Internal rate of return: A cautionary tale

Tempted by a project with a high internal rate of return? Better check those interim cash flows again.

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Maybe finance managers just enjoy living on the edge. What else would explain their weakness for using the internal rate of return (IRR) to assess capital projects? For decades, finance textbooks and academics have warned that typical IRR calculations build in reinvestment assumptions that make bad projects look better and good ones look great. Yet as recently as 1999, academic research found that three-quarters of CFOs always or almost always use IRR when evaluating capital projects.[1]

Our own research underlined this proclivity to risky behavior. In an informal survey of 30 executives at corporations, hedge funds, and venture capital firms, we found only 6 who were fully aware of IRR's most critical deficiencies. Our next surprise came when we reanalyzed some two dozen actual investments that one company made on the basis of attractive internal rates of return. If the IRR calculated to justify these investment decisions had been corrected for the measure's natural flaws, management's prioritization of its projects, as well as its view of their overall attractiveness, would have changed considerably.

So why do finance pros continue to do what they know they shouldn't? IRR does have its allure, offering what seems to be a straightforward comparison of, say, the 30 percent annual return of a specific project with the 8 or 18 percent rate that most people pay on their car loans or credit cards. That ease of comparison seems to outweigh what most managers view as largely technical deficiencies that create immaterial distortions in relatively isolated circumstances.

Admittedly, some of the measure's deficiencies are technical, even arcane,[2] but the most dangerous problems with IRR are neither isolated nor immaterial, and they can have serious implications for capital budget managers. When managers decide to finance only the projects with the highest IRRs, they may be looking at the most distorted calculations—and thereby destroying shareholder value by selecting the wrong projects altogether. Companies also risk creating unrealistic expectations for themselves and for shareholders, potentially confusing investor communications and inflating managerial rewards.

We believe that managers must either avoid using IRR entirely or at least make adjustments for the measure's most dangerous assumption: that interim cash flows will be reinvested at the same high rates of return.

The trouble with IRR

Practitioners often interpret internal rate of return as the annual equivalent return on a given investment; this easy analogy is the source of its intuitive appeal. But in fact, IRR is a true indication of a project's annual return on investment only when the project generates no interim cash flows—or

EXHIBIT 1

Identical IRRs, but very different annual returns

Internal-rate-of-return (IRR) values are identical for 2 projects . . .

Project A							IRR
Year	0	1	2	3	4	5	
Cash flows, $ million	–10	5	5	5	5	5	41%

Project B							IRR
Year	0	1	2	3	4	5	
Cash flows, $ million	–10	5	5	5	5	5	41%

. . . however, interim cash flows are reinvested at different rates

Key assumption: reinvestment rate = IRR

Project A							CAGR[1]
Year	0	1	2	3	4	5	
Value of cash flows at year 5 if reinvested at 41%		5	→	→	→	20	41%
			5	→	→	14	41%
				5	→	10	41%
					5 →	7	41%
						5	
Year 5 value of $10 million investment =						**$56 million**	**41% CAGR[1]**

Key assumption: reinvestment rate = cost of capital

Project B							CAGR[1]
Year	0	1	2	3	4	5	
Value of cash flows at year 5 if reinvested at 8%		5	→	→	→	7	8%
			5	→	→	6	8%
				5	→	6	8%
					5 →	5	8%
						5	
Year 5 value of $10 million investment =						**$29 million**	**24% CAGR[1]**

True return is nearly 50% less because of lower reinvestment rate

[1]Compound annual growth rate.

when those interim cash flows really can be invested at the actual IRR.

When the calculated IRR is higher than the true reinvestment rate for interim cash flows, the measure will overestimate—sometimes very significantly—the annual equivalent return from the project. The formula assumes that the company has additional projects, with equally attractive prospects, in which to invest the interim cash flows. In this case, the calculation implicitly takes credit for these additional projects. Calculations of net present value (NPV), by contrast, generally assume only that a company can earn its cost of capital on interim cash flows, leaving any future incremental project value with those future projects.

IRR's assumptions about reinvestment can lead to major capital budget distortions. Consider a hypothetical assessment of two different, mutually exclusive projects, A and B, with identical cash flows, risk levels, and durations—as well as identical IRR values of 41 percent. Using IRR as the decision yardstick, an executive would feel confidence in being indifferent toward choosing between the two projects. However, it would be a mistake to select either project without examining the relevant reinvestment rate for interim cash flows. Suppose that Project B's interim cash flows could be redeployed only at a typical 8 percent cost of capital, while Project A's cash flows could be invested in an attractive follow-on project expected to generate a 41 percent annual return. In that case, Project A is unambiguously preferable.

Even if the interim cash flows really could be reinvested at the IRR, very few

practitioners would argue that the value of future investments should be commingled with the value of the project being evaluated. Most practitioners would agree that a company's cost of capital—by definition, the return available elsewhere to its shareholders on a similarly risky investment—is a clearer and more logical rate to assume for reinvestments of interim project cash flows (Exhibit 1).

When the cost of capital is used, a project's true annual equivalent yield can fall significantly—again, especially so with projects that posted high initial IRRs. Of course, when executives review projects with IRRs that are close to a company's cost of capital, the IRR is less distorted by the reinvestment-rate assumption. But when they evaluate projects that claim IRRs of 10 percent or more above their company's cost of capital, these may well be significantly distorted. Ironically, unadjusted IRRs are particularly treacherous because the reinvestment-rate distortion is most egregious precisely when managers tend to think their projects are most attractive. And since this amplification is not felt evenly across all projects,[3] managers can't simply correct for it by adjusting every IRR by a standard amount.

How large is the potential impact of a flawed reinvestment-rate assumption? Managers at one large industrial company approved 23 major capital projects over five years on the basis of IRRs that averaged 77 percent. Recently, however, when we conducted an analysis with the reinvestment rate adjusted to the company's cost of capital, the true average return fell to just 16 percent. The order of the most attractive projects also changed considerably. The top-ranked project based on IRR dropped to the tenth-most-attractive project. Most striking, the company's highest-rated projects—showing IRRs of 800, 150, and 130 percent—dropped to just 15, 23, and 22 percent, respectively, once a realistic reinvestment rate was considered (Exhibit 2). Unfortunately, these investment decisions had already been made. Of course, IRRs this extreme are somewhat unusual. Yet even if a project's IRR drops from 25 percent to 15 percent, the impact is considerable.

What to do?

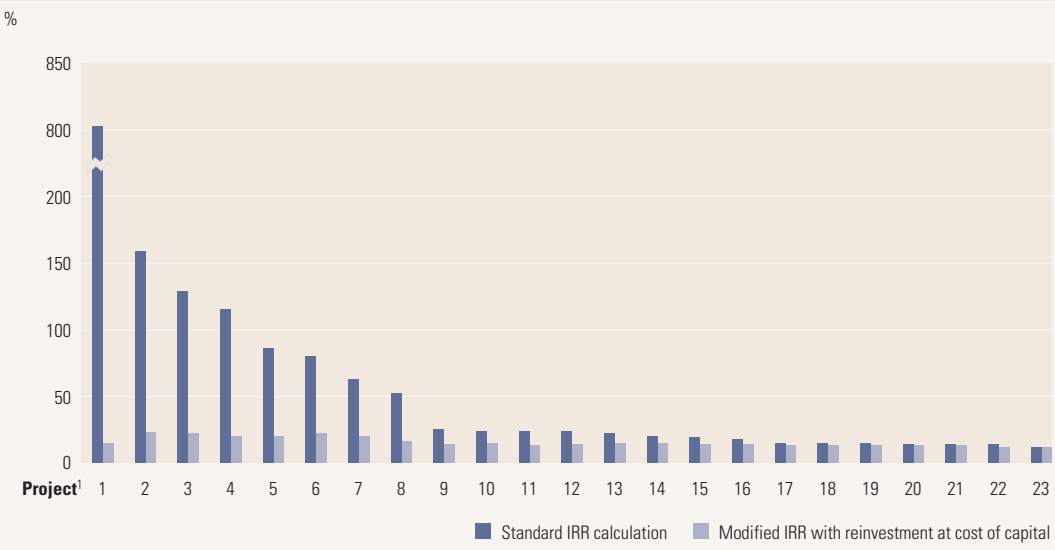
The most straightforward way to avoid problems with IRR is to avoid it altogether. Yet given its widespread use, it is unlikely to be replaced easily. Executives should at the very least use a modified internal rate of return. While not perfect, MIRR at least allows users to set more realistic interim reinvestment rates and therefore to calculate a true annual equivalent yield. Even then, we recommend that all executives who review projects claiming an attractive IRR should ask the following two questions.

1. *What are the assumed interim-reinvestment rates?* In the vast majority of cases, an assumption that interim flows can be reinvested at high rates is at best overoptimistic and at worst flat wrong. Particularly when sponsors sell their projects as "unique" or "the opportunity of a lifetime," another opportunity of similar attractiveness probably does not exist; thus interim flows won't be reinvested at sufficiently high rates. For this reason, the best assumption—and one used by a proper discounted cash-flow analysis—is that interim flows can be reinvested at the company's cost of capital.

2. *Are interim cash flows biased toward the start or the end of the project?* Unless

EXHIBIT 2

A rude surprise



[1] Disguised example of large industrial company.

the interim reinvestment rate is correct (in other words, a true reinvestment rate rather than the calculated IRR), the IRR distortion will be greater when interim cash flows occur sooner. This concept may seem counterintuitive, since typically we would prefer to have cash sooner rather than later. The simple reason for the problem is that the gap between the actual reinvestment rate and the assumed IRR exists for a longer period of time, so the impact of the distortion accumulates.[4]

Despite flaws that can lead to poor investment decisions, IRR will likely continue to be used widely during capital-budgeting discussions because of its strong intuitive appeal. Executives should at least cast a skeptical eye at IRR measures before making investment decisions. MoF

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[1] John Robert Graham and Campbell R. Harvey, "The theory and practice of corporate finance: Evidence from the field," Duke University working paper presented at the 2001 annual meeting of the American Finance Association, New Orleans (available at http://ssrn.com/abstract=220251).

[2] As a result of an arcane mathematical problem, IRR can generate two very different values for the same project when future cash flows switch from negative to positive (or positive to negative). Also, since IRR is expressed as a percentage, it can make small projects appear more attractive than large ones, even though large projects with lower IRRs can be more attractive on an NPV basis than smaller projects with higher IRRs.

[3] The amplification effect grows as a project's fundamental health improves, as measured by NPV, and it varies depending on the unique timing of a project's cash flows.

[4] Interestingly, given two projects with identical IRRs, a project with a single "bullet" cash flow at the end of the investment period would be preferable to a project with interim cash flows. The reason: a lack of interim cash flows completely immunizes a project from the reinvestment-rate risk.