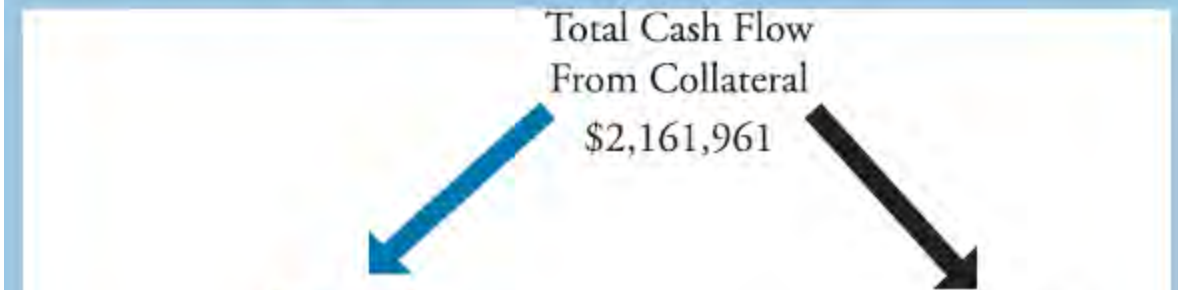
Calculating principal payments:

- Tranche A gets the entire principal payment as well as its share of the interest.
- Tranche B only receives interest.

Tranche A principal payment = $391,128
Tranche A ending principal balance = $200,000,000 – $391,128 = $199,608,872
Tranche A interest = $200,000,000 × (0.085/12) = $1,416,667

Tranche B principal payment = $0
Tranche B ending principal balance = $50,000,000 - $0 = $50,000,000
Tranche B interest $50,000,000 × (0.085/12) = $354,167

Cash Flow to Sequential Pay Tranches: Month 1



Tranche A	$391,128	$1,416,667
Tranche B	$0	$354,167

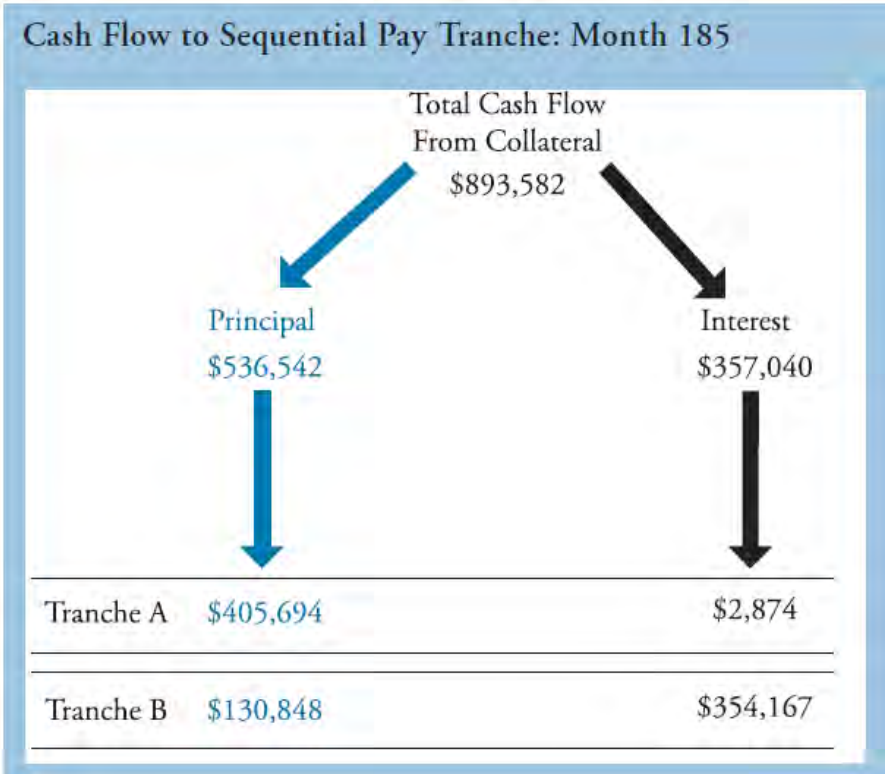
Calculate the principal payments, ending principal balance, and interest payments to each tranche in the 185th month, assuming the principal balance of Tranche A is now $405,694:

185	50,405,694	536,542	357,040	893,582

The total principal payment is $536,542 and the total interest payment is $357,040. Tranche A receives enough principal to pay off its balance, as well as its share of the interest. Tranche B receives the remaining principal as well as its interest.

Tranche A principal payment = $405,694
Tranche A ending principal balance = $405,694 - $405,694 = $0
Tranche A interest = $405,694 × (0.085/12) = $2,874

Tranche B principal payment = $536,542 - $405,694 = $130,848
Tranche B ending principal balance = $50,000,000 - $130,848 = $49,869,152
Tranche B interest $50,000,000 × (0.085/12) = $354,167



- The time period between the first and last principal payments on a CMO tranche is called the **principal pay down window**. The principal pay down window of Tranche A in the previous example is 185 months because the principal balance of Tranche A falls to zero in month 185.

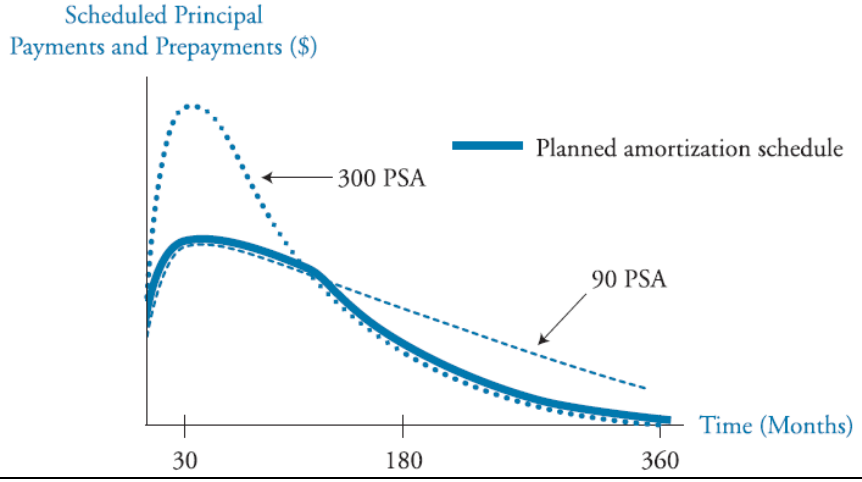
- For many sequential-pay CMO structures, **the last tranche to receive principal also does not receive current interest until the other tranches have been paid off**. This tranche is called the **Z-tranche** or *accrual tranche*, and the securities that represent a claim against its cash flows are called Z-bonds or accrual bonds. The interest that would ordinarily be paid to the accrual tranche is applied against the outstanding principal of the other tranches, in sequence. The diverted interest from the accrual tranche accrues. That is, it is added to the outstanding principal balance of the Z-tranche.

➢ Planned Amortization Class (PAC) CMO

- A PAC is a tranche that is amortized based on a sinking fund schedule that is established within a range of prepayment speeds called the *initial PAC collar*.

- There are two principal repayment schedules associated with a PAC bond, one for the lower prepayment rate and one for the upper rate of the initial PAC collar. PAC bondholders are guaranteed a principal payment that is equal to the lesser amount prescribed by these two repayment schedules. This planned amortization schedule **gives the PAC tranche a highly predictable life**.

Planned Amortization Schedule for PAC Tranche I (an initial collar of 90 PSA to 300 PSA)



- The principal payments at 300 PSA are much higher through the 30 months because of higher prepayments, then decline much more quickly than the 90 PSA after 30 months. After approximately 90 months, principal payments on the 90 PSA begin to exceed the 300 PSA because the higher earlier prepayments under the 300 PSA significantly reduced the outstanding balance. The planned amortization schedule promised to the PAC I tranche is the minimum of the two prepayment speeds.

➢ Support Tranche

- What makes a PAC bond work is that it is packaged with a **support**, or **companion, tranche** created from the original mortgage pool. **Support tranches** are included in a structure with PAC tranches specifically to *provide prepayment protection for the PAC tranches* (each tranche is, of course, priced according to the timing risk of the cash flows).

- The **certainty of PAC bond cash flow** comes **at the expense of increased risk to the support tranches**.

- When **prepayments are slower** than planned, the **average life of the support tranche is extended** in that the PAC tranches have priority claim against the cash flows, principal payments to the support tranches must be deferred until the PAC repayment schedule is satisfied.

- When actual **prepayments come faster** than expected, the support tranches must absorb the amount in excess of that required to maintain the repayment schedule for the PAC. In this case, the **average life of the support tranche is contracted.**

Notice that the prepayment risk protection provided by the support tranches causes their average life to extend and contract. This relationship is such that as the prepayment risk protection for a PAC tranche increases, its average life variability decreases, and the average life variability of the support tranche increases.

➢ Risk Characteristics of CMO Tranches

Prepayment risk encompasses *contraction risk* and *extension risk.*

	mortgage rates	prepayment rates	average life
Contraction risk	***fall***	***faster***	***decrease***
Extension risk	***rise***	***slow***	***increase***

Risk of CMO Tranches

Tranche	*Contraction Risk*	*Extension Risk*
A (sequential pay)	HIGH	LOW
B (sequential pay)	↑	↓
C (sequential pay)		
D (sequential pay)		
Z (accrual)	LOW	HIGH

- The early tranches are protected against extension risk, while the later tranches are protected against contraction risk. The Z bond has low contraction risk, because reinvestment risk is eliminated until the other tranches have paid off.

➢ Stripped Mortgage-Backed Securities

- *traditional passthrough security* is that the interest and principal payments generated by the underlying mortgage pool are allocated to the bondholders on a **pro rata basis**.
- *Stripped mortgage-backed securities* differ in that **principal and interest are not allocated on a pro rata basis**. The unequal allocation of principal and interest results in a price/yield relationship for the stripped securities that is significantly different from that of the underlying passthrough.
- The two most common types of stripped MBS are **principal only (PO) strips** and **interest-only (IO) strips**.

Principal Only (PO) Strips

1. A class of securities that receive only the principal payment portion of each mortgage payment. They are sold at a considerable discount to par.
2. The PO cash flow stream starts out small and increases with the passage of time as the principal component of the mortgage payments grows.
3. The entire par value of a PO is ultimately paid to the PO investor. The only question is whether realized prepayment rates will cause it to be paid sooner or later than expected.

Interest-Only (IO) Strips

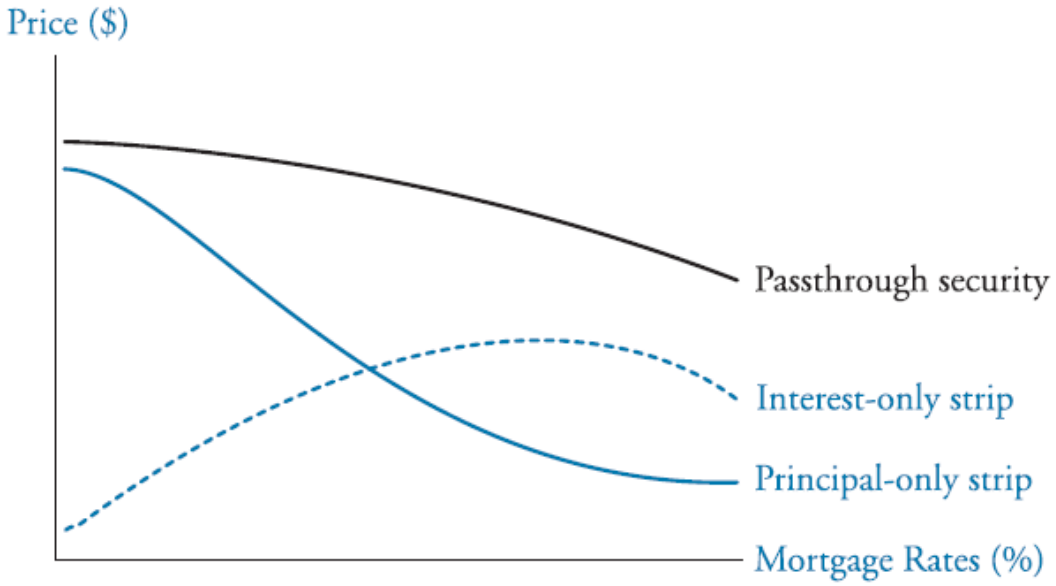
1. A class that receives only the interest component of each payment.
2. IO strip cash flow starts out big and gets smaller over time. Thus, IOs have shorter effective lives than POs.
3. The major risk associated with IO strips is that the value of the cash flow investors receive over the life of the mortgage pool may be less than initially expected and possibly less than the amount originally invested. That is because the amount of interest produced by the pool depends on its beginning-of-month balance. If market rates fall, the mortgage pool will be paid off sooner than expected, leaving IO investors with no interest cash flows.

➢ Investment Characteristics of IOs and POs:

- The investment performance of a **PO** is extremely sensitive to prepayment rates. **Higher prepayment rates** result in a faster-than-expected return of principal and, thus, **a higher return**. Since prepayment rates increase as mortgage rates decline, PO prices increase when interest rates fall. They also exhibit **some negative convexity at low rates**.

- The IO price is positively related to **mortgage rates** at low current rates. When market rates decline below the average mortgage rate in the pool, prepayment rates increase and the principal amount falls. Interest payments to the IO decrease because they are based on the outstanding principal on the underlying pool. The diminished cash flow usually causes the IO price to decline despite the fact that the cash flows are now being discounted at a lower rate. On the other hand, as interest rates rise above the contract rate, the expected cash flows improve. Even though the higher rate must be used to discount these improved cash flows, there is usually a range above the contract rate for which the price increases.

- Both IOs and POs exhibit greater price volatility than the passthrough from which they were derived. This occurs because IO and PO returns are negativelycorrelated (their prices respond in opposite directions to changes in interest rates), but the combined price volatility of the two strips equals the price volatility of the passthrough.



Mortgage-Backed Sector of the Bond Market

➢ Commercial mortgage-backed securities (CMBS)

Commercial mortgage-backed securities (CMBS) are backed by income-producing real estate, typically in the form of:

- ✓ Apartments (multi-family).
- ✓ Warehouses (industrial use property).
- ✓ Shopping centers.
- ✓ Office buildings.
- ✓ Health care facilities.
- ✓ Senior housing.
- ✓ Hotel/resort properties.

These loans are typically originated by conduit organizations (commercial mortgage companies). They negotiate and close commercial real estate loans which are then incorporated into a CMBS.

- The biggest difference between residential and commercial MBS loans is the obligation of the underlying borrower. Residential MBS loans are repaid by homeowners; commercial MBS loans are repaid by real estate investors who, in turn, rely on tenants and customers to provide the cash flow to repay the mortgage loan.

- CMBS mortgages are structured as nonrecourse loans, meaning that the lender can only look to the collateral as a means to repay a delinquent loan if the cash flows from the property are insufficient. In contrast, the residential mortgage lender can go back to the borrower personally in an attempt to collect a delinquent mortgage loan.

- For these reasons, the analysis of CMBS securities focuses on the **credit risk of the property** and not the credit risk of the borrower.

Two key Ratios to assess credit risk

- Debt-to-Service Coverage Ratio (DTSCR) = $\frac{NOI}{Debt\ Service}$;
  - NOI = Net Operating income; is calculated after the deduction for real estate taxes but before any relevant income taxes.
  - Normal Condition: $1 < DTSCR < 2$
  - The borrower is not capable of making the debt payments and is likely to default, if $DTSCR < 1$.

- Loan-to-Value Ratio = $\frac{current\ mortgage\ amount}{current\ appraised\ value}$;
  - Loan-to-value ratios determine the amount of collateral available, above the loan amount, to provide a cushion to the lender should the property need to be foreclosed on and sold.
  - the lower the better for this ratio from the perspective of the lender and the MBS investor.

Creating CMBS-level call protection

- **Prepayment lock out**. For a specific period of time (typically two to five years), the borrower is prohibited from prepaying the mortgage loan.

- **Defeasance**. Should the borrower insist on making payments on the mortgage loan, the mortgage loan can be defeased, which means the loan proceeds are received by the loan servicer and invested in U.S. Treasury securities, essentially creating cash collateral against the loan. Upon completion of the defeasance period, these U.S. Treasuries are liquidated and the proceeds are used to repay the mortgage. Treasuries provide higher-quality collateral than the underlying real estate, so defeased loans increase the credit quality of a CMBS loan pool.

- **Prepayment penalty points**. A penalty fee may be charged if the borrower prepays the mortgage loan. This penalty fee is typically much higher in the early years of the loan (e.g., 5% of the loan amount in the first year) and then steps down over time until it finally disappears after several years. In many cases, this penalty fee is quoted loan in the first year, and 1% of the principal amount if repaid in the fifth year of the mortgage. Beginning in the sixth year of the mortgage, there is no prepayment penalty to the borrower.

- **Yield maintenance charges**. The borrower is charged the amount of interest lost by the lender should the loan be prepaid. This make whole charge makes the lenders indifferent to prepayment, as they are in the same economic position whether the loan is prepaid or not.