**Mortgage Backed Securities**

Fixed-Rate, Level-Payment, Fully Amortized Mortgage

Payments due on the 1st of each month

Interest payments made in arrears

Each monthly payment consists of:

1. Interest of 1/12 of the fixed annual interest rate (monthly rate – since annual rate is given as APR) times the amount of the outstanding mortgage balance at the beginning of the previous month
2. A repayment of a portion of the outstanding mortgage balance (principal).

Look at the Excel Spreadsheet “Loan Amortization in Excel” to see how payments are calculated and the loan amortizes.

Servicing Fee (Servicing Spread)

A portion of the mortgage rate paid to the institution that collects the payments, sends out notices, etc.

Typically 50 BP

Since it is a percentage of the outstanding balance, it declines over time as the principal is paid down.

Prepayment Risk – The risk that the homeowner will repay the principal faster than the scheduled payments (no prepayment penalty) and thus alter the expected cash flow and reduce the rate of return for the investor. Prepayments will come from:

1. Making unscheduled payments of principal
2. Refinancing the mortgage

Mortgage Passthrough Securities – security created when one or more holders of mortgages form a pool of mortgages and sell shares in the pool (similar to a mutual fund).

The cash flow of any passthrough security depends on the cash flow of the underlying pool of mortgages.

Payments to security holders are made monthly.

Coupon Rate on passthrough = Passthrough Rate < Mortgage Rate due to servicing and other fees.

Mortgages in a pool will have different mortgage rates and maturities

WAC = Weighted Average Coupon Rate = weighted average of the mortgage rates (interest rates on the mortgages) in the pool weighted by the outstanding mortgage balances.

WAM = Weighted Average Maturity = weighted average of the number of months to maturity for each mortgage in the pool weighted by the outstanding mortgage balances.

Passthrough prices are quoted the same as U.S. Treasury Notes and Bonds: 98:16 = 98 16/32% of par value = 98.5% of par value.

Pool factor = percentage of initial mortgage balance still outstanding.

Dollar Price = Quoted Price x Par Value x Pool Factor

Example: $1 million par value passthrough pool with a pool factor of 80 and a quoted price of 95:20 will be $765,000

Prepayment Rate

Never known in advance

Must make some projections to estimate cash flows

**SMM** = Single Monthly Mortality Rate

Prepayment in month t .

Beginning mortgage balance for month t – Scheduled principal payment in month t

The SMM tells us what percentage of the outstanding mortgage balance which was available to prepay in month t actually did prepay in month t.

**CPR** = Conditional Prepayment Rate = Annualized SMM

CPR = 1 – (1 – SMM)12 and thus SMM = 1 – (1 – CPR)1/12

Note that CPR will be less than (SMM)(12) because when it is reduced each month, it is a percentage of a smaller amount. This is the opposite of how we normally think of compounding (percentage of a bigger amount each month).

**PSA** Prepayment Benchmark – result of a study in 1980s of prepayment patterns in residential mortgages.

A series of SMMs over the life of the mortgage

Assumes low prepayment rates when mortgage is new and higher as they age

100 PSA assumes:

If t < 30 then CPR = 6% (t/30)

If t > 30 then CPR = 6%

where t is the number of months since the mortgages were originated (months seasoned).

Example: WAM is currently 357 months, so t = 3 months. 100 PSA

Two months from now, t = 5 and CPR = 6% (5/30) = 1% = .01

SMM = 1 – (1-.01)1/12 = .000837 = .0837%

Meaning that it is projected that .0837% of the principal available for prepayment will be prepaid that month.

Slower or faster projections of prepayments are expressed as a percentage of PSA.

150 PSA means 1.5 times the CPR of the PSA prepayment benchmark.

Note that we multiply CPR by 1.5, not SMM.

Example from above at 165 PSA:

Two months from now, t = 5 and CPR = 6% (5/30) = 1% = .01

165 PSA = 1.65(.01) = .0165

SMM = 1 – (1-.0165)1/12 = .001386 = .1386%

Meaning that it is projected that .1386% of the principal available for prepayment will be prepaid that month instead of .0837% as was projected at 100 PSA.

**Average Life** – average time to receipt of principal payments (scheduled principal payments and projected prepayments)

Average Life = Σ (t) (Projected principal received at time t)

(12) (Total principal)

Average Life is a similar concept to duration.

Average life is dependent on prepayment assumption. If PSA increases (gets higher), mortgages are projected to be paid off more quickly and the average life will shorten. With a lower PSA, you get a longer average life.

Look at Passthrough Cash Flow Example in Excel.

This shows how a prepayment assumption impacts the cash flow and the average life for a passthrough

Factors Affecting Prepayment Behavior

1. Prevailing Mortgage Rate – if it is significantly below the rate paid by the homeowner, there is incentive to refinance.
2. Housing Turnover – if you move out of your home, you pay off the mortgage
3. Characteristics of the underlying residential mortgage loans – the region of the country the loans come from and the seasoning (age) of the mortgages are a couple.

Two Forms of Prepayment Risk

1. Contraction Risk – If interest rates go down.

This increases the incentive for the borrower to refinance or pay down the mortgage sooner. It also means that the investor will have to reinvest monthly payments at a lower interest rate (reinvestment risk)

1. Extension Risk – If interest rates go up.

The value of any fixed income asset will decline when interest rates rise (interest rate risk). Rising rates will also slow down the rate of prepayments which means the investor will have fewer dollars to reinvest at these higher rates than he had anticipated.

Some investors are more concerned with contraction risk while others are more concerned with extension risk.

**CMOs** – Collateralized Mortgage Obligations alter the cash flows of the securities so as to minimize one type of risk or another.

CMOs redirect the cash flows of passthrough securities to different bond classes, called **tranches**.

CMOs do not eliminate prepayment risk. They redistribute the various forms of this risk.

**Sequential-Pay Tranches** – each class of the bond is retired sequentially.

Divide the par value of the pool among the various tranches (can be allocated in any manner as long as the totals agree)

Make all principal payments to Tranche A until it is completely paid off

After Tranche A is paid off, make all principal payments to Tranche B until it is completely paid off.

After Tranche B is paid off, make all principal payments to Tranche C until it is completely paid off.

Continue through each sequential tranche

Pay monthly coupon interest to each tranche based on the amount of principal outstanding for each tranche at the beginning of the month.

Looking at the same Excel Spreadsheet (also shown in Exhibit 6 pages 276-277 in text), you can see how the distributions are made and how each tranche has a different Average Life.

Remember that this is based on a Prepayment Assumption (given as a percent of PSA). To see how different prepayment rates affect the cash flows, change the PSA assumption on the spreadsheet.

Tranche A is protected against extension risk but has more contraction risk

Tranche D is protected against contraction risk but has more extension risk

The total risk is the same, but now investors can select which risk they want to be exposed to and which they want to be protected from.

**Accrual Tranches** – at least one tranche does not receive current interest.

Z Tranches (accrual tranches) have their interest payments diverted to other tranches in the early years so that the other tranches can have their principal repaid more quickly.

For the Z Tranches, their interest accrues and is added to their principal balance.

Payment Rules:

Pay monthly coupon interest to tranches A, B, and C on the basis of the amount of principal outstanding for them at the beginning of the month.

For Z, accrue the interest based on the principal plus accrued interest in the previous month.

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

Make principal payments to Tranche A until it is completely paid off

After Tranche A is paid off, make principal payments to Tranche B until it is completely paid off.

After Tranche B is paid off, make principal payments to Tranche C until it is completely paid off.

Continue through each sequential tranche until you get to Z.

Make principal payments to Tranche Z until its original principal balance plus accrued interest is completely paid off.

This system will reduce the Average Life for Tranches A, B, and C (all non-Z tranches) and increase the Average Life for Z.

Tranche Z appeals to investors who are more concerned with reinvestment risk since there are no coupon payments to reinvest during the early years.

The second worksheet of the Excel Spreadsheet includes Tranche Z instead of Tranche D.

Note that I haven’t worked out all the formulas for Tranche Z yet, so if you change some of the parameters, it may not work out exactly correct.

**Floating-Rate Tranches** (note that you can’t take LIBOR higher than 9.5% on my spreadsheet)

You can create floating-rate tranches even if you have only fixed-rate mortgages in the pool.

You need both a floating-rate tranche and an inverse floating-rate tranche. They are both carved out of one of the Sequential-Pay tranches (out of Tranche C in our example).

A floating rate security has its coupon rate tied to a benchmark rate so that when the benchmark rate goes up, the security’s coupon rate goes up.

An inverse floater also has its coupon rate tied to a benchmark rate, but when the benchmark rate goes up, the inverse floater’s coupon rate goes down.

The principal payments to both the floater and the inverse floater are determined by the principal payments to the tranche from which it was created.

Example in Spreadsheet:

Par value for floater is $72,375,000

Par value for inverse floater is $24,125,000

Note this is a 3:1 ratio

Coupon rate for the tranche that they were created from (Tranche C) is 7.5%

The coupon formula for the floater is 1-month LIBOR plus 50 bp.

If LIBOR is 3.75%, floater will receive (.0425/12) (Outstanding Balance of original $72,375,000)

Note that the outstanding balance will decrease each month as it does with any mortgage

The coupon formula for the inverse floater is K – [L (1-month LIBOR)]

K = inverse floater interest when reference rate for floater is zero

Principal for inverse floater

K is the cap (maximum coupon) rate for the inverse floater. Since the interest paid to the tranche from which these two sub-tranches came from must be equal to the interest paid to the floater plus the interest paid to the inverse-floater, and since the 1-month LIBOR benchmark can’t go lower than zero (actually, it can, but we assume that it won’t), this means there has to be a cap on how much interest can be paid to the inverse floater.

If 1-month LIBOR is zero for the first month’s payment, the coupon rate for the floater is 0.5% and it will receive (.005/12) ($72,375,000) = $30,156.25.

The total interest to be split between the floater and inverse floater is

(.075/12) ($72,375,000 + $24,125,000) = $603,125.00

This means that the inverse floater will receive $572,968.75.

Based on principal of $24,125,000, this equates to 2.375% for the month which is 28.5% APR.

So 28.5% is the cap rate on the inverse floater (K in the equation)

L is the ratio of the par value of the floater to the par value of the inverse floater. In our example, it is 3.0 ($72,375,000/$24,125,000). L tells us the leverage that the inverse floater has. In this example, for every one basis point change in LIBOR, the inverse floater coupon rate changes by 3 basis points.

If LIBOR goes up too high (above 9.5% in our example), the floater could be scheduled to receive more interest than is being paid to the underlying tranche (which would result in a negative coupon rate for inverse floater). To prevent this, we establish a cap rate for the floater and a floor for the inverse floater.

If the floor for the inverse floater is set at zero (typical), the cap rate for the floater is the ratio of the underlying tranche interest to the principal for the floater. This just means that all the available interest goes to the floater.

In our example: (.075) ($96,500,000) / ($72,375,000) = 10% = cap for floater

In all cases, the weighted average coupon rate of the floater and the inverse floater will equal the coupon rate of the underlying tranche

In our example, the coupon rate for the inverse floater is 28.5% - [3\*(3.75%)] = 17.25%

So, in our example, if, for the first month, the one-month LIBOR reference rate is 3.75%, the floater will receive (.0425/12) ($72,375,000) = $256,328.13

And the inverse floater will receive 28.5% - 3 x 3.75% = 17.25% APR which translates to (.1725/12) ($24,125,000) = $346,796.88

The total interest (with rounding) adds up to $603,125 which is the interest being paid to the underlying tranche for the month (.075/12) ($96,500,000)

The average life for both the floater and the inverse floater will be the same as it was for the underlying tranche that they were each built from. All this can be seen in the Floater worksheet on the excel spreadsheet.

**Structured Interest-Only Tranches**

The coupon rate for at least one tranche is less than the coupon rate for the underlying pool. The excess interest from the tranche(s) with lower coupon rates is diverted to the interest-only (IO) tranche.

There is no par amount for the IO tranche because the IO investor receives no principal, only interest. The interest payments are determined by a coupon rate and a notional amount.

Using the same Tranches A, B, C and D that we have been using, along with the same underlying pool of $400,000,000 in par mortgages with a 7.5% coupon rate, if we adjust the coupon rate to 6% for A, 6.5% for B, 7% for C and 7.25% for D, we can give the IO investor a 7.5% coupon rate on a notional amount of $52,566,667.

The notional amount for the IO is the sum of the notional amounts created from each of the tranches which are giving up some of their interest.

With Tranche A for example, they are giving up 1.5% of $194,500,000 which is $2,917,500. This is interest going to the IO tranche. If we express that dollar amount of interest as a 7.5% coupon rate of some principal amount, we get $38,900,000. So if we give the IO a coupon rate of 7.5%, it is based on a notional amount of $38,900,000 (from Tranche A).

Notional Amount for IO

= (Original tranche’s par value x Excess Interest Rate) / Coupon rate for IO

Doing this for Tranches B-D (which give up 1%, .5%, and .25% respectively) we end up with our notional amount of $52,566,667 for the IO tranche with a 7.5% coupon rate.

This can be seen in the Excel Spreadsheet.

Note that there is no average life for the I.O. Tranche because there are no principal payments.

**Planned Amortization Class Tranches (PAC)**

The idea is to create less uncertainty about the average life for one or more tranches and thus reduce both expansion and contraction risk for it (them).

An initial PAC band is set up for which we will guarantee the PAC tranche what their principal payments will be as long as the actual prepayment rate is within the PAC band. This means that if the actual prepayment rate is within the PAC band, the average life is very stable.

The PAC band involves a lower PSA assumption and a higher PSA assumption. Each assumption has its own corresponding set of principal payments.

Every month, the PAC band will receive the minimum principal payment from these two assumptions – as long as the actual prepayments fall within the band we have set up. This means that our principal payments are known with certainty as long as the prepayments aren’t faster nor slower than we have set the PAC band up to accommodate for.

When the actual principal payments are high, the support tranche(s) absorb the surplus above what the PAC tranche receives. If the actual principal payments are low, the support tranche(s) give up their (otherwise) scheduled principal payments so that the PAC tranche still receives what it needs.

Again, this will work as long as the actual prepayments are within the PAC band we set up. If they are outside the band, the PAC tranche will still have a more stable average life than it would otherwise have had, but it will vary from what it would be within the PAC band.

In our excel spreadsheet, I’ve created a PAC band from 90 PSA to 300 PSA. There is one PAC tranche and one supporting tranche. You can see that whenever you vary the actual PSA but keep it within the band (90-300), the PAC tranche will maintain a stable average life of 7.26. The support tranche absorbs the shocks.

PAC tranches can be designed to guarantee principal payments only in certain years (a PAC window) as long as the actual prepayments fall within the band the CMO allows for. This allows for the CMO to be highly structured to meet the specific cash flow needs of an investor. Of course, this will only work if we also create support tranches which will absorb the shock of prepayments at one end of the band or the other. These support tranches expose investors to the greatest level of prepayment risk, so there must be investors willing to accept this risk.

An actual CMO may employ several different types of tranches within one CMO. One example I’ve seen shows a CMO with 17 tranches: 10 PAC tranches (with different PAC bands), three scheduled tranches, a floating-rate support tranche, an inverse floater support tranche, and two residual tranches (residual tranches receive any excess cash flows remaining after the payment of all the tranches).