Business Horizons (2008) **51**, 321—329

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# MIRR: A better measure

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**KEYWORDS**
Modified internal rate of return;
Capital budgeting;
Investment decisions;
Discounting;
Discounted cash flow

**Abstract** Over the past 60 years Net Present Value (NPV) and the Internal Rate of Return (IRR) have emerged from obscurity to become the overwhelming choices for the quantitative measurement of investment attractiveness in modern corporations. Despite their current popularity, neither NPV nor IRR was designed to deal effectively with the vast majority of investment problems, meaning those where periodic free cash flows are generated between the time of asset purchase and the time of sale. NPV assumes that periodic cash flows can and will be reinvested at the NPV discount rate, either at the cost of capital or another risk adjusted discount rate; IRR assumes reinvestment at the IRR. Neither assumption is usually realistic. In addition, when evaluating projects in terms of their financial attractiveness, the two measures may rank projects differently. This becomes important when capital budgets are limited. Finally, a project may have several IRRs if cash flows go from negative to positive more than once. The Modified Internal Rate of Return (MIRR), discovered in the 18th century, does account for these cash flows. This article explains the problems with NPV and IRR, describes how MIRR works, and demonstrates how MIRR deals with weaknesses in NPV and IRR.


## 1. Another look at investment decisions

Over the past 60 years Net Present Value (NPV) and the Internal Rate of Return (IRR) have emerged from obscurity to become the overwhelming choices of decision makers to use in measuring the financial attractiveness of investment opportunities. Both have been used to evaluate alternatives in a wide variety of situations: from equipment and real estate acquisitions to company acquisitions, from the valuation of intellectual property to choices relating to offshore production, and from new product introduction decisions to decisions to close down factories.

NPV discounts or reduces future expected cash inflows from an investment at a rate that reflects three factors: the investment's risk, expected inflation, and the desire of investors to retain cash in case a better opportunity turns up. If the sum of the discounted future cash inflows exceeds the initial cash requirement for funding, NPV is positive and the project is financially attractive. It will add value to the investor or the firm.

IRR is that rate of return percentage, which when used as the discount rate, will cause the sum of discounted future cash inflows to exactly equal the

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0007-6813/$ — see front matter 
doi:10.1016/j.bushor.2008.02.005

initial cash outflow. If IRR is greater than the rate of return required by investors, the investment is financially attractive. The Modified Internal Rate of Return (MIRR) is a derivative of IRR that avoids the latter's problems, and provides a more accurate percentage measure of financial attractiveness.

Ryan and Ryan's (2002) study of Fortune 1000 companies indicated that 85% use NPV 75-100% of the time in investment. Seventy-six percent of the respondents use IRR 75-100% of the time. Many earlier studies point to the dominance of both methods but show a preference for IRR because of its intuitive appeal; executives apparently feel more comfortable dealing in percentages (Burns & Walker, 1997; Gitman & Forrester, 1977).

Despite their current popularity, neither NPV nor IRR was designed to deal effectively with the vast majority of investment problems—those where periodic free cash flows are generated between the time of asset purchase and the time of sale. The Modified Internal Rate of Return, first discovered in the 18th century and rediscovered in the 1950s, does account for these cash flows (Baldwin, 1959; Biondi, 2006).

Although some academics have given it positive reviews (Athanasopoulos, 1978; Hartman & Schafrick, 2004; McDaniel, McCarty, & Jessell, 1988; Plath & Kennedy, 1994; Wiar, 1973), MIRR has not received the attention it deserves. In the 15 significant and highly respected finance textbooks reviewed for this article (see Appendix), nearly all either ignored MIRR or gave it little space. None explored the full potential of the method, although some noted its superiority over IRR. The Ryan and Ryan (2002) study indicates that MIRR is used 75-100% of the time in only 9.3% of the firms they surveyed.

Given the widespread use of both NPV and IRR in companies all over the world, it is important that their limitations, and the value of MIRR, be appreciated. It is also important that MIRR be well explained to correct some of the ways it has been misunderstood and misused. Current spreadsheet programs such as Excel provide a calculation for MIRR, but are not yet equipped to deal adequately with the cash flows involved. This article explains the problems with both NPV and IRR, describes how MIRR works, and demonstrates how MIRR solves inherent weaknesses in NPV and IRR.

## 2. Both NPV and IRR share a major problem

The following example demonstrates the proper use of both NPV and IRR. A restaurateur is considering the purchase of a piece of fine art for $50,000. He plans to sell the piece in 5 years and replace it with another to add variety to the décor of his restaurant. Since his experience suggests he will double his investment at the time of sale, the art will have an IRR of 14.87%. If the restaurateur's cost of capital is 10% and he uses this as his discount rate, his NPV will be $12,092. If it is 20%, he stands to lose $9,812 in economic value. Both NPV and IRR clearly and accurately describe the potential results of the investment.

Notably absent from this example are periodic free cash flows or dividends common to most investments. Cash flows from these investments presumably will be reinvested in other ventures to earn returns. But the question is, at what rate of return? Technically, both IRR and NPV are silent on this issue.

The NPV reinvestment rate can only be whichever discount rate is used. In other words, the discount rate determines the reinvestment rate. In the restaurateur's case, $50,000 invested in an alternative opportunity providing a 10% compounded return per year will yield $80,525.50. That yield subtracted from the $100,000 from the sale of the art equals $19,475.50. When $19,475.50 is discounted back 5 years at 10%, the NPV is $12,092, the same as that calculated above at the 10% cost of capital. The return from an alternative investment yielding 20% is $124,416. The negative difference of $24,426 discounted back at $(1.2)^5$ gives a NPV of negative $9,812, the same as above. No other rates will produce the same NPVs. They are unique.

IRR is described by most authors in mathematical terms as that discount rate which equates the present value of the opportunity to the initial investment required, and therefore, NPV to zero (Brealey, Meyers, & Allen, 2006; Hartman & Schafrick, 2004). IRR refers only to the percentage that is derived as a result of the IRR calculation (Bierman & Smidt, 1957; Karathanassis, 2004; Lohmann, 1988). If $100,000 is discounted to the present using the IRR of 0.1487 as the discount factor, the result would be $\$100,000/(1 + .1487)^5 = \$50,000$. It follows that the rate of return that equates $50,000 to $100,000 and NPV to zero over 5 years is 14.87%. The IRR is determined by the beginning and ending dollar values, not the discount rate.

Beaves (1988, p. 280) notes the limitations of NPV and IRR:

> Net present value and rate of return are essentially single-period indices designed for projects that have no intermediate cash flows. These indices are uniquely determined only when the investor's initial wealth commitment, Wo, and his terminal wealth, Wn, are uniquely determined. Without a reinvestment assumption, Wo and Wn are uniquely determined only for projects that

have no intermediate cash flows. These single-period indices can be generalized to projects that have intermediate cash flows, but such generalization requires a reinvestment assumption whether implicit or explicit.

Here is an example with periodic cash flows to demonstrate the point. A company spends $1,000,000 replacing laptops and associated equipment with new equipment that will have a life of 3 years. Management believes the company's free cash flow will be enhanced by $500,000 per year plus the third year salvage value after taxes of $50,000.

The net present value from this investment at a 10% discount rate is $280,992. If management reinvests the first $500,000 savings at the end of year 1 at 10% compound interest, the company will have $500,000 $\times$ $(1.10)^2$ or $605,000 at the end of year 3. The second $500,000 will provide $550,000 a year later at 10%. The third will remain at $550,000. These figures summed and discounted back to the present at 10% give the company a NPV of $280,992. The company must reinvest the cash flows at exactly 10% to produce the $280,992 NPV.

The laptop alternative has an IRR of 25.106%. Using the methodology explained above, management must reinvest the first $500,000 at 25.106% compound interest and obtain $782,576 at the end of 2 years. The second $500,000 garners $625,530 at that rate in time period 3. The third cash flow, $550,000, stays the same. When summed, the three cash flows total $1,958,031; when the total is discounted to the present at 25.106%, the NPV is zero. But the NPV is zero if, and only if, the reinvestment rate is 25.106%.

The two examples demonstrate that reinvestment rates are inherent in the calculations of NPV and IRR. The NPV reinvestment rate is determined by the discount rate used. IRR is determined only by the size and timing of the free cash flows, not by the reinvestment rate (Crean, 1989). The IRR reinvestment rate—shown to be equal to the IRR—is a result of the cash flows and their timing, not the cause.

Liu and Wu (1990) observed that IRR equates the amount borrowed from the firm (the negative cash flow) to the amount lent from the investment back to the firm (the positive cash flow). This view specifically takes account of the fact that some investments require outlays beyond the initial time period.

If NPV is calculated using the cost of capital, the assumption must be that the cash flow will be reinvested at that rate. If no such opportunities are available at that rate, NPV misstates the true attractiveness of the opportunity and is not a reliable number. IRR will be in error—as an IRR—if the actual reinvestment rate is something other than the IRR itself. It is often unreasonable to expect to find future investment opportunities at the IRR rate.

In both cases, management is locked into assumptions about future investment opportunities that may not exist. Taken one step further, reinvestment rates require that decisions be made in the future to invest cash flows at the discount rate used by NPV or calculated as IRR. In the laptop case, management must arrange that funds be reinvested at 10% for the NPV to have meaning. Funds must be reinvested at the 25.106% rate for the IRR to have meaning.

In other words, neither NPV nor IRR are equipped to deal with investments that have cash flows occurring between the beginning of the investment and its end. Both require investors to assume they can reinvest these cash flows at exactly the rate indicated by the measure: the discount rate in the case of NPV, and the IRR in the case of IRR. In practice, such reinvestment opportunities may be impossible to find. The problems are magnified when the expected rate of return is unusually high, as with venture capital investments, or unusually low, as with investments in some safety enhancement projects.

## 3. NPV has unique drawbacks

NPV by itself suffers from two limitations. First, consider a new product introduction project with risk higher than the firm's cost of capital. Its cash flows should be discounted at a higher rate to reflect that risk. But if they are, the reinvestment rate becomes, in a sense, *unhooked* from the cost of capital; the investment rate for the new product introduction is higher than the company's usual cost of capital. To be conservative, however, one should assume a reinvestment rate at the cost of capital. What should be done?

Second, suppose you are examining two projects of unequal size. You cannot do both, and you notice that the first project has a higher NPV, but a lower IRR, than the second project. Which project do you take?

### 3.1. The cost of capital and hurdle rates

The firm's cost of capital measures the weighted average risk that debt and equity investors expect from all the projects taken on by the company. If management can find an opportunity at this expected risk level that has returns greater than the cost of capital, that opportunity adds value to the company. Its NPV is positive.

Management ordinarily must seek value-adding investments, except in extraordinary cases where employee safety, company strategy, or other factors take precedence. Conservatism was usually why NPV was preferred to IRR in the textbooks reviewed for this article. Firms set the discount rate at the cost of capital so the free cash flows are assumed to be reinvested in projects with a return at least at the capital cost. This is the rate at which no value is added to the firm.

In practice, most firms adjust project discount rates to account for risk when projects indicate greater or lesser risk than that implied by the firm's cost of capital. Gitman (2003, p. 434) defines the risk-adjusted discount rate (RADR) as "the rate of return that must be earned on a given project to compensate the firm's owners adequately—that is to maintain or improve the firm's share price." Another term for RADR is *hurdle rate*.

If the discount rate is adjusted, however, the implied reinvestment rate of the free cash flow is not at the firm's cost of capital. If the firm's cost of capital is 10%, for example, a 15% project RADR will assume that other projects of risk equal to the one being considered (at 15%) not only can, but will, be found in the future.

For a project less risky than that of the firm as a whole where, for example, a 7% hurdle rate is used, the expected reinvestment rate is 7%. This presupposes that in the future, the firm has made a decision to invest in projects that promise a return less than the cost of capital.

The point is that RADRs fix management attention on the risk associated with the investment at hand, rather than on the implications for future investment decisions. As such, they can lock management into making future decisions that may be unwise. In the case of a 15% RADR, management must find a way to reinvest the cash flows of the current investment opportunity at 15% if the NPV for the current opportunity is to have any meaning. A 15% RADR will not ensure conservatism in investment practice when the cost of capital is 10%.

A reinvestment rate of 7% will not cover the cost of capital. Yet management is locked into 7% decisions for the cash flow if that NPV is to have any meaning. When RADRs are used, the advantage of NPV as a conservative measure of project attractiveness is significantly reduced.

### 3.2. The ranking problem

Liu and Wu (1990, p. 65) note that, "In fact, ranking investment projects by NPVs favors those with large initial outlays. It can lead to erroneous investment decisions if the firm's borrowing capacity is limited at the given cost of capital." Assume you are trying to decide whether to invest $1 million or $1.5 million in laptop computers for your company. You know productivity will be enhanced if you invest the greater amount. If productivity is increased by less than 150%, NPV for the $1.5 million investment will be larger than for the $1 million investment. However, the IRR will be lower for the $1 million investment. If productivity is increased exactly 1.5 times, NPV will be larger, but IRR will be the same as it was at the $1 million level. If productivity is increased by more than 150%, of course both NPV and IRR will be higher. The problem is that the size of project can cause projects to be ranked differently depending upon which measure you use.

Brealey, Myers, and Allen (2006, pp. 95-96) consider ranking a problem with IRR, but not with NPV. Nevertheless, they show that the problem can be resolved by analyzing the incremental difference between the two alternatives. If the return on the difference between the two alternatives is more than 50% higher than the returns on the $1 million investment, the $1.5 million investment is preferred. Otherwise, the $1 million investment is the better one.

Incrementalism, however, can bring its own set of potential dilemmas. Suppose the choice is between laptops and an integrated product line consisting of three items. Item 1 faces a marketplace characterized by high risk. Item 2's risk is just above the 10% cost of capital; item 3's risk is very low. If each requires an investment of $500,000, what discount rate should be used to discount the difference and compare with the IRR? Each discount rate will bring with it an assumed reinvestment rate with its attendant problem as discussed above.

In addition, imagine the challenges presented if many projects are under consideration. The more the projects, given a fixed budget, the greater the number of difference analyses that must be done.

In summary, NPV has two drawbacks. When RADRs are used, the conservative nature of the NPV cost of capital is lost. The RADR discount rate, whether higher or lower than the cost of capital, is different from investors' required rate of return on their investment in the company, and therefore is unhooked from that conservative measure. NPV also can lead to different project rankings when compared with IRR. This can be a problem when capital budgets are limited and opportunities are many.

## 4. IRR also has unique drawbacks

NPV is preferred over IRR in part because of a number of special difficulties with IRR. These are documented to a greater or lesser extent in most textbooks and in the literature of the 1950s (Alchian, 1955; Bierman & Smidt, 1957; Lorie &

Savage, 1955; Solomon, 1956). However, not all would agree that these difficulties are insurmountable when IRR is used (Hazen, 2003). The problems include the reinvestment assumption, ranking of mutually exclusive projects, and the potential for multiple IRRs.

The reinvestment assumption and the ranking problem with respect to project size have been discussed above. A second ranking problem, discussed here, occurs when projects with different lives are compared. How do you compare projects when one has a 3-year life, one starts in year 2 and ends in year 3, and the third has a 2-year life?

Another special problem with IRR is its curious proclivity to assign several IRRs to one project when its free cash flows change from negative to positive two or more times over the life of the investment. Which IRR is the right one?

In addition to the problems discussed in the 1950s, there is also the problem implied by locking-in of management decision making to the preprogrammed risk level of the IRR. In the usual situation, NPV is preferred to IRR because of its conservatism.

## 4.1. Timing and the ranking problem

IRR will always exceed the cost of capital or the hurdle rate, signaling a decision to invest, when NPV is positive. The reverse is also always true; when the cost of capital or the hurdle rate exceeds IRR, NPV will be negative. However, IRR may not rank mutually exclusive projects in the same order as NPV when the projects have different timing or are of unequal size. The problem of size and ranking was discussed above.

Consider the example in Table 1. The division manager of a company is considering (a) the purchase of laptops and associated equipment for a number of the salespeople and staff, (b) a new piece of software for nearly all of the employees, and (c) the early replacement of some manufacturing equipment. The software will be available 1 year from now, but the cost must be prepaid now. Budget limitations will not allow the division to invest in all three. Each will result in substantial savings represented by the cash inflows. As is typical in finance, all cash flows are assumed to occur at the end of the year. The time periods are annual.

The software is preferred over the laptops alternative on the basis of NPV, even though its IRR is lower. In cases where IRR tends to be low while NPV is relatively high, the cause is later cash flows. These flows are discounted to lower amounts at a higher compounded IRR rate than they would be if they appeared earlier when the rate is compounded to a lesser degree. The laptop free cash flows are being divided by 1 + .25 in year 1. The factor in year 2 is $(1 + .25)^2$ or 1.5625; in year 3 it is $(1.25)^3$ or 1.9531. The factor is compounding 1.25, 1.56, and 1.95. It is not adding 1.25, 1.50, and 1.75.

There is another way of understanding this; the software's $750,000 is reinvested only in period 3, earning a significantly smaller amount through compounding over period 3 than if it is earned in period 1 and reinvested in periods 2 and 3. The first year cash throw off of the laptop alternative is $500,000. It is reinvested in years 2 and 3 and is compounded twice.

The manufacturing equipment alternative has a much smaller cash flow which results in the lowest NPV. Its IRR is highest because of timing. The funds are invested for only 2 years, but the most return comes in year 1 and is reinvested twice.

It only makes sense to compare the alternatives over a common time period if the equipment's cash flow runs out at the end of time period 2. The period involved when comparing alternative investments should equal or exceed the longest lived project (McDaniel et al., 1988). With IRR, investments over differing time periods cannot be made equal without some difficulty.

It is easy to pick the best projects, meaning those with the highest IRR and NPV. As funds are committed and cash runs short, or projects are mutually exclusive, however, managers may have to elimi-

**Table 1** Laptops and the alternatives: NPV vs. IRR

| | t = 0 | t = 1 | t = 2 | t = 3 |
|---|---|---|---|---|
| Laptops | ($1,000,000) | $500,000 | $500,000 | $550,000 |
| NPV | $280,992 | | | |
| IRR | 25% | | | |
| New software | ($1,000,000) | $0 | $750,000 | $900,000 |
| NPV | $296,018 | | | |
| IRR | 22% | | | |
| Equipment | ($1,000,000) | $1,100,000 | $250,000 | $0 |
| NPV | $206,612 | | | |
| IRR | 29% | | | |

nate some projects with positive NPVs and IRRs that exceed their hurdle rates. How can you do that if IRR and NPV rank differently? Many authors recommend NPV or a technique known as the equivalent annual cost approach. The latter is beyond the scope of this article and is obviated by the use of MIRR.

### 4.2. How many IRRs?

The French philosopher, Rene Descartes (1596-1650), found that a series of numbers being discounted or compounded may have as many *roots* as the number of sign changes from negative to positive. In the usual case, there is only one root (or IRR) because there is only one change from negative to positive. All cash flows beyond the initial investment are positive.

There are cases, however, when multiple sign changes occur. A project may require large investments over its life such that the cash flows change from positive to negative several times. In mining ventures it is often the case that the initial investment will be negative for a few periods, turn positive over the life of the mine, and then turn negative as funds are expended to return the site to its original state at the end of operations. In that case, there can be two IRRs that equate NPV to zero.

Plath and Kennedy (1994, p. 82) present a situation where the initial cash outflow is 16. In year 1, there is a cash inflow of 100; while in year 2 there is a cash outflow of 100. There are two sign changes: the negative 16 followed by a positive 100, and the positive 100 followed by a negative 100. If you discount (divide) the positive 100 by $1 + .25$ and the negative 100 by $(1 + .25)^2$, the sum is a positive 16. NPV is zero. Now change the discount rate from 25% to 400%, discount the positive and negative 100s, and the result is also a positive 16. Again, NPV is zero. Two sign changes give two IRRs.

Brealey et al. (2006, pp. 94-95) provide a similar demonstration with a hypothetical strip mine where there is an initial cash outflow at startup, and an additional outflow at the end of operations when the land is returned to pristine condition. Experimentation with multiple sign cash flows demonstrates that (a) the cash flows generating multiple IRRs are rare, and (b) when they happen, all but one of the IRRs are generally implausibly high or implausibly negative. Nevertheless, the issue is a real one.

The two problems uniquely associated with IRR are challenging ones. The issue of timing when budgets are limited is perhaps more vexing because projects rarely have the same lifespan. It is also important to equalize the timing of investment alternatives. Multiple IRRs where there is real confusion concerning which to choose are rare, but real.

## 5. What is MIRR; why is it better?

Executives have avoided MIRR for several reasons. In the Burns and Walker (1997, p. 10) study of the Fortune 500, MIRR was used only 3% of the time and, although it "uses a more realistic reinvestment rate," it was considered "difficult to understand and compute." A lack of academic support has also produced graduates relatively unaware of the power of MIRR. However, Ryan and Ryan (2002) suggest that due to strong theoretical support and its appearance in spreadsheet programs, MIRR will gain acceptance over time, just as NPV has.

The idea behind MIRR is simple in computation, but may be challenging in practice because of the need to estimate reinvestment rates. The MIRR calculation proceeds in three steps: (a) discount the investment funds committed to the project back to the present at a hurdle rate that fairly represents the investment risk, (b) compound the free cash flows (excluding investments) forward to a time horizon at a chosen reinvestment rate that represents expected future opportunities with risks equal to the investment risk, and (c) calculate the IRR.

The modified IRR will be the discount rate that makes the investment equal to the future value of the cash flows from the investment. NPV will equal zero. The time periods between the initial investment and the future value are filled with zeros. If management wishes to be conservative, the free cash flows can be projected at the firm's cost of capital. But this need not be the case if reinvestment possibilities are different.

As with unmodified IRR, a project is financially attractive when MIRR exceeds the project's hurdle rate. When comparing investments of equal size, the higher the MIRR, the more attractive the investment. Also, when two or more investments are involved, the time horizon should be as long or longer than the alternative covering the greatest number of time periods.

MIRR deals effectively with most problems of NPV and IRR. The following problems with NPV and IRR have been identified so far:

1. NPV and IRR are two period measures that cannot account for free cash flows between the periods. In the usual case, a firm's cost of capital will not equal the risk inherent in the reinvestment of the free cash flows. IRR is determined by the size and timing of cash flows, not the cost of capital or the reinvestment potential.

2. If a RADR or hurdle rate is used to account for project market or cost saving risk, the RADR will not reflect the risk associated with the investment

funds of the company as a whole, because it is cut off from the firm's cost of capital. As such, management is locked into the assumption that it not only can, but also will make future investments of the same size at the RADR risk level. NPV and IRR focus management attention on the risk of the investment in question, but not on the future reinvestment implications of their decision.

3. NPV and IRR may rank mutually exclusive projects differently when size, timing, or unequal lives are involved. This issue becomes important when funding is limited or projects are mutually exclusive.

4. IRR may exhibit multiple rates of return when cash flows go from negative to positive more than once.

When IRR is modified properly, it takes account of the cash flows such that there are only two single period indices. Except for investments of unequal size, problems with both NPV and IRR are dealt with. MIRR speaks to Beaves' point (1988, p. 280) quoted previously: These two single period indices (NPV and IRR) "can be generalized to projects that have intermediate cash flows, but such generalization requires a reinvestment assumption whether implicit or explicit." MIRR allows, or requires, the user to determine a discount rate for the investment and a reinvestment rate for cash flows. The rates may be set with or without specific reference to the firm's cost of capital or subsequent IRR of the venture. RADRs may be used with confidence because the reinvestment rate is explicitly considered.

The following example in Table 2 demonstrates MIRR's use and how it solves the ranking problem enumerated above. Here the cost of capital is 10% and the reinvestment rate is 10%.

In each case MIRR consistently ranks the alternatives in the same order as NPV; the larger the NPV, the larger the MIRR will be. This holds true as long as the reinvestment rate equals the cost of capital or hurdle rate. In every case, MIRR is less than IRR because the former specifies a reinvestment rate at the conservative 10% cost of capital, while IRR implies reinvestment at the higher IRR rate. If IRR were lower than the cost of capital, for example at 7%, the cash flows would produce a MIRR higher than IRR and lower than the capital cost.

Table 3 shows that even when the cash flows are dissimilar in time, MIRR ranks projects the same way as NPV when the reinvestment rate is the same as the cost of capital.

MIRR solves Descartes' problem of multiple rates of return. It discounts negative cash flows from investment to the present, and compounds positive and negative cash flows from operations to a future terminal value. Negative cash flows from operations are usually cancelled out by the positive ones, so only one sign change from negative to positive occurs.

When the investment and reinvestment rates are the same as the NPV discount rate, MIRR is the equivalent of the NPV in percentage terms. When they are different, MIRR will be the better measure because it directly accounts for reinvestment of the cash flows at the different rate. As Kharabe and Rimbach (1989, p. 74) note, "Both MRR [MIRR] and NPV can be used to evaluate projects, but the MRR, when interpreted as the interest rate paid by a project or alternative, provides an indication of project efficiency not provided by NPV."

## 6. Adjustments needed for NPV, IRR, and MIRR

As noted above, NPV and IRR face a problem when projects require different investment amounts, and

**Table 2** Laptops and the alternatives: NPV vs. IRR vs. MIRR

| | t = 0 | t = 1 | t = 2 | t = 3 |
|---|---|---|---|---|
| Laptops | ($1,000,000) | $500,000 | $500,000 | $550,000 |
| NPV @ .10 | $280,992 | | | |
| IRR | 25% | | | |
| MIRR | 19% | | | |
| New software | ($1,000,000) | $1,100,000 | $200,000 | $50,000 |
| NPV @ .10 | $140,626 | | | |
| IRR | 29% | | | |
| MIRR | 17% | | | |
| Equipment | ($1,000,000) | $50,000 | $300,000 | $1,400,000 |
| NPV @ .10 | $345,229 | | | |
| IRR | 23% | | | |
| MIRR | 21% | | | |

**Table 3** Laptops and the alternatives redux: NPV vs. IRR vs. MIRR

| | t = 0 | t = 1 | t = 2 | t = 3 |
|---|---|---|---|---|
| Laptops | ($1,000,000) | $500,000 | $500,000 | $550,000 |
| NPV | $280,992 | | | |
| IRR | 25% | | | |
| MIRR | 19% | | | |
| New software | ($1,000,000) | $0 | $1,000,000 | $650,000 |
| NPV | $314,801 | | | |
| IRR | 24% | | | |
| MIRR | 21% | | | |
| Equipment | ($1,000,000) | $1,100,000 | $250,000 | $0 |
| NPV | $206,612 | | | |
| IRR | 29% | | | |
| MIRR | 17% | | | |

funds are limited or projects are mutually exclusive. MIRR also cannot solve that problem on its own. All three must be adjusted using incremental analysis.

A related problem is highlighted when investment funds are required beyond the initial time period. NPV, as generally calculated by hand, discounts all cash flows but the initial one back to the present at the cost of capital or hurdle rate. Hand calculators and spreadsheet programs do this as well. Many opportunities, however, require fixed capital outlays over 1 or more years, and some of them may occur at the same time as cash inflows. If this happens, the resulting free cash flow is a mixture of investment and return.

McDaniel et al. (p. 379) argue that financial outlays should be separated from free cash flows, and discounted at the marginal cost of capital because the marginal cost of capital ''measures the cost of meeting obligations to the capital providers.'' NPV, as usually calculated, does not deal with this issue since it discounts all free cash flows, including investment back to the present. IRR cannot deal with this issue since it is determined solely by the amount and timing of cash flows. MIRR, calculated by spreadsheet programs such as Excel, discounts negative free cash flows back to the present, even if the flows represent a mixture of positive and negative flows. Users of NPV and MIRR need to make the separation between outlays and operating cash flows that McDaniel et al. suggest. Hopefully, computer programs will be developed in the future to deal with this issue.

## 7. Takeaways

Currently, NPV and IRR are the preferred measures of investment attractiveness. NPV is used most often by academics and practitioners, even though executives have evidenced an intuitive preference for IRR.

There are three practical takeaways from this article:

1. Both NPV and IRR have significant drawbacks. Care should be exercised in interpreting what the measures are implying. The drawbacks include (a) management is locked into assumptions about how free cash flows will be reinvested, thereby giving an unrealistic view of an investment's real potential; (b) problems of size, timing, and ranking make comparisons among alternatives difficult when budgets are limited or projects are mutually exclusive; and (c) unmodified IRR suffers from the special problem of multiple IRRs.

2. MIRR deals with these problems by specifically recognizing that cash flows produced by an investment can be reinvested. However, (a) management must specify a return on investment that takes account of the risk of the investment, and (b) management must specify a reinvestment rate given the risks associated with the future investments of the cash flows.

3. All three measures cannot deal with the issue of size differential among alternatives without incremental analysis.

MIRR is a more accurate measure of the attractiveness of an investment alternative because attractiveness depends not only on the return on the investment itself, but also on the return expected from cash flows it generates. Executives seeking to hone their decision making skills will do well to consider the power of this measure.

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