# Mortgage Basics II: Payments, Yields, and Values

This presentation builds on the legal structure of mortgages introduced previously, focusing on the quantitative aspects of mortgage analysis. We'll explore how to calculate loan payments, values, and yields, enabling you to design and structure loans effectively and analyze debt investments with confidence.

While the material is technical, modern financial calculators and spreadsheets have eliminated much of the formula memorization and number crunching, allowing us to focus on the underlying economics. These practical skills are essential for borrowers, lenders, and investors alike.

# Abbreviations for Calculating Loan Payments

$L$ = Initial contract principal amount (the loan amount)

$r_t$ = Contract simple interest rate applicable for payment in period $t$

$INT_t$ = Interest owed in period $t$

$AMORT_t$ = Principal paid down in the period $t$ payment

$OLB_t$ = Outstanding principal balance *after* the period $t$ payment has been made

$PMT_t$ = Amount of the loan payment in period $t$

# Four Basic Rules for Calculating Loan Payments

1

## Interest Calculation

The interest owed in each payment equals the applicable interest rate times the outstanding principal balance at the end of the previous period: $INT_t = (OLB_{t-1})\, r$.

2

## Principal Amortization

The principal amortized (paid down) in each payment equals the total payment (net of expenses and penalties) minus the interest owed: $AMORT_t = PMT_t - INT_t$.

3

## Balance Update

The outstanding principal balance after each payment equals the previous outstanding principal balance minus the principal paid down the payment: $OLB_t = OLB_{t-1} - AMORT_t$.

4

## Initial Balance

The initial outstanding principal balance equals the initial contract principal specified in the loan agreement: $OLB_0 = L$.

# Interest-Only Loans: The Simplest Structure

## Key Characteristics

Interest-Only mortgages represent the oldest and most basic pattern of mortgage payments. There is no amortization of principal; the outstanding loan balance remains constant throughout the life of the loan.

The entire original principal is repaid in a single lump-sum "bullet" payment at the loan's maturity date, while regular payments consist purely of interest.

## Advantages & Disadvantages

- Lower regular payments than amortizing loans
- Entire regular payment is tax-deductible
- Maximizes total interest paid over loan life
- Creates repayment spike at maturity
- Forces refinancing or property sale at maturity

# Constant-Amortization Mortgage (CAM)

## Equal Principal Payments

A constant amount of principal is paid down in each loan payment (AMORTt = L/N).

## Declining Payment Pattern

As the loan balance is reduced by a constant amount each period, the interest owed falls by a constant amount as well.

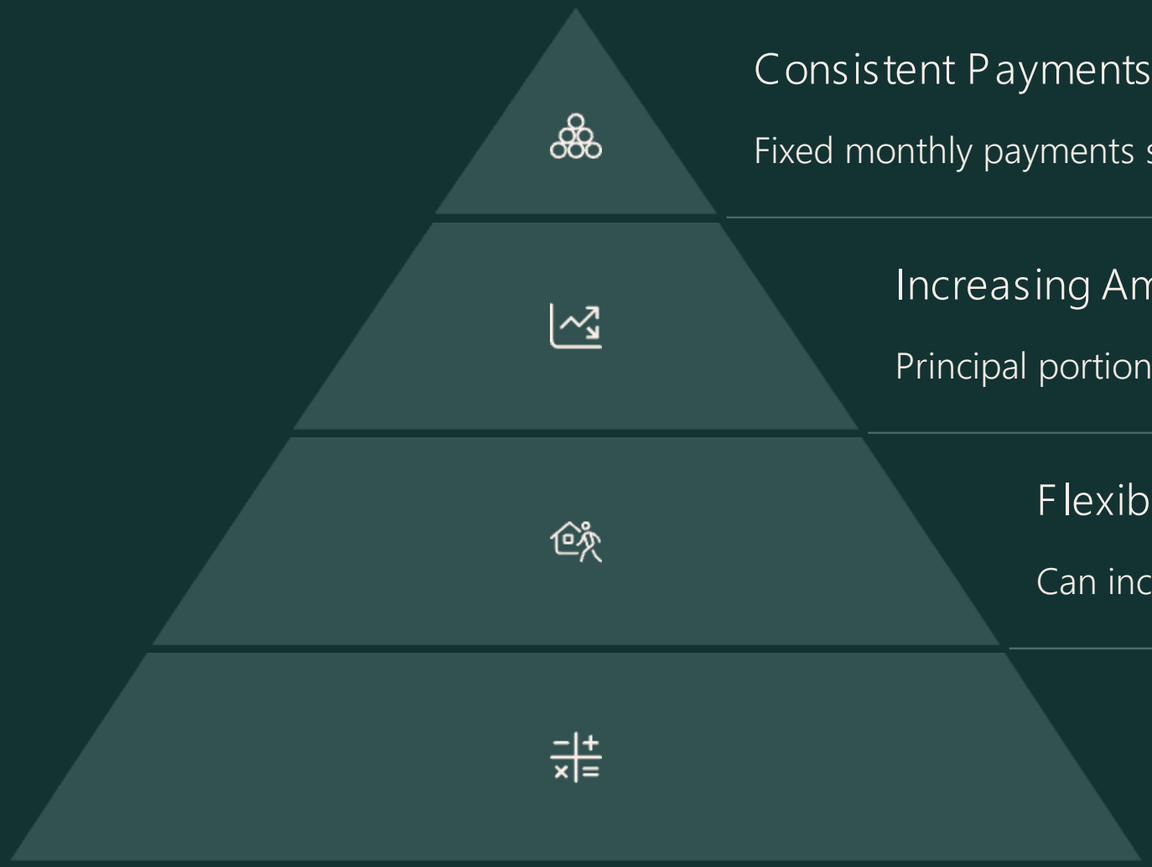
## Historical Context

CAMs were used in the 1930s when interest-only loans caused havoc during the Great Depression and persistent deflation in declining rents and land values. Rarely used today.

## Practical Limitations

The declining payment pattern can be undesirable for both borrowers (high initial payments) and investors (constant reinvestment of capital).

# Constant-Payment Mortgage (CPM): The Classic Solution



### Consistent Payments

Fixed monthly payments simplify budgeting

### Increasing Amortization

Principal portion grows over time

### Flexible Structure

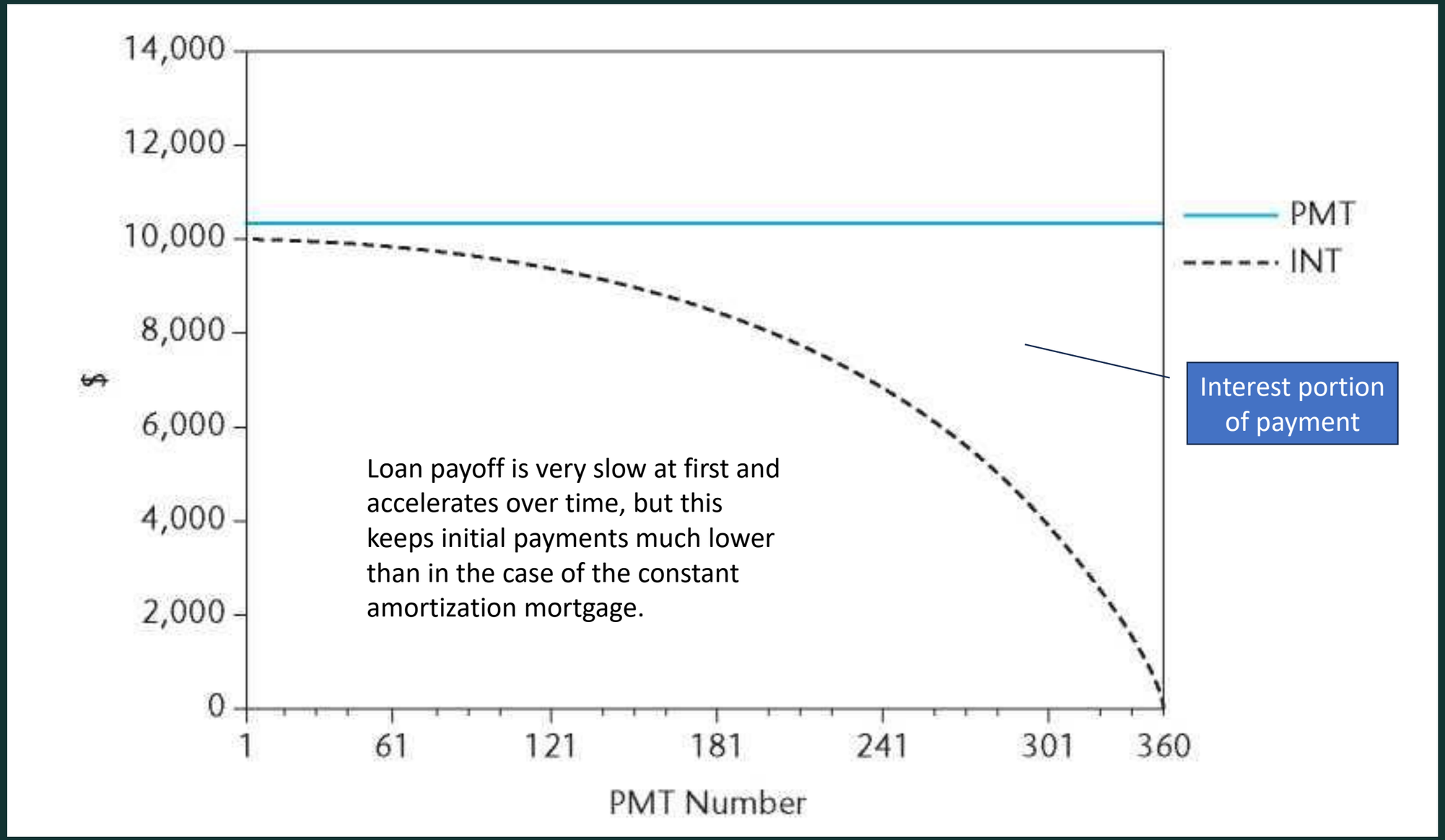
Can include balloon payment options

### Mathematical Foundation

Based on annuity formula

The CPM solves many problems associated with interest-only loans and CAMs. Its consistent payments simplify budgeting for both borrowers lenders, and it better matches typical rent growth patterns in income properties. The CPM offers flexibility in balancing payment levels, amortization rates, and maturity periods.

# Inside the CPM: Slow Initial Principal Reduction



# Adjustable Rate Mortgage (ARM): Sharing Interest Rate

### Periodic Rate Adjustments

The contract interest rate adjusts periodically to changes in prevailing debt market rates, reducing interest rate risk for the lender and potentially lowering initial rates for the borrower.

### Index + Margin Structure

ARMs are typically based on a publicly observable index (like U.S. Treasury bonds) plus a constant margin to reflect greater default risk. The index must not be be subject to manipulation by the lender.

### Yield Curve Advantage

ARMs offer particular advantages when a steeply upward-sloping yield curve prevails in the bond market, allowing borrowers to access rates based on the short-term end of the yield curve.

# ARM Payment Calculation Process

## Initial Rate Setting

The ARM begins with an initial interest rate, which may be a "teaser rate" below the fully indexed rate to attract borrowers.

## Adjustment Interval

At predetermined intervals (often annually), the rate adjusts based on the current value of the index plus the margin.

## Payment Recalculation

The new payment is calculated using the updated rate, remaining loan balance, and remaining amortization period.

## Ongoing Adjustments

This process repeats throughout the loan term, creating a payment pattern that reflects market interest rate movements.

# ARM vs. Fixed Rate: Risk and Return Tradeoffs

## ARM Advantages

- Lower initial interest rate and payment
- Rate decreases automatically when market rates fall
- May be appropriate when planning to sell/refinance before first adjustment
- Can benefit from falling interest rate environments

## ARM Disadvantages

- Payment uncertainty makes budgeting difficult
- Payments can increase substantially if rates rise
- Applicable rate may exceed fixed rate at some point
- Prepayment option less valuable than in FRMs

# Customized Loan Structures

## Creative Design

With spreadsheets and the four basic rules, rules, you can develop your own loan and payment patterns.

## Financial Engineering

Combine elements of different loan types to meet specific needs.

## Negotiation Opportunity

Commercial mortgage business is less standardized and often allows more customization.

## Special Situations

Particularly useful for unique properties or investment circumstances like developments and turnarounds.

# Understanding Mortgage Yields

## Yield-to-Maturity (YTM)

The internal rate of return (IRR) computed over the full remaining potential life of the loan, assuming no prepayment.

## Contract Rate vs. YTM

The YTM will differ from the contract interest rate whenever the cash flow differs from the outstanding loan balance.

## Market Value Impact

In the secondary market, YTM reflects the market value regardless of par value or contractual interest rate.

# Computing Mortgage Yields

## Basic YTM Calculation

For a standard loan with no fees, the YTM equals the contract interest rate. For example, a $1 million, 30-year CPM with an 8% annual interest rate would have monthly payments of $7,337.65, and its YTM would be 8%.

## Impact of Origination Fees

With a 1% origination fee (or discount point), the lender disburses only $990,000 on a $1 million loan. This increases the YTM to 8.11%, or 11 basis points over the stated contract rate.

## Secondary Market Effects

If market yields drop and the loan sells for $1,025,000 in the secondary market, the buyer's YTM would be 7.74%, reflecting the premium paid over the par value.

# Factors Affecting Effective Yield

## Contract Rate

The stated interest rate in the loan agreement


## Origination Fees

Points and fees paid upfront

## Prepayment Horizon

Expected time until loan is paid off

## Default Risk

Probability of borrower non-payment

## Prepayment Penalties

Fees for early loan repayment

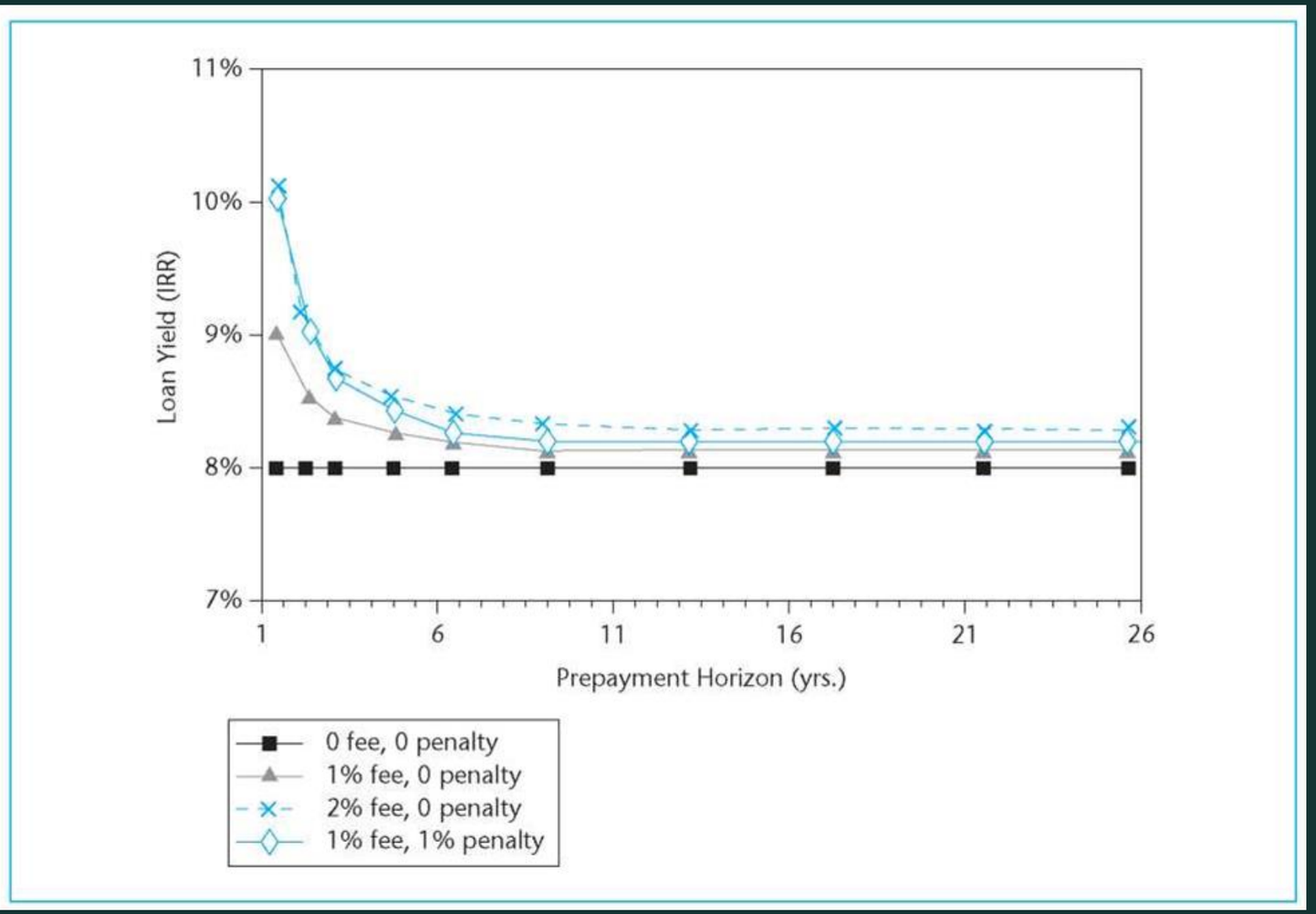
# The Impact of Prepayment on Loan Yield

| Prepayment Horizon (yrs.) | 1 | 2 | 3 | 5 | 10 | 20 | 30 |
|---|---|---|---|---|---|---|---|
| 0% fee, 0 penalty | 8.00% | 8.00% | 8.00% | 8.00% | 8.00% | 8.00% | 8.00% |
| 1% fee, 0 penalty | 9.05% | 8.55% | 8.38% | 8.25% | 8.15% | 8.11% | 8.11% |
| 2% fee, 0 penalty | 10.12% | 9.11% | 8.77% | 8.50% | 8.31% | 8.23% | 8.21% |
| 1% fee, 1% penalty | 10.01% | 9.01% | 8.67% | 8.41% | 8.21% | 8.13% | 8.11% |

The shorter the prepayment horizon, the greater the effect of disbursement discounts on the realistic yield of the mortgage. The effect is hyperbolic, not linear, with much greater impact on yield the shorter the prepayment horizon.

For example, with one point of disbursement discount, the yield would be 8.25% over a five-year horizon, or 8.55% over a two-year horizon. Prepayment penalties cause a similar (though slightly smaller) effect.

# The Impact of Prepayment on Loan Yield

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# Why Points and Fees Exist

### Broker Compensation

In the commercial mortgage industry, origination fees often compensate mortgage brokers who find and filter loan applications for financial institutions.

### Administrative Cost Recovery

Loan originators face overhead and administrative costs that differ from the opportunity cost of capital. While capital costs accrue over the loan life, administrative costs are sunk at origination.

### Prepayment Disincentive

Up-front fees provide some disincentive against early prepayment of the loan by the borrower due to the hyperbolic relation between yield and prepayment horizon.

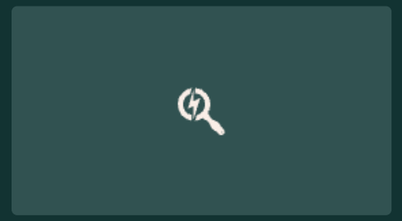
### Payment Level Trade-off

Greater origination fees and discount points allow lower regular loan payments for the same yield, creating the familiar mortgage menu offered by lenders.

These choices below all provide the same 10- year 8.15% yield to the lender.

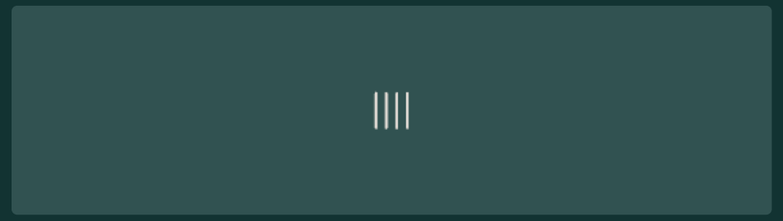
| Discount Points | Interest Rate | Monthly Payment |
|---|---|---|
| 0 | 8.15% | $7,444.86 |
| 1 | 8.00% | $7,337.65 |
| 2 | 7.85% | $7,230.58 |
| 3 | 7.69% | $7,124.08 |

# Using Yields to Value Mortgages



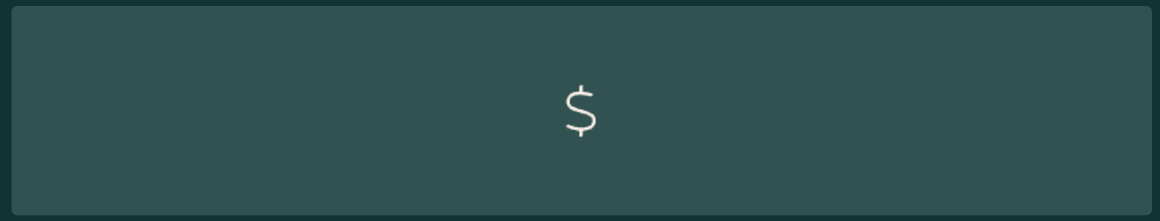
### Identify Market Yield

Determine the appropriate yield for similar loans in the current market



### Apply DCF Valuation

Discount the loan's cash flows using the market yield



### Determine Market Value

The resulting present value represents the loan's market worth

For a given loan with specified contractual future cash flows, a given yield will correspond to a certain price, and vice versa. Yields become a convenient way to measure and quote mortgage prices in the debt market. By applying the relevant market yield to a given mortgage, you can determine its market value.

# Mortgage Valuation Example

$1M

Loan Amount

30-year amortization, 10-year maturity

8%

Contract Rate

Fixed interest rate

7.5%

Market Yield

Current required return

$1.03M

Market Value

Premium over par value

This example shows how a $1 million, 8% loan with monthly payments of $7,337.65 would be valued at $1,033,509 if the market yield at that time is 7.5%. This premium reflects the fact that the loan's contract rate exceeds the current market yield.

Conversely, if the market yield were 8.5%, the loan would be worth only $967,888, requiring 3.2112 points of prepaid interest or origination fees to make up the difference.

# The Refinancing Decision

## Evaluate Current Loan

Calculate remaining payments and outstanding balance

## 2 Determine Market Rate

Find current yield for comparable new loans

## 3 Calculate NPV

Compare value of old liability to cost of paying it off

## Make Decision

Refinance if NPV is significant and positive after transaction costs

# Traditional Refinancing Calculation

### Step 1: Calculate Liquidating Payment

Determine the outstanding balance plus any prepayment penalty required to pay off the existing loan.

### Step 2: Determine Opportunity Cost

Calculate the yield on a new loan over the remaining maturity of the old loan, including any origination fees.

### Step 3: Calculate Present Value

Compute the present value of the old loan's remaining cash flows using the opportunity cost as the discount rate.

### Step 4: Compute NPV

Subtract the liquidating payment from the present value of the old loan, then deduct transaction costs.

This approach views refinancing fundamentally as a decision about whether to exercise the old loan's prepayment option. It doesn't matter whether the old loan would be paid off with capital from a new loan, additional equity, or some combination - the analysis focuses on comparing the current liability value with the cash required to pay it off.

# Prepayment Option Value: What Traditional Analysis Misses


Traditional refinancing analysis ignores the value of the prepayment option in the existing loan. This option has positive value to the borrower and is extinguished when exercised. The loss of this option is therefore a cost that should be considered.

In practice, a simple rule of thumb is that when yields on new loans get to around 200 basis points below the interest rate on the old loan, prepayment likely makes sense. However, with little remaining maturity or expectations of further rate decreases, it may still be better to wait. Conversely, with long remaining maturity or if rates are likely at their bottom, refinancing may make sense even with less than a 200 basis point differential.