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Multifamily Boot Camp

Internal Rate of Return (IRR)

Here at Southport Financial, “Internal Rate of Return” is a tool we use when looking at possible multifamily investments. It is just one of many ways in which we evaluate the attractiveness of a potential acquisition related to other opportunities which are available to us. The IRR calculation is particularly well suited to our typical cash flow pattern where an initial investment is followed by years of cash income and then the sale of the property.

The accepted definition of IRR is:

“The Internal Rate of Return (IRR) is the discount rate that makes the net present value (NPV) of a project zero.”

When I look at a statement like this, I shake my head and decide that it is time to go for a cup of coffee. So, let’s try to boil it down and make the concept a bit clearer.

What IRR illustrates is how the cash flow over time relates to the original investment, showing it as a percentage. It is implying that if you put your investment in the bank at that IRR percentage; then, over the same period of time, you would end up with the same overall result.

Here are a couple of examples (*to make them easier to read, we have not shown the \$ signs*):

	Invest:	1	2	3	4	5		
#1	-100	200					IRR	100%
#2	-100	0	0	0	0	200	IRR	15%

In example #1, the investment is 100 (shown as a negative number) and the cash return or yield (we will call it cash flow) is 200 in the first year. The IRR is 100%. If the cash flow had been 300, the IRR would have been 200%. If the cash flow had been 500, the IRR would have been 400%, (the cash investment returned plus 400).

In example #2, the investment is also 100 and the cash flow is also 200 but paid at the end of five years instead of at the beginning. In this case, the IRR is 15%. The IRR calculation has demonstrated that if you invested the 100 at a return of 15% compounded, you would have 200 at the end of five years.

That is all there is to it. Once you add more numbers it gets more complicated but, luckily, we have spreadsheet programs like Excel to do the work for us.

But there are some **potential problems** with the IRR calculation. If the investment is not just in the first year, or if some of the years show losses, or if the cash flows are proportionately large in the first few years, then the IRR calculation may not work or may not be valid. The problem is that, as the IRR formula calculates and interpolates a series of investments and returns, it assumes the interim cash flows are reinvested or compounded at the IRR itself.

If the acquisition being evaluated has a high IRR, the calculation is assuming that the cash flow each year is being reinvested at that same high yield. For instance, assume an investment of \$1,000,000 returning \$150,000 or 15% each year. The calculation will assume that each \$150,000 will be invested at the same 15% rate (or higher), when the investor might actually be putting that cash in the bank at a relatively low rate of interest.

The answer to this is to use what is called the **“Modified Internal Rate of Return” (MIRR)**, which corrects the IRR calculation for the above deficiencies. Here are another two examples:

	Invest:	1	2	3	4	5				
#3	-100	15	17	20	23	125	IRR	19%		
							MIRR	15%		
#4	-100	40	40	40	40	40	IRR	29%	assumes reinvesting at 29%	
							MIRR	18%	assumes reinvesting at 6%	

In example #3, the investment is 100 and the cash flow is 15% compounded each year (100 times 1.15, and that result multiplied by 1.15 and so on for each year.) Repayment of the 100 invested is in year five. As in the three other examples, the investment is 100 and the cash flow is 200. Each example shows a different cash flow pattern.

The IRR of this investment and cash flow stream is 15%. This must be true because we actually reinvested or compounded the cash returns at 15% in the example. Try it for yourself. Surprisingly, the IRR calculation (using Excel or any other calculator) is showing 19%, obviously not correct and indicating that the calculation is reinvesting the annual cash flow at 19% instead of 15%.

The modified IRR calculation (MIRR) shows the correct IRR of 15%.

In example #4, the investment is again 100 and the cash flow returns are 40 each year, again totaling 200. In this case, the annual cash flows are large compared to the investment and the IRR is much higher than the MIRR because it is reinvesting the cash flow at 29%, which is more than most investors would be able to achieve on a consistent basis. Using the MIRR formula, we can specify reinvestment of the cash flow at 6% and this results in an IRR of 18% which is likely more realistic.

In our day-to-day work at **Southport Financial**, we use internal rate of return as one of our most useful tools in evaluating potential property acquisitions. Although we usually use the initials IRR, often we are using the underlying modified IRR calculation.

If you are interested in “looking under the hood,” on the following pages, we show you how the underlying calculations work.

Under the Hood:

We should begin by emphasizing that internal rate of return (IRR) is only used to evaluate and compare cash flows. As such, it is purely a financial tool and does not evaluate risk, feasibility, or other factors which go into making an investment decision.

On an earlier page, we gave the accepted definition of Internal Rate of Return (IRR):

“The Internal Rate of Return (IRR) is the discount rate that makes the net present value (NPV) of a project zero.”

Looking at the above definition, a “discount rate” is essentially the same as an “interest rate.”

The definition specifies “**net** present value,” so let’s first discuss the terms “present value” and “future value.”

Take for example, a choice between bank deposits. If you can deposit \$100.00 in a bank account for five years at 4% interest per year, and another banker at a similarly safe bank comes along and says that if you put the money in her bank, she will give you \$200.00 at the end of five years, which deposit would you make? Present value is the technique which helps you make this decision.

By making a few calculations, you find that investing \$100.00 at 15% interest compounded will give you a future value of \$200.00 at the end of five years. 15% interest is greater than the 4% compounded offered by the first banker so, clearly, you should put your money in the second bank. The calculation you made is \$100.00 with 15% interest added each year (100 times 1.15, times 1.15, times 1.15, times 1.15 equals \$200.00).

The definition of present value is:

“the current value of a future sum of money or stream of cash flows given a specified rate of return.”

So, in the above example, the current value of receiving \$200.00 at the end of five years, given a specified rate of return of 15%, is its present value, in this case, \$100.00.

If we had chosen to put our money with the first banker at 4% per year, we would have only \$122.00 at the end of five years. Or, alternatively, the present value of receiving \$122.00 at the end of five years is \$100.00 if the interest rate or discount rate is 4%.

Net present value (NPV) means combining or **netting** the present values of the cash investments (negative) and cash returns (positive). The **net present value** to insert in the IRR definition at the top of the page, is the combination of the present value of the investment plus the present value of the cash flow or flows.

In this case the investment is at the beginning, so its present value is minus \$100.00 (-100). As we calculated above, the present value of \$200.00 at a discount (interest) rate of 15% is \$100.00 (100). The definition stated above will then read **“The internal rate of return of (15%) is the discount rate that makes the investment (-100) + the discounted cash flow (100) = zero (0).”**

Now, let's state the same definition of internal rate of return (IRR), but in mathematical language:

Where:

CF_0 = Initial Investment / Outlay

$CF_1, CF_2, CF_3 \dots CF_n$ = Cash flows

n = Each Period

N = Holding Period

NPV = Net Present Value

IRR = Internal Rate of Return

$$0 = NPV = \sum_{n=0}^N \frac{CF_n}{(1 + IRR)^n}$$

Or, the same formula, expanded:

$$0 = CF_0 + \frac{CF_1}{(1 + IRR)} + \frac{CF_2}{(1 + IRR)^2} + \frac{CF_3}{(1 + IRR)^3} + \dots + \frac{CF_n}{(1 + IRR)^n}$$

The Greek symbol Sigma means "to sum up" and indicates that the equation is to be summarized. Looks awesome doesn't it? The second equation is exactly the same as the first, but easier for a non-mathematician to follow. The term CF_0 means the initial cash flow (the subscript 0 indicates time). The terms CF_1 or CF_2 indicate the cash flows in year one and year two.

Using the example where the bank pays \$200.00 at the end of five years, the second equation reads: $0 = CF_0 + CF_5 / (1 + IRR)^5$.

Remember that a couple of pages ago, we calculated \$100 with 15% interest added each year (100 times 1.15, times 1.15, times 1.15, times 1.15, times 1.15 equals \$200.00). Where we show a number to its 5th power $(1+.15)^5$ we are making the same type of calculation. 1.15 x 1.15 x 1.15, five times is 2. See the solution below:

$$0 = CF_0 + CF_5 / (1 + IRR)^5$$

$$0 = -100 + 200 / (1+.15)^5$$

$$0 = -100 + 200 / 2$$

$$0 = -100 + 100$$

$$0 = 0$$

Accordingly, using mathematical language, we have calculated that an IRR of 15% is the discount rate that makes the net present value of this transaction = 0.

Because we are using an investment with just one cash flow at the end of five years, the calculation is quite simple. When we add many more cash flows in different periods and possible negative cash flows or further investments in later years, calculations become more difficult. And, to begin calculating, you must make an initial guess of an appropriate discount or interest rate, and then keep substituting rates in an iterative process, until the equation equals zero.

Before spreadsheets and computers made these calculations easy, analysts used charts like the ones below:

The first chart shows the future value of one dollar discounted for periods from one to five at discount (interest) rates ranging from 1% to 20%. It calculates: $(1+.15)^5$ as equal to 2.0114 (\$2.00), that is, the future value of \$1.00 at the end of five years at 15% interest.

Period	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%	20%
1	1.0100	1.0200	1.0300	1.0400	1.0500	1.0600	1.0700	1.0800	1.0900	1.1000	1.1100	1.1200	1.1300	1.1400	1.1500	1.1600	1.2000
2	1.0201	1.0404	1.0609	1.0816	1.1025	1.1236	1.1449	1.1664	1.1881	1.2100	1.2321	1.2544	1.2769	1.2996	1.3225	1.3456	1.4400
3	1.0303	1.0612	1.0927	1.1249	1.1576	1.1910	1.2250	1.2597	1.2950	1.3310	1.3676	1.4049	1.4429	1.4815	1.5209	1.5609	1.7280
4	1.0406	1.0824	1.1255	1.1699	1.2155	1.2625	1.3108	1.3605	1.4116	1.4641	1.5181	1.5735	1.6305	1.6890	1.7490	1.8106	2.0736
5	1.0510	1.1041	1.1593	1.2167	1.2763	1.3382	1.4026	1.4693	1.5386	1.6105	1.6851	1.7623	1.8424	1.9254	2.0114	2.1003	2.4883

The second chart shows the present value of \$1.00 cash flow coming at the end of five years at 15% interest as .4972 (\$.50). This is the solution of the equation: $1 / (1+.15)^5$

The numbers in the two charts are reciprocals of each other. $1 / .4972 = 2.0114$ and $1 / 2.0114 = .4972$.

Period	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%	20%
1	0.9901	0.9804	0.9709	0.9615	0.9524	0.9434	0.9346	0.9259	0.9174	0.9091	0.9009	0.8929	0.8850	0.8772	0.8696	0.8621	0.8333
2	0.9803	0.9612	0.9426	0.9246	0.9070	0.8900	0.8734	0.8573	0.8417	0.8264	0.8116	0.7972	0.7831	0.7695	0.7561	0.7432	0.6944
3	0.9706	0.9423	0.9151	0.8890	0.8638	0.8396	0.8163	0.7938	0.7722	0.7513	0.7312	0.7118	0.6931	0.6750	0.6575	0.6407	0.5787
4	0.9610	0.9238	0.8885	0.8548	0.8227	0.7921	0.7629	0.7350	0.7084	0.6830	0.6587	0.6355	0.6133	0.5921	0.5718	0.5523	0.4823
5	0.9515	0.9057	0.8626	0.8219	0.7835	0.7473	0.7130	0.6806	0.6499	0.6209	0.5935	0.5674	0.5428	0.5194	0.4972	0.4761	0.4019

When it was necessary to do the calculations by hand, using the charts did make it much easier. I wonder if analysts back then understood the IRR process better because they had to perform the labor themselves?