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The Internal Rate of Return (IRR): Projections, Benchmarks and Pitfalls

Abstract

Purpose:
To discuss the use of the IRR as a principal measure of performance of investments and to highlight some of the weaknesses of the IRR in evaluating investments in this way.

Design/methodology/approach:
This education briefing is an overview of the limitations of the IRR in making capital budgeting decisions. It is illustrated with a number of counter-intuitive examples

Findings:
The advantage of the IRR is that is, on the surface, a wonderfully simple benchmark. One figure that tells a story. But, the disadvantage is that if used in isolation the IRR can give misleading results when used to assess investment proposals.

Practical implications:
The IRR should be used in conjunction with other analyses to appraise projects, so that the user can determine its veracity in the context of other benchmarks. This context is particularly important when assessing investment with unusual cash flows.

Originality/value:
This is a review of existing models.

Keywords:
Property valuation, Target Rate, Expected Rate of Return, Internal Rate of Return, IRR, performance measurement.

Paper type:
General review.

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The Internal Rate of Return (IRR): Projections, Benchmarks and Pitfalls

Introduction

In a previous Education Briefing (French & Patrick, 2015), we looked at the plethora of yields and benchmarks that are used in the finance world. This concluded that yields, in all their forms, are simply expressions (normally in percentage terms) of the attractiveness of an investment. They are benchmarks; nothing more, nothing less and different investors use different benchmarks.

That said, the Internal Rate of Return (IRR) is probably the preferred performance measure for the real estate industry as a means of assessing projected investment returns. However, finance textbooks, including those specifically on real estate such as Brown & Matysiak (2000) indicate that Net Present Value (NPV) is a superior method to IRR) for evaluating potential investments.

But, in practice, the IRR remains dominant. It is a simple metric to understand and its appeal is that it meets the demand for a single number against which a project can be compared with other opportunities or a benchmark. This simplicity belies its true nature and the many problems that can arise in using it to assess capital investment projects.

This paper reviews what the IRR is, illustrated with examples of cash flows where it gives a misleading or erroneous results.

Performance Measurement and the IRR

Any investment will only become a good investment if it achieves, or exceeds, the expected returns that were factored into the pricing of the investment at the time of purchase.

In determining whether an investment will prove to be a good investment in the future, it is normal that the investor pays heed to how that investment has performed previously. And, whilst past performance is no guarantee of future performance, it an important influence on the measurement of the financial attractiveness of an investment. Measures of Performance are yields /returns that the investor has actually received over the preceding time period.

If the cash flow turns out to be exactly as predicted, then assuming the asset was rationally priced, the investor will have achieved exactly the target rate of return (required rate of return) they had hoped. If the cash flow is higher than expected, the actual return will have been greater than the target rate; if the cash flows are less than expected, the actual return will be less than the target return.

You therefore have 2 distinct types of return.

1. The required rate of return which is the target rate identified at the commencement of the investment
2. The actual rate of return that is the rate actually received at the end of, or at interim periods during, the life of the investment.

Confusingly, both of these measures are referred to, in the market, as IRRs. The required rate is an "ante" (before) IRR, the actual rate a "post" (after) IRR. This Education Briefing is looking at the later.

Mathematically, what is the IRR?
The IRR is the discount (interest) rate which equates the sum of the present values of a cash flow to zero. If the NPV of a project is zero at a selected discount rate, that rate is, by definition, the IRR. The IRR is then an algebraic equivalence. No more and no less. Mathematically it is expressed as:

$$0 = \sum_{t=0}^{n} \frac{C_t}{(1+i)^t}$$

where C_t is a cash flow (-ve if a payment or +ve if a receipt) in period t and i is the internal rate of return. This equivalence cannot be re-arranged in terms of i . The solution for i therefore has to be found iteratively. This is easily achieved with the IRR function in a spreadsheet.

Table 1 shows, by manually discounting a simple cash flow, the IRR in this case is 6% as the sum of the present values of the individual payments and receipts equals zero.

TABLE 1

Period	0	1	2	3	4	5
Cashflow	-500,000	30,000	30,000	30,000	30,000	530,000
PV @ 6.0%	-500,000	28,302	26,700	25,189	23,763	396,047
NPV (sum of PVs)	=	0				

In relation to a real estate investment the IRR:

- Tells the investor nothing about the size or timing of a project
- Does not distinguish between cash flows from operations or proceeds on sale
- Does not distinguish between early and late cash flows
- Assumes cash flows can be re-invested at the IRR
- Assumes cash flows in all years are equally risky
- Says nothing about leverage risk
- Says nothing about property, leasing, operating or liquidity risk

Clearly it has a number of limitations, which we can explore by looking at some example cash flows. The aim of this paper is not to discredit the IRR entirely but to make sure that, by knowing its limitations, that it is used prudently and effectively. It remains a useful measure, but one which should be handled with care.

A cash flow may not have a unique IRR.

The cash flow in Table 1 is typical of those encountered in analysing let (income producing) properties. It starts with a negative cash flow, the purchase, and is followed by a series of positive ones being the rental income and eventual sale proceeds. There has to be at least one change in direction of the cash flow to determine an IRR. But if there are multiple changes in direction of the cash flow then there may be multiple IRRs.

These are not particularly uncommon. For example the analysis might be of a potential purchase where some further expenditure on improvements is planned for a later date. Each change in direction creates the possibility of another IRR. If a spreadsheet is used to perform the analysis it will find the first value that solves the equation, but not reveal any others that may exist.

With a spreadsheet, these additional IRRs can be forced into the open by calculating the NPV of the cash flow for a range of discount rates (using the NPV, rather than IRR function) and plotting the results in a graph.

The cash flow in Table 2 has two changes of direction and values of 9% and 27% which both solve for the IRR as they meet the requirement that the NPV = 0

TABLE 2

Year	Cash flow
0	-145
1	100
2	100
3	100
4	100
5	-275

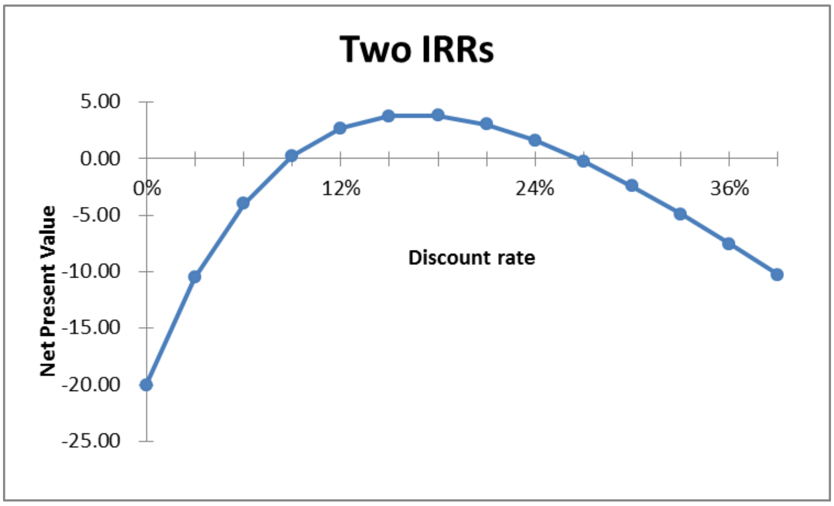

Table 3 shows the result dramatically in another way. Here the cash flow has IRRs of zero and 10%

TABLE 3

Interest Rate	0%			Interest Rate	10%		
Period	0	1	2	Period	0	1	2
Cashflow	-10	21	-11	Cashflow	-10	21	-11
DCF	-10	21	-11	DCF	-10	19	-9
NPV	0			NPV	0		

Negative IRRs can be misleading

Table 4 shows an investment which is clearly a poor one. In cash flow 1, payments totalling 130 earn a single receipt of 87 at the end of the period. Cash flows 2 and 3 are the same except that the final receipt is delayed a further one then two periods.

All the cash flows have a negative IRR but cash flow 3, which involves the longest wait for the final receipt, has the least, worse IRR. What is going on? How could the worst cash flow show the best return?

TABLE 4

Period	Cash flow 1	Cash flow 2	Cash flow 3
1	-100	-100	-100
2	-10	-10	-10
3	-10	-10	-10
4	-10	-10	-10
5	87	0	0
6		87	0
7			87
IRR	-10.88%	-8.54%	-7.04%

All three cash flows have the same absolute loss of 43 (=87-130), but in cash flows 2 and 3 it takes longer to make that loss so the loss in terms of % per period is lower. Negative returns compound a number which is less than 1 so it becomes smaller for every additional period of compounding, rather than larger as occurs when the returns are positive. The end result is the counter-intuitive outcome of the IRR appearing to improve as the cash flow worsens. In fairness, this may not happen often in investment cash flows, where positive incomes are, hopefully, more likely. However, for corporate occupiers who are analysing outgoings only, all cash flows are negative and all IRRs are the same. Here, this counter-intuitive outcome can be very misleading. It may be for this reason that corporate clients tend to be happier looking at the NPV, based on their weighted average cost of capital (WACC), as their preferred benchmark.

Receiving back less than you invested appears to be good
Table 5 shows a cash flow where the cash received is less than the cash paid. It also has more than one change of direction so may have multiple IRR solutions.

TABLE 5

Period	0	1	2	3
Cash flow	-100	400	-400	50
DCF @ 12.0%	-100	357	-319	36
NPV =	-26			
IRR =	40%			

The solution found by a spreadsheet IRR function is 40% yet the NPV, using a discount rate of 12% is negative. In other words, NPV analysis indicates that this project does not achieve a 12% return. But the IRR evaluation says that it achieves 40%.

The IRR may rank projects incorrectly
Table 6 shows two projects, A and B. It is self-evident that Project B is better than Project A as it involves a smaller outlay for the same cash return. But the two projects have the same IRR.

TABLE 6

Target rate 12.0%			
Period	**Project A**	**Project B**	
0	-100	-150	
1	-100	0	
2	600	600	
IRR	100%	100%	
NPV	289	328	

Both projects also exceed the desired Target return of 12%. On the NPV measure Project B shows clearly as the better project. This underlines the view that NPV is a more appropriate measure. It indicates which project adds most to net wealth, if the selected Target rate is the investor's opportunity cost of capital.

The IRR is not reliable for comparing opportunities with large differences in scale.

Consider the following two opportunities. Project A has the better IRR although at the Target rate of return, Project B has the greater NPV.

TABLE 7

Target rate 3.0%			
Period	**Project A**	**Project B**	
0	- 1,000	- 30,000	
1	-	-	
2	-	-	
3	-	-	
4	1,200	35,000	
IRR	4.7%	3.9%	
NPV	66	1,097	

A large percentage return on a small sum may be a smaller profit than a lower return on a larger project.

The timing of cash flows, is important in decision making

In Table 8, projects A and B both have the same initial investment. Project A eventually returns more cash but project B has a higher NPV at the Target rate of return.

TABLE 8

Target rate 11.0%			
Initial investment	20,000		
Period	**Project A**	**Project B**	
1	6,000	10,000	
2	3,000	6,000	
3	10,000	9,000	
4	8,000	1,000	
Total	27,000	26,000	
Cash flows discounted at hurdle rate			
1	5,405	9,009	
2	2,435	4,870	
3	7,312	6,581	
4	5,270	659	
Total	20,422	21,118	
IRR	11.9%	14.2%	

In this case the IRR gives the same signal as the NPV analysis. Although Project B returns less cash than Project A, more of this cash is returned sooner making it the preferred project on both an IRR and Target rate of return basis.

Rate of return, in isolation, is not the only decision factor

Suppose an investor is faced with two opportunities. The first is to make 100 in to 140 over 1 year (a 40% return). The second is to make 100 into 300 over 4 years (a 32% return).

Both opportunities are exceptional. But although the first shows the greater return, the second is a better investment unless you believe the world is full of one year 40% return opportunities.

Conclusions

You can see, by reference to some very simple examples, that the IRR is not as robust as many users believe. But, as said before, knowing the pitfalls and how to interpret the results correctly can negate some of these shortcomings and allow the user the benefit of a simple benchmark that is used (if not understood) industry wide.

References

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