All IRRs Are Not Created Equal!

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Newcomers to commercial mortgage-backed securities (CMBS) investing often misunderstand the cash flow, discounting and price volatility nuances associated with yield and price calculations that can materially influence relative value. Assessing CMBS bonds requires experience in fixed income products coupled with an awareness of the subtleties of CMBS. To illustrate these issues, consider the following sample problem:

> A fixed income instrument has a 6.00% coupon and is discounted at a yield based on a spread of +200 basis points (bp) over the 10-year Treasury with a yield of 4.00%. What is the price: (1) above par, (2) par, or (3) below par?

The obvious initial choice is (2) par. However, under certain circumstances both (1) and (3) could represent the correct answer. There are in fact five crucial pieces of information that need to be addressed before an accurate conclusion can be provided:

1. How is the coupon calculated?
2. How are the cash flows discounted?
3. What type of spread is being used?
4. How is yield being calculated?
5. What does "par" mean?

These critical questions that relate to four cash flow arbitrage contributors to the profitability of CMBS for bond issuers are discussed below.

IRR: The Logical Fallacy

There is a logical fallacy involved in calculating an IRR[1] (internal rate of return). The fallacy is that IRR assumes that all interim cash flows are re-invested at the original IRR. Below is an example of two vastly dissimilar cash flows streams that result in the same IRR:

Investment #1: Invested $1,000,000	Investment #2: Invested $1,000,000
Received $2,000,000 at end of month 12	Received $1,000,000 at end of month 01 Received $ 112,252 at end of month 12
Monthly Compounded IRR of 71.36%	Monthly Compounded IRR of 71.36%
Net Dollar Profit $1,000,000	Net Dollar Profit $112,252

Although the IRRs are identical, clearly, Investment #1 is a superior opportunity *unless* the $1 million returned at the end of month one can be reinvested at a monthly compounded yield higher than 71.36%. Thus, when comparing CMBS bonds or CMBS versus another sector, the IRR has to be interpreted correctly in order to determine the preferred investment.

Calculation of Coupon

In order to understand the cash flows to be incorporated in a yield or price calculation, it is necessary to identify:

- **The frequency of payment on the bond** (monthly, quarterly, semi-annually, annually, zero coupon). Commercial mortgages and CMBS are usually monthly pay; collateralized debt obligations (CDOs) are frequently quarterly pay; and real estate investment trust (REIT) and other corporate debt are usually semi-annual pay. Annual pay bonds are extremely rare. CMBS are unique because similar to most asset-backed securities (for example, residential mortgage-backed securities (RMBS)), it is monthly pay, but yet in terms of spread and yield (as will be discussed later), CMBS are treated as semi-annual pay. Thus, a BBB rated CMBS and a BBB rated REIT may have the same identical yields, but different return parameters since the CMBS require monthly reinvestment of cash flows.

  As much as possible, bond issuers attempt to arrange for the payment frequency on the bonds to be the same or less than the payment frequency on the underlying collateral in order to minimize the negative arbitrage on cash held in the collection account.

- **The interest calculation method.** (30/360, Actual/360, Actual/365).

  — **30/360** is the standard interest calculation method for fixed-rate debt. CMBS, corporate debt, RMBS, and REIT debt are all based on the 30/360 method. Interestingly, the commercial mortgages collateralizing a CMBS are one of the few debt instruments where fixed-rate paper often does not use the 30/360 convention. 30/360 assumes that every year has 12 months of exactly 30 days.

— **Actual/360** is the norm for floating rate debt. This methodology assumes that every year has 360 days, but every month has the absolute number of days in it. Thus, April, June, September, and November have 30 days; January, March, May, July, August, October, and December have 31 days; and February has 28 days, but 29 when it is a leap year. This artificially creates a higher coupon by 1.39% (365÷360) in a non leap year and 1.67% (366÷360) in a leap year. In more concrete terms, a 7.00% mortgage with an Actual/360 coupon is in effect a 7.10% mortgage: a 10 basis point increase. Many fixed-rate commercial mortgages employ this methodology. A result of this is that WAC CMBS bonds receive varying amounts of interest depending on the number of days in that particular payment month.

— **Actual/365** is by far the least common of the three. In essence, over the course of a year, a borrower never pays more than 30/360, but the amount of interest varies from month to month. This calculation assumes each year has 365 days, and each month has the exact number of days in it.

— Assuming a $1,000,000 balance, a 7.00% coupon and monthly payments of interest only (IO), a comparison of the interest due under the three methods for January 2005 as well as the entire calendar year is shown in Charts 1 and 2.

Chart 1: Interest Calculations for January 2005

30/360	Actual / 360	Actual / 365
$1,000,000 * 7.00% * 30 / 360 = $5,833	$1,000,000 * 7.00% * 31 / 360 = $6,028	$1,000,000 * 7.00% * 31 / 365 = $5,945

Chart 2: Interest Calculations for Calendar Year 2005

Accrual Begin	Accrual End	Actual Days	30/360 Days	30/360 Interest	Actual/360 Interest	Actual/365 Interest
1/1/2005	2/1/2005	31	30	$5,833	$6,028	$5,945
2/1/2005	3/1/2005	28	30	$5,833	$5,444	$5,370
3/1/2005	4/1/2005	31	30	$5,833	$6,028	$5,945
4/1/2005	5/1/2005	30	30	$5,833	$5,833	$5,753
5/1/2005	6/1/2005	31	30	$5,833	$6,028	$5,945
6/1/2005	7/1/2005	30	30	$5,833	$5,833	$5,753
7/1/2005	8/1/2005	31	30	$5,833	$6,028	$5,945
8/1/2005	9/1/2005	31	30	$5,833	$6,028	$5,945
9/1/2005	10/1/2005	30	30	$5,833	$5,833	$5,753
10/1/2005	11/1/2005	31	30	$5,833	$6,028	$5,945
11/1/2005	12/1/2005	30	30	$5,833	$5,833	$5,753
12/1/2005	1/1/2006	31	30	$5,833	$6,028	$5,945
		365	360	$70,000	$70,972	$70,000

One very interesting aspect of CMBS (and the first cash flow contributor to the arbitrage profitability of CMBS) is that the interest received on the underlying mortgages is generally based on Actual/360 calculations whereas the interest paid on the CMBS bonds themselves is determined on the 30/360 method.

Spread Calculation

Another material item is the "spread" methodology. In calculating a discount rate, a spread is added to the benchmark yield (Treasuries, swap spreads, LIBOR, etc.). However, there are two different methods of deriving the ultimate yield. It is important to distinguish whether the spreads are monthly (a.k.a. mortgage) or semi-annual (a.k.a. corporate or bond equivalent). With mortgage spreads, the spread is added to the Treasury yield, and the result becomes the *monthly compounded yield*. With corporate spreads, the spread is added to the Treasury. That becomes the *semi-annual compounded yield*, but it has to be converted to a lower monthly compounded yield. The significance is that CMBS are treated on spread basis like semi annual pay corporate bonds, yet on a cash flow basis it is treated like monthly pay asset-backed paper. This is the second unique feature of CMBS that creates an arbitrage. For example, if the 10-year Treasury was 4.00% and the spread was +100, the monthly yield would be 5.00%, yet the monthly yield on the bond equivalent spread would be only 4.95% as opposed to 5.00%. Thus, an RMBS, which employs a monthly spread, with the equivalent nominal spread and identical cash flows of a CMBS bond would have a lower price than the CMBS.

Discount Rate (a.k.a. Yield)

Similar to the payment frequency of the fixed income investment (monthly[2], quarterly, semi-annually[3] , annually), there are discount rates corresponding to all of these. *The discounting method is totally independent of the frequency of the payments*, yet many make the erroneous assumption that they are related. For example, quarterly pay bonds can be discounted at a semi-annual discount rate. However, it is common practice to use the same "discounting frequency" as the payment frequency. One notable exception is CMBS that pay monthly but are quoted on a semi-annual yield basis. This is the third cash flow component of the arbitrage. All things being equal (ceteris paribus), a commercial mortgage loan that yields 7.00% would provide a higher return than a CMBS with a 7.00% yield since the CMBS is a semi-annual compounded yield and the individual mortgage is a monthly compounded yield. When quoted yields, you must always be aware of the "yield frequency."

Another common misconception is that the conversion between yield frequencies is connected to the specific

Chart 3: Yield Frequencies

Monthly	Quarterly	Semi-Annually	Annually
10.00%	10.08%	10.21%	10.47%
9.92%	**10.00%**	10.13%	10.38%
9.80%	9.88%	**10.00%**	10.25%
9.57%	9.65%	9.76%	**10.00%**
0.00%	0.00%	0.00%	0.00%
5.00%	5.02%	5.05%	5.12%
10.00%	10.08%	10.21%	10.47%
15.00%	15.19%	15.48%	16.08%
20.00%	20.34%	20.85%	21.94%
25.00%	25.52%	26.34%	28.07%
30.00%	30.76%	31.94%	34.49%
35.00%	36.03%	37.65%	41.20%
40.00%	41.35%	43.49%	48.21%
45.00%	46.71%	49.44%	55.55%
50.00%	52.11%	55.51%	63.21%

cash flow stream. The relationship is *purely mathematical* and independent of the cash flows.

The formula for converting from one yield frequency to another is:

Pmtsperyearto ∗ ((1+yield/pmtsperyearfrom) ^ (pmtsperyearfrom / pmtsperyearto) -1)

For example:

From 10% semi-annual to monthly is:

12 ∗ ((1+10.00% / 2) ^ (2 / 12) -1) = 9.798%

From 10% quarterly to annual is:

1 ∗ ((1+10.00% / 4) ^ (4 / 1) -1) = 10.381%

Thus, by mathematical definition, for all yields greater than zero, the "higher payment frequency" yield is always greater than the "lower payment frequency" yield. Moreover, as shown in Chart 3, the gap between the different yield frequencies increases as yield increases. For this reason, private equity funds and other investment vehicles that receive incentive compensation after achieving hurdle rate IRRs frequently use annual returns—you can get there quicker!

One last point about discount rates is that they are almost always a 30/360 based discounting method. It is theoretically possible to use an Actual/360 or Actual/365 discount rate, but both of those discounting methodologies are very rarely employed.

Par and Delay

The conventional wisdom is that "par" is equivalent to a price of 100%. That is not correct in all instances. A more accurate definition of par is a price that will remain unchanged regardless if the timing and amount of the cash flows change due to prepayments (but not credit losses and assuming no prepayment penalties). The situation where par is not 100% can arise when there is a "delay" in the receipt of payments from an investment. In recent years, to avoid this negative arbitrage, most CMBS begin accruing on the same day of the month in which the bonds pay. For example, a deal will start accruing on June 15, and payments are received on the fifteenth of July and every fifteenth of the month thereafter.

However, some CMBS and most RMBS have delay factors. The main reason for the occurrence of a delay is the time required for the trustee or pass-through agent to process the mortgage payments and remit them to the bondholders. For example, a deal may accrue from the first to the first but not pay until the tenth. With Residential Agency pass-throughs there are different methodologies. GNMA's have a 44 day delay and pay on the fifteenth of the month; FNMA's pay on the 25th and have a 54 day delay; and FHLMC's pay on the fifteenth of the month and have a 44 day delay. FHLMC's originally paid on the fifteenth of the following month for a 74 day delay.

There are three slight differences between RMBS and CMBS when calculating delay and the value of the delay:

1. With RMBS, the interest accrual period (30 days) is included when referring to the delay. Thus, an RMBS with no delay would be termed a 30-day delay.

2. RMBS now conforms to the CMBS methodology by excluding the day the payment is received from being included in the delay factor. This revision is more accurate since the lag in receipt of the payment (e.g., for a GNMA which pays on the fifteenth) is really only 14 days and not 15.

3. The last variance is a slight mechanical difference in the calculation of NPV based on the dates used in discounting the cash flows.

Average Life/Half Life

Average life is the average amount of time that each dollar of principal is outstanding. It is calculated by multiplying each month's principal payment times the month in which it arrives, adding up all of those numbers and then dividing by the current balance (in other words the "sumproduct"). Ceteris paribus, the lower the amortization term on a mortgage, the lower the average life. For example, a 20-year due in ten has a shorter average life than a 30-year due in ten. However, coupon level also plays a role in the determination of average life.

Chart 4: Summary

	CMBS (fixed)	REIT	RMBS	CDO (fixed)
Bonds				
Payment Frequency	Monthly	Semi-Annually	Monthly	Usually Quarterly
Delay	Infrequent	No	Yes	No
Interest Type	30/360	30/360	30/360	30/360
Spread Type	Bond Equivalent	Bond Equivalent	Mortgage Equivalent	Bond Equivalent
Yield Type	Bond	Bond	Mortgage	Bond
Priced Off	Average Life	Maturity	Average Life	Average Life
Underlying Collateral				
Collateral	Commercial Mortgages	NAP	Residential Mortgages	CMBS, RMBS, CDO's, REIT Debt…
Payment Frequency	Monthly	NAP	Monthly	Monthly, Quarterly, & Semi-Annually
Interest Type	Actual/360 and 30/360	NAP	30/360	Various
Priced Off	Remaining Term	NAP	Average Life	Various
Spread Type	Mortgage Equivalent	NAP	Mortgage Equivalent	Various
Priced Off	Remaining Term	NAP	Remaining Term	Various

Ceteris paribus, the higher the coupon, the longer the average life. An interest only loan's average life is equal to the remaining term since all principal is paid at maturity.

Average life is used as the determination for which Treasury/swap spread to use as the benchmark to price a CMBS bond whereas a borrower's mortgage rate is usually priced off of the longer term to maturity. This is the fourth cash flow arbitrage component to CMBS that provides a boost in profit to the loan originators.

Half life is the amount of time it takes for an investor to recoup half of their principal. It is not the same as average life unless the investment is either IO or a fully amortizing constant principal payment loan.

Duration

No discussion of IRR can be complete without a brief discussion of duration[4] , a term that is frequently used and less frequently understood. Literally, duration is the first derivative of price with respect to yield (dP/dY). It is a measure of the percentage change in price for a percentage change in yield. Since yield and price are non-linearly correlated, duration will change at different points on the price/yield curve. Duration indicates the volatility of the price with changes in yield. Occasionally, average life is used synonymously with duration. Although a longer average life usually leads to a higher duration, duration is the present value weighting of each cash flow (including interest) versus average life which is the non-present value weighting of principal only. Some of the principal characteristics of duration are:

- The longer the term of the investment, the higher the duration.
- The higher the absolute yield, the lower the duration. For example, a change in yield from 2% to 3% will have a more dramatic impact than a change in yield from 22% to 23%.
- A zero coupon bond will always have a higher duration than a bond with the same coupon and maturity that pays current interest and/or principal.

When determining which bonds to purchase, knowing the duration (price volatility) of the various bonds should be a factor in the investment decision.

Convexity and Negative Convexity

Convexity is the second derivative of price with respect to yield, which is equivalent to percent change in duration as percent change in yield. Since duration, like yield, is a non-linear relationship between variables, at different points on the yield/price curve, duration changes at different rates. Negative convexity is a complicated sounding term with a simple explanation. In Finance 101, everyone has been taught that price and yield are inversely related. An increase in yield leads to a decrease in price and vice versa. However, this axiom only holds true when the cash flows are independent of external forces. With mortgages that do not have call protection (especially residential mortgages), a steep drop in rates can lead to a dramatic increase in prepayments which can in reality cause the price to drop even with a drop in yield. Consider the following residential mortgage pool:

- WAC: 7.00%
- WAM: 300 Months
- CPR: 1% per year
- Monthly discount rate: 6.50%
- **Initial Price: 104.36%.**

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spread concession framework that the market is used to. The greater the default expectations, and the smaller the size of the current-pay class relative to the transaction, the greater the required spread concession per point. Some of these risk measures need to be taken into account even if the security is currently trading close to par. Finally, not many can dispute that the true duration of current-pay classes is shorter than the full duration. Hedging to the true duration will diminish the correlation between excess returns on current-payer portfolios and interest rates. The hedge ratio can be ascertained based on the spread concessions that the market applies. ❑

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[1] *Of course, the next sequential class will become the new current-payer when that happens.*

[2] *We assume a 35% loss severity and 12 months to recovery.*

[3] *The spread concession per point of premium (c) needs to be expressed in percentage terms. For example, if the concession on a security is 4 bp per point of premium, the appropriate value of c is 4/100, or 0.04.*

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transactions average around 15% and 5.5%, respectively. These levels are 15 and 5.5 times, respectively, the expected base-case loss. The reduced support levels and greater multiples are more significant at speculative-grade credit classes relative to those at the investment-grade classes. ❑

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[1] *For a detailed discussion, see "Rating Transitions 2003: Resilient U.S. CMBS Endure Stressed Real Estate Fundamentals,"* RatingsDirect, *January 16, 2004.*

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If rates dropped 200 bp with no change in the prepayment rate, the price would be expected to increase to 125.16%. However, the 200 basis point drop in rates could propel the prepayment speed to catapult from 1% to 50% which would cause the *price to veritably drop* to 103.40%.

Convexity is an important measure for total return buyers when comparing bonds. Since duration is calculated at one particular time, two bonds could have the exact same duration but very different convexities. For example, a 7-year zero coupon and a 30-year amortizing bond could both have the same duration, but duration would change at different rates on the two bonds. Thus, if rates move dramatically, the price of the two bonds could be drastically different.

As a consequence, proper hedging of interest rate fluctuations should incorporate the effects of both duration and convexity. It is imperative that as interest rates fluctuate, the long and short positions are duration (and convexity) matched. Knowing the duration and convexity of both sides of the hedge can prevent the hedger from getting out of balance should rates move in either direction. Based on duration calculations, a 50 bp increase in yield will have a lesser impact on price than a 50 bp decrease in yield.

Conclusion

Once when traveling, a businessman had to make a connecting flight in Las Vegas. He had some spare change and decided to try his luck at the slots. Within a matter of minutes, he parlayed $2 into $4. That return translated into an almost infinite yield on an annualized basis. However, he still only had an extra $2 in his pocket. Remember, when comparing the relative value of CMBS, all IRRs are not created equal! ❑

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[1] *IRR and discount rate are both measures of yield, and all three terms are often used interchangeably. More precisely, IRR is the derived rate from the combination of a stream of cash flows and a given net present value (NPV). Discount rate is an input to derive an NPV. Yield may be used either way.*

[2] *Also referred to as mortgage yield.*

[3] *Also referred to as corporate yield or bond equivalent yield.*

[4] *Also known as modified duration or MacCaulay's duration.*