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Turning Pricing IRRs into Intelligent Rates of Return

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What do the following projects have in common?

Table 1: Projects available for investment

Project	CF ₁	CF ₂	CF ₃	CF ₄	CF ₅
A	(1,000)	100	100	100	1,100
B	1,000	(100)	(100)	(100)	(1,100)
C	(100,000)	10,000	10,000	10,000	110,000
D	(1,000)	700	700	(500)	235

If you read the title of this article, you may guess (correctly) that the answer lies in the Internal Rate of Return (IRR) for each project. All are 10 percent, when calculated using the Excel IRR function. Which project, then, is the best investment? Are all acceptable?

The answers to those questions depend on a number of variables which are not captured in the IRR: available capital (now and in the future), reinvestment rates, borrowing rates, and company strategy, to name a few. So what does that 10 percent mean?



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IRRs can be difficult to understand, potentially returning illogical solutions or no solutions at all. The purpose of this article is to examine the theory behind IRRs, their practical limitations, and how to get the most out of IRR calculations.

IRR Theory

The internal rate of return for a project is defined as the interest rate that makes the Net Present Value (NPV) of all cash flows equal to zero. In other words, it is the interest rate that equates your investments to your returns, on a present value basis.

IRRs are easiest to understand in a venture capital-type setting of only two cash flows: an initial investment at time zero followed by a payoff at some time in the future. While this simplicity would be a pricing actuary's dream, insurance cash flows are never quite that easy.

In practice, because it is such a succinct measure of profitability, a project's IRR has come to be used frequently by

corporate executives in much more complicated settings. Specifically, IRRs are considered very valuable because they allow comparison of projects irrespective of the magnitude of the investment and subsequent cash flows. Applications to insurance products, however, may be inconsistent with the definition of an IRR.

Using IRRs with Insurance Products

What happens when cash flows occur between the initial investment and the ultimate payoff? That answer depends on the sign of the cash flow, whether it is positive (a profit) or negative (an investment).

Interim profits – When calculating an internal rate of return, *every* cash flow is discounted at one rate (the IRR), implicitly assuming that all profits earned over the life of the product will be reinvested in the same project or a project with an equivalent rate of return.

In reality, the project's profits are more akin to distributable earnings, and they will only earn a return based on the investments available to the company at the time the profit is realized. For a life insurance product, profits may be earned over many decades, in many different reinvestment environments.

For instance, consider Project A from Table 1. A \$100 profit is earned in the second year of the project (CF₂), but this is a five year project. In order for the project's overall return to be 10 percent, the \$100 earned in year two must grow to \$133.10 by the end of the project (three years of compounded 10 percent growth). Are reinvestments available to facilitate that growth? If profits are retained, will free surplus earn a 10 percent return?

Often, reinvestment rates are much lower than the IRR, because higher reinvestment rates would imply that a better investment option exists than the project being funded. An IRR calculation will overstate profitability when interim profits cannot be reinvested to earn the IRR (or understate profitability if interim profits can be reinvested at a rate greater than the IRR).

Interim investments – Similar to interim profits, additional investments (negative cash flows) occurring during a projection will also be discounted at the IRR.

Ignoring the mathematical issues caused by losses amid profits (discussed in the next section), the IRR may be an inappropriate discount rate if it is significantly different from the rate at which the company would finance additional investments.

Calculating the IRR of an Insurance Product

Assuming that an IRR is appropriate in the pricing situation, there are still potential issues related to the mathematics of an IRR calculation. Solving for an IRR is essentially solving a polynomial equation with degree equal to the period of the ultimate payoff. This becomes more complicated as the number of terms increases, and may cause three undesirable outcomes.

No solution – There are several ways to get a series of cash flows without an IRR. The simplest is all positive or all negative cash flows, i.e., a product that does not require an investment or never makes money. Another is to have a positive cash flow surrounded by larger negative cash flows on either side. The earlier negative cash flow is larger than the positive cash flow when the discount rate is high, and the latter negative cash flow is larger than the positive cash flow when the discount rate is low. Thus, it is impossible to find a discount rate to equate the cash flows.

Multiple solutions – As mentioned previously, an IRR calculation involves solving a polynomial based on the projected cash flows. Frequent sign changes (when cash flows alternate between profits and losses) increase the number of roots for this polynomial and can lead to multiple answers.

Illogical solutions – Suppose that a project generates a positive cash flow followed by a series of negative cash flows (such as Project B in Table 1). In this case, a positive IRR is mathematically possible, and increasing the magnitude of the negative cash flows will raise that IRR. From a practical standpoint, the IRR has lost its meaning as a rate of return on an investment. Because it is an upfront “return” followed by subsequent “investments,” the solved for rate is more synonymous with a borrowing rate than a return.

Alternative IRR Calculations

Today, stochastic projections are common practice for many product types. While a standard IRR calculation will typically produce a reasonable number for deterministic modeling, stochastic projections generate increased volatility in earnings, and are more likely to produce one of the three situations described above. To deal with these issues, there are two main alternative formulas for calculating an IRR.

Generalized (Becker) IRR – This IRR method is calculated from the last cash flow, working backward, by making a binary decision at the time of each cash flow. If the present value of future profits is negative, discount at the finance rate. If it is positive, discount at the IRR (start with a guess).

This process will result in a present value of profits at time zero based on the initial IRR guess. To calculate the IRR, iteratively adjust the guess until the present value of the stream of profits is zero.

Modified IRR – While the generalized IRR method assigns a separate discount rate to interim investments, the modified IRR formula also accounts for interim profits. The mathematical formula can be expressed as:

$$MIRR = \sqrt[n]{\frac{FV(\text{Positive CFs @ reinvestment rate})}{-PV(\text{Negative CFs @ finance rate})}} - 1$$

All profits are accumulated forward to the end of the project, while all investments are discounted back to the start of the project, and then the root corresponding to the duration of the project is found. By accumulating and discounting at rates which may differ from the IRR, the formula can provide a truer measure of the return provided solely by the project’s cash flows, stripping out reinvestment and financing inaccuracies. Modified IRRs may be easily calculated in Excel using the built-in “MIRR” function.

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For a demonstration of these methods, consider Project D from Table 1 above. The finance rate (used in both generalized and modified IRR calculations) is typically assumed to be the reserve valuation rate, representing the cost of holding adequate liability provisions, and is assumed to be 5 percent in this demonstration. The reinvestment rate (used by the modified IRR calculation only) is usually equal to the company's cost of capital rate as a proxy for available investments, and is assumed to be 9 percent. The three IRR methods produce the following results:

Table 2: Demonstration of IRR methodologies

Method	Value
IRR	10.0%
Generalized IRR	9.2%
Modified IRR	8.3%

As the table shows, for this pattern of cash flows the IRR function returns the highest value, because it is overly optimistic about reinvestment returns and understates the cost of future losses.

Note that in a venture capital-type investment of only two cash flows, both of these alternative methods will produce the same result as the standard IRR calculation. This is also true if the reinvestment rate, finance rate, and IRR are all equal.

Other Pricing Considerations

Corporate financial theory tells us to maximize shareholder wealth by choosing projects with the highest NPV of cash flows. IRRs, in contrast, are a secondary decision-making criterion which identifies the universe of satisfactory projects from which to choose: those with an IRR above a cost of capital or hurdle rate. What should that rate be?

The reference to cost of capital is an important one, because cost of capital will vary with the economic environment. Pricing is not a static exercise, and (as current interest rates continually remind us) it is unrealistic to price to a fixed percentage return in all economic climates. IRR targets should be reflective of the options available to the company at that time.

Conclusion

When evaluating insurance products, pricing metrics are often viewed as a hurdle; there is a target level above which the product becomes satisfactory and below which the product must be adjusted. IRRs in particular are useful in this role, because they allow easy comparison of different investment sizes. Understanding the math behind an IRR number can provide a more complete picture of the project and maximize its value to your company. □

The views expressed are the author's own and not representative of Oliver Wyman's.

IRRs and Excel

Commonly, IRRs will be calculated in Excel from a given stream of projected cash flows. Before using this value, it is important to understand the calculations Excel performs with the built-in IRR function. Excel uses an iterative process, similar to using the Goal Seek option, to solve for the discount rate that sets the NPV of a series of cash flows equal to zero. The maximum number of iterations performed is 20, after which an error message is displayed.

If there is more than one answer, Excel requires a "guess" (defaulting to 10 percent if left blank), and will converge to the solution closest to that input even if it returns a nonsensical answer.