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Pitfalls in Evaluating Risky Projects

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In recent years, the leaders of American companies have been barraged with attacks on their investment policies. Critics accuse American executives of shortsightedness and point out that managers in Japan and Europe often fix their vision on more distant horizons. Here, it is claimed, managers pay too much attention to quarterly earnings reports and not enough to such basic elements of industrial strength as research and development. Some analysts see the root of this problem in the tendency of American companies to rely on discounted cash flow techniques in weighing long-term investments.[1] These critics argue that DCF techniques have inherent weaknesses that make them inappropriate for evaluating projects whose payoffs will come years down the road.

We disagree with the contention that DCF techniques are inappropriate for evaluating long-term or strategic investment proposals. We do believe, however, that companies often misapply or misinterpret DCF techniques. Misuse is particularly serious in evaluating long-term capital investments, such as ambitious R&D projects, that appear to involve high risk.

Misapplication of DCF techniques can certainly contribute to an unwarranted aversion to making long-term investments. However, the problem lies not in the technique but in its misuse. Money has a time value in every economy, and cash is the lifeblood of every business. To evaluate cash flows (costs or revenues) generated in different periods requires a procedure for making comparisons. For evaluating and ranking investment proposals, whether they have short or long lives, and involve capital equipment, R&D, or marketing expenditures, we need techniques that recognize that cash flows occur at different times. Discounting provides a rational and conceptually sound procedure for making such evaluations.

Unfortunately DCF techniques, like computers, can yield impressive-looking but misleading outputs when the inputs are flawed. Managers with biased assumptions may end up with biased conclusions. The fault, however, lies not with the technique but with the analyst. The path to improved capital budgeting requires education in the proper use of rational techniques rather than their rejection out of hand.

In our view, DCF techniques provide valuable information to *assist* management in making sound investment decisions. We emphasize the word assist because it is people, rather than analytical tools, who make decisions. Managers may have many objectives and face many constraints in their decision making. Nevertheless, they need information on the relative financial merits of different options. Properly employed, DCF techniques provide such information. The alternative is to ignore the time value of money and implicitly assume that, for example, a dollar earned ten years from now will have the same value as a dollar today.

DCF procedures, as commonly applied, are subject to three serious pitfalls:

Improper treatment of inflation effects, particularly in long-lived projects.

Excessive risk adjustments, particularly when risk declines in later phases of a project.

Failure to acknowledge how management can reduce project risk by diversification and other responses to future events.

Awareness of these pitfalls should help managers avoid uncritical use of DCF techniques that may lead to poor decisions.

An R&D Project, for Example

Although the comments here apply to a variety of investment proposals, we shall illustrate these three major pitfalls with the analysis of an R&D project. (*Exhibit I* lists examples of other investment projects that are frequently misevaluated for the reasons described in this article.) Because of their risk characteristics, R&D projects present some especially thorny problems. The pronounced uncertainties in these projects affect the analysis of risk in many ways. As a result, R&D projects with acceptable—even exciting—risk/return profiles may fail to meet the payoff criteria that management has established.

Exhibit I	Long-Term Risky Investments Frequently Misevaluated
1	A consumer goods company considers test marketing the first of a proposed new family of products.
2	A paper company studies investment in a new processing technique that could revolutionize paper making.
3	A drug company looks at increasing its investment in biomedical research and the pilot plant that will be required if the research is successful.
4	A real estate developer analyzes the first-stage investment in improvements at a greenfield site for industrial commercial facilities.
5	A financial services firm considers investment in a telecommunications facility that could radically alter the future distribution of its services.
6	A natural resources company evaluates a mineral-rights lease of a site that will require extensive development.

Exhibit I Long-Term Risky Investments Frequently Misevaluated

Let’s look at a typical (hypothetical) project that would be rejected on the basis of the incomplete DCF analysis common in industry today. Then we’ll show how a more complete and careful analysis reveals the project to be not only acceptable but highly desirable.

Our project has three distinct phases, as shown in *Exhibit II*. If the research (Phase 1) is successful, the project moves to market development (Phase 2), after which the resulting product may enjoy a long and profitable period of production and sales. The research and market development phases are periods of investment; returns are forthcoming only during the third period (Phase 3) when the product is sold.

Exhibit II	Project Description
Phase 1	**Research or product development**
	$18 million annual research cost for 2 years
	60% probability of success
Phase 2	**Market development**
	Undertaken only if product development succeeds
	$10 million annual expenditure for 2 years on the development of marketing and the establishment of marketing and distribution channels (net of any revenues earned in test marketing)
Phase 3	**Sales**
	Proceeds only if Phase 1 and Phase 2 verify opportunity
	Production is subcontracted
	The results of Phase 2 (available at the end of year 4) identify the product's market potential as shown below:

Product demand	Product life	Annual net cash inflow	Probability
High	20 years	$24 million	.3
Medium	10 years	$12 million	.5
Low	Abandon project	None	.2

Note: For simplicity, we assume that production is subcontracted in Phase 3 and that all cash flows are after tax and occur at year end. This assumption permits us to ignore some potentially complex tax issues involving depreciation and financing strategies. While a radical departure from reality, this assumption allows us to focus on issues of cash flow timing and risk that appear to be less widely understood.

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It is important to differentiate between these phases, since each has decidedly different risk characteristics. Market development (Phase 2) will not be undertaken unless the research (Phase 1) is successful; thus, considerable uncertainty disappears before Phase 2 proceeds. Similarly, the sales period (Phase 3) follows only after successful results from research and market development. The information from Phase 2 will refine market projections, and Phase 3 cash flows are relatively low risk. In sum, uncertainty about the project diminishes progressively as we acquire more information.

According to the probabilities shown in Exhibit II, the project viewed as a whole (rather than by phases) has the expected-value cash flows shown in *Exhibit III* and an expected internal rate of return (IRR) slightly over 10%. This appears distinctly unattractive, even ridiculous, when compared with customary rates of return (hurdle rates) of 20% or more for high-risk projects. Given this analysis and results, most managers would almost certainly reject the project unless other strategic reasons dictated the investment.

Exhibit III **Expected Cash Flows for the Project**
in $ millions

Years	Expected value calculations
1	− 18
2	− 18
3	.6 (− 10) = − 6
4	.6 (− 10) = − 6
5–14	.6 (.3 × 24 + .5 × 12) = 7.92
15–24	.6 (.3 × 24) = 4.32

Expected IRR = 10.1%

Exhibit III Expected Cash Flows for the Project in $ millions
Expected IRR = 10.1%

Many (if not most) U.S. companies, unfortunately, would probably analyze the project in this way, concluding that it is indeed risky and has an expected IRR below normal hurdle rates. The interpretation of these “facts” is far from obvious, however, and requires a deeper understanding of DCF calculation procedures. The issue is not which buttons to push on a calculator, but rather the appropriate interpretation of the inputs and consequent output since the DCF procedure is no more than a processing technique. The analysis appears sophisticated with its use of probabilities and discounting, but it is incomplete and seriously misleading.

Adjusting for Inflation

The most obvious shortcoming of the analysis is that it ignores how inflation will affect the various cash flows. At one extreme, they may not be affected at all. On the other hand, the cash flows may adjust directly and completely with inflation, that is, an 8% inflation rate next year will raise cash flows in that and following years by 8%. Most likely, inflation will affect different components of the cash flows in different ways and, when aggregated, the cash flows will adjust partially with inflation. Meaningful interpretation of the calculated IRR requires knowledge of this inflation adjustment pattern.

If complete adjustment were anticipated, the calculated IRR would represent an expected real return. However, comparing such real returns with nominal hurdle rates—including inflation—or nominal investment yields (for example, from government bonds) is not appropriate.[2] Historically, real yields on low-risk investments have averaged less than 5%, and the real yield on short-term U.S. Treasury securities has equalled close to zero. For higher risk investments, a frequent standard of comparison is the return (including dividends) on the Standard & Poor's "500" stock index. Over a 53—year period (1926–1978) the real rate of return on the S&P "500" averaged 8.5%. While we cannot be certain that history will repeat itself, long-run averages do provide one standard for comparison. Since listed securities represent an alternative investment, projects of comparable risk reasonably should have expected returns at least as great.

Returning to our hypothetical project, if cash flows adjust fully with inflation, the project offers a real return greater than the historic 8.5% of the S&P "500."

Many types of cash flows, of course, do not adjust fully with inflation, and some do not adjust at all. For example, depreciation tax shields, many lease payments, fixed-rate borrowing (like debentures), and multiyear fixed-price purchase or sales contracts do not change with the inflation rate. Consequently, a proper analysis requires an understanding of the inflation adjustment patterns for different cash flow segments.

While American managers' awareness of the impact of inflation on project evaluation has risen in the last decade, even today many of them have at best a cursory understanding of it. Failure to incorporate inflation assumptions in DCF analyses can be particularly troublesome in decentralized companies. Corporate financial officers commonly specify companywide or divisional hurdle rates based on a current (nominal) cost of capital. Furthermore, analysts at the plant or division level often estimate future cash flows (particularly cost savings) based on current experience. Unless those analysts consciously include anticipated inflation, they will underestimate future cash flows and, unfortunately, many good projects may be rejected.

Parenthetically, the converse is unlikely to occur: it is hard to conceive of an analyst using inflated cash flows with real discount or hurdle rates. Also, projects that go forward usually undergo several reviews that are likely to result in some tempering, or lowering, of overly optimistic cash flow assumptions. By contrast, rejected projects are seldom given subsequent reviews that might reveal unrealistically low inflation assumptions.

The mismatch of inflation assumptions regarding cash flows and hurdle rates is generally most pronounced for projects with payoffs years down the road. So long as the inflation rate is positive (even if declining), the gap between projected real cash flows and their nominal equivalents grows with time. For example, suppose that inflation rates for the next three years are expected to be 8, 6, and 4% respectively. Consider an item that sells for $1 now. If its price will increase at the rate of inflation, its nominal price should be $1.08 next year, $1(1.08)(1.06) = $1.14 in two years, and $1(1.08)(1.06)(1.04) = $1.19 in three years. These inflated prices, rather than the current $1 price, should be incorporated into the DCF analysis if discounting is to occur at nominal rather than real interest rates.

The error that arises from the failure to include inflation in cash flow estimates compounds with time as long as inflation is positive. Under these circumstances, distant cash flows, such as those characteristic of research and development investments, have present values that are more seriously understated. It is difficult to know how widespread such errors have been during recent years, but almost surely they explain in part the shift toward shorter lived projects and myopic investment decisions in many businesses.

Avoiding Excessive Risk Adjustments

A second flaw in the original DCF calculations for our hypothetical R&D project is the use of a single discount rate (IRR) for a project in which risk declines dramatically over time. As a result, the project appears less attractive than it really is. If we make appropriate adjustments for the differing risks in different stages of the project, the investment becomes much more attractive.

A typical discount rate (k) used in DCF analyses may be viewed as composed of three parts: a risk-free time value of money (RF), a premium for expected inflation ($E\pi$), and a risk premium (Δ) that increases with project risk. This relationship can be represented as:

$$1 + k = (1 + RF)(1 + E\pi)(1 + \Delta)$$

For example, a risk-free rate of 3% with 10% expected inflation and a 6% risk premium would imply $1 + k = (1.03)(1.10)(1.06) = 1.20$, or a nominal discount rate of approximately 20%.

Since inflation, as well as project risk and even the risk-free rate (RF), can vary over time, we should permit k to have different values at different times. The subscript t indicates the relevant time period; thus k_t is a function of the RF_t, $E\pi_t$, and Δ_t values for that period. To focus on situations where project risk is expected to change significantly through time, we will use real (deflated) cash flows and real discount rates with RF constant. It is, of course, very important to adjust for expected inflation properly. Without losing sight of that point, let's shift the focus of discussion to risk adjustments by assuming that the inflation adjustments have been executed properly.

Denoting the real (risky) discount rate for period t as r_t, we have:

$$1 + r_t = (1 + RF)(1 + \Delta_t)$$

This differs from k_t simply by the removal of the inflation factor $(1 + E\pi_t)$. Then by definition, the NPV of a project with expected real cash flows (CF_t) occurring in two periods is:

$$\begin{aligned} NPV &= \frac{CF_1}{1 + r_1} + \frac{CF_2}{(1 + r_1)(1 + r_2)} \\ &= \frac{CF_1}{(1 + RF)(1 + \Delta_1)} \\ &\quad + \frac{CF_2}{(1 + RF)^2(1 + \Delta_1)(1 + \Delta_2)} \end{aligned}$$

This brings us to a key point. If $\Delta_1 = \Delta_2 = \Delta$, this formula collapses into the familiar form with a single discount rate:

$$\begin{aligned} NPV &= \frac{CF_1}{(1 + RF)(1 + \Delta)} + \frac{CF_2}{(1 + RF)^2(1 + \Delta)^2} \\ &= \frac{CF_1}{1 + r} + \frac{CF_2}{(1 + r)^2} \end{aligned}$$

In practice, virtually all DCF calculations are performed using a constant discount rate such as r. Indeed, financial calculators are programmed that way. Under what conditions, however, can we assume that $\Delta_1 = \Delta_2$ (even approximately)?

This assumption is reasonable if we anticipate that errors in predicting real cash flows result from a random walk process—that is, predictions one period into the future always entail the same uncertainty. Thus if we were at time 1, each dollar of real cash flow in period 2 would look just as risky as each dollar of CF_1 looks now. However, predicting two periods into the future is more risky; thus CF_2 viewed from the present deserves a larger risk adjustment. Consequently, CF_2 is multiplied by $1/(1 + \Delta)^2$ as opposed to simply $1/(1 + \Delta)$ for CF_1. In more general terms, the risk adjustment factor for a cash flow t period in the future is $1/(1 + \Delta)^t$. The risk adjustment grows geometrically with time.

Using a single risk-adjusted discount rate, therefore, implies an important and somewhat special assumption about the risks associated with future cash flow estimates: such risks increase geometrically with chronological distance from the present. On the infrequent occasions when this assumption is mentioned, it is usually justified on the grounds that the accuracy of our foresight decreases with time. While that argument has merit, consider what can happen when an investment proposal does not fit this pattern.

Recall our R&D project. If the cash flows of Exhibit II are in real terms, the project has an expected real IRR of 10%; but there is a 40% chance of investing $36 million (real, after tax, but undiscounted) during the first two years and receiving nothing. Many decision makers would demand a much higher return than 10% (real or otherwise) to undertake such an investment. If the project proceeds to Phase 3, the cash flows in that phase are considered relatively low risk. The large risk adjustments that were appropriate for early phases are no longer appropriate once we reach Phase 3.

To highlight this point, let's suppose that Phase 3 could be sold if the project successfully proceeds through the first two phases. Given its low risk, potential investors might evaluate Phase 3 with a low discount rate such as 5% (real). Suppose market research reveals a high demand for the product during Phase 3: 20-year life with annual net cash inflows of $24 million. Discounting these flows at 5%, we reach a value at the beginning of Phase 3 (end of year 4) of $299 million. Thus if strong demand develops for the product, it's possible the rights to produce and market it could be sold for a considerable sum. This value depends, however, on the marketing results from Phase 2. Thus we need to check what happens if less favorable demand conditions are revealed in Phase 2. Performing similar calculations for the other possible market conditions, we obtain the values in *Exhibit IV*.

Exhibit IV **Anticipated Phase 3 Values if Sold**
in $ millions

Demand	Probability	Value of Phase 3 year 4
High	.3	299
Medium	.5	93
Low	.2	0
Expected value =		136

Exhibit IV Anticipated Phase 3 Values if Sold in $ millions

Even though there is a 20% chance of low demand, the overall expected value of selling Phase 3 is $136 million. Suppose we now recalculate the project's expected IRR assuming such an outright sale of Phase 3 for its expected value: $136 million. Using the 60% probability of Phase 1 success, we calculate the expected cash flows to be those in *Exhibit V*. Those net expected cash flows are equivalent to an expected IRR of approximately 28%. In other words, the prospect that Phase 3 could be sold as just discussed leads us to revise the overall expected IRR for investing in the project from 10 up to 28%. Since these calculations are in real terms, the project now appears quite attractive.

Exhibit V **Expected Cash Flows with Phase 3 Sale**
in $ millions

Year	Outflow	Inflow	Net
1	– 18		– 18
2	– 18		– 18
3	– 10 × .6		– 6
4	– 10 × .6	136 × .6	75.6

Exhibit V Expected Cash Flows with Phase 3 Sale in $ millions

Pushing this analysis one step further, let's assume the project could also be sold at the end of Phase 1 if the research is successful. That is, the new owner after purchasing the project would pay an estimated $10 million per year of Phase 2 costs and receive the Phase 3 value (depending on marketing research results) as shown in Exhibit IV. The purchaser would now encounter the expected cash flows indicated in Exhibit VI.

Exhibit VI	Expected Cash Flows for Purchaser of Phase 2 in $ millions		
Year	**Outflow**	**Inflow**	**Net**
3	– 10		– 10
4	– 10	136	126

Exhibit VI Expected Cash Flows for Purchaser of Phase 2 in $ millions

Clearly this proposition is riskier than just buying Phase 3, since the marketing research results of Phase 2 are not yet known. Suppose a potential purchaser evaluated the cash flows in Exhibit VI using a 20% discount rate (well over twice the historic real return on the S&P “500”). The implied purchase price (present value at the beginning of Phase 2) is slightly over $79 million. But what is the implied return to the first owner—the initial developer of the product who undertakes the risky proposition of investing $18 million for each of two years in research—if a successful project could be sold at the end of two years for $79 million? The expected real return (including the 40% chance of Phase 1 failure) is over 63%—a far cry from our initial estimate.

This analysis illustrates a pitfall in evaluating projects with risk patterns that differ significantly from the simple random walk assumption. In our example, uncertainty is greatest during the first two years. But it is unreasonable to penalize more than 20 years of subsequent cash flows for that risk. To dramatize this point, we have assumed that the project can be sold in its latter phases. Indeed, the project acquires a dramatically high value if Phase 1 succeeds—a point missed by the initial IRR calculation, which implicitly discounted all cash flows at the same rate.

The difficulty with using a single risk-adjusted discount rate (or IRR) is that the analysis blends time discount and risk adjustment factors. Unless project risk follows a simple random walk pattern, this blending is inappropriate. Although this problem is discussed in the academic literature,[3] it is generally ignored in practice. For projects with dramatically different risk phases, the result can be a serious misestimation of project value.

A more appropriate procedure for evaluating such projects is to separate timing and risk adjustments using the concept of certainty equivalent value (CEV). The CEV of a cash flow in a given year is simply its risk-adjusted value in that year. If we converted all future cash flows to CEVs, we could then discount the CEVs to the present using a single risk-free discount rate. With the timing and risk adjustments thus separated, we avoid the possibility of compounding risk adjustments unintentionally.

As a practical matter, attempting to convert each year's cash flow into a CEV can be cumbersome since the CEV for period t may depend on probabilities for cash flows in the previous period (t–1), which in turn depend on probabilities from t–2, and so on. In our example, the cash flows in Phase 3 depend on results from Phases 1 and 2. Indeed, we have assumed that management would abandon the project altogether if the research is unsuccessful or market tests indicate low demand.

Although it is important to consider interactions among cash flows in different periods, the analysis of all possible management responses or other contingencies would be extraordinarily complex and unwieldy. Thus we need reasonable approximations. Managers and analysts must exercise judgment regarding which risks and possible actions should be included in the analysis. We recommend that high-risk projects be evaluated as a sequence of distinct risk phases (of perhaps several years each).

In our example, we did not attempt to calculate CEVs for each year in Phase 3. Rather, we estimated a value for the whole phase conditional on the demand level. Similarly, our calculated $79 million value for the project if Phase 1 succeeded is a CEV (at the beginning of year three) for Phases 2 and 3 combined. In both cases, these CEVs are estimates of the project's potential selling price—its market value at the end of years two and four respectively. While the project might be worth more to the company if it retained all phases, the market CEVs represent opportunity costs for retaining Phases 2 and 3 that are useful (and conservative) yardsticks for evaluating the entire project.

Estimating market values for different phases is obviously an imprecise process. Using a single risk-adjusted rate for an entire phase (rather than separate rates or CEVs for each cash flow) produces only an approximation, unless risks within that phase have a random walk pattern. The approximation is reasonable, however, if the discount rate is low and/or the phase covers a fairly short period of time (as in Phases 1 and 2 above). If a phase is both long and risky, analysts should divide it into subphases.

To restate our argument, we recommend segmenting projects into risk phases, then valuing sequentially each phase, working backward from the last. This procedure can be used to determine either an expected IRR on the initial phase (as already illustrated) or an NPV for the project. In general, we prefer calculating NPVs since this avoids technical problems with IRR, including scale ambiguities. Although slightly more complex than a standard expected NPV or IRR calculation, our approach is not difficult per se. It simply entails a short sequence of expected NPV calculations using different interest rates to value different risk phases. When a project's risk pattern differs substantially from the simple random walk assumption, such differences should be recognized and the evaluation procedure modified accordingly. As we have shown, evaluation based on inappropriate analysis can be very misleading.

Considering the Eye of the Beholder

A third major problem in project evaluations is correctly assessing project risk and how managers can influence its nature and level. Here it is important to consider the perspective of the analyst. Risk that seems excessive to an R&D or project manager may appear reasonable to a corporate executive or a shareholder who can diversify the risk by spreading it across other investments. Also, managers can influence the level of risk by future actions that affect the ultimate payoff of a project investment.

Frequently, the major uncertainty in R&D investments is whether the research phase will produce a viable product. From the perspective of financial market theories such as the Capital Asset Pricing Model (CAPM), risks associated with the research phase are apt to be largely diversifiable. Consequently, a public shareholder with a well-diversified securities portfolio will probably voice little or no concern about these risks. Success or failure in the lab is probably correlated weakly (if at all) with broad economic forces or other systematic nondiversifiable factors that affect returns in the stock market as a whole.

The CAPM and related theories stress that a project's total risk normally contains both diversifiable and nondiversifiable components. To the extent shareholders can easily diversify their holdings in the financial markets, they can reduce *their* portion of the project's diversifiable risk to a very small level. Under these circumstances, the shareholders need worry only about the systematic portion of project risk. Thus a financial market approach suggests that the typical R&D project is much less risky from the perspective of a well-diversified public shareholder than it may appear to the individual performing the DCF analysis.

In contrast, managers, creditors, and even suppliers may focus on total risk (including both diversifiable and systematic components) at the company level. These groups have interests that are not easily diversified in the sense that the CAPM assumes. Thus they are concerned about total cash flow variability but at the company (not project) level. Even at the company level, however, the R&D budget may be spread across many projects. A multi-industry company of even moderate size is probably sufficiently diversified to allow large reductions in cash flow variability per dollar of R&D investment. Once again, the risk of a particular project appears lower from a portfolio perspective than from the perspective of an analyst looking only at the project itself.

Calculating Inflation's Effects

To correctly allow for inflation in a DCF analysis, some analysts include it in the cash flows and use nominal …

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Most managers are aware of portfolio effects and the arguments regarding shareholder welfare based on financial market models such as the CAPM. Nevertheless, it is understandable that they view a project with over a 50% chance of no payoff (as in our example) as highly risky. Under such circumstances, it is easy to ignore portfolio effects and worry too much about the risk of that particular investment opportunity. This excessive risk aversion is frequently manifested in a too-high discount or hurdle rate, thus compounding the pitfalls already discussed.

Analysts may also use conservative estimates: overestimates of development time or costs and underestimates of both the magnitude and duration of subsequent payoffs. Although the tendency toward excessive conservatism is both inevitable and difficult to overcome, management needs to be aware of its existence and sensitive to its consequences. As we said earlier, projects that have been rejected are seldom reevaluated. It is all too easy for a good project to be lost.

While excessive risk adjustments are certainly not unique to R&D proposals, the problem may be more severe here because R&D projects involve large and obvious uncertainties. The key is that these risks are likely to be highly diversifiable. Failure to recognize this fact represents a systematic bias against R&D projects.

Managers can also affect the level of risk by influencing the distribution of project payoffs. In our example, there is a 30% chance that Phase 3 will be worth $299 million. There is not a symmetric chance of losing $299 million—because the company will abandon the project if faced with low product demand. The result is an *expected* value for Phase 3 ($136 million) which is $43 million above the *most likely* estimate of $93 million. Unfortunately, many project evaluations consider only the most likely cash flow estimates and ignore the asymmetry or skewness of the payoffs. This practice understates the project's true value in situations in which future management actions can improve profits or limit losses.

This problem is more significant for R&D projects than for other investments because the company has greater flexibility to expand production for highly successful products and to abandon apparently unprofitable efforts. Such managerial actions can result in greater returns than estimated originally (larger revenues over a longer period) as well as reduced downside risk.

In our example, suppose progress can be monitored throughout Phase 1, and management has the option to abandon the project at the end of the first year if certain goals are not met. If the probability of research failure is equally divided between years one and two (20% each), the expected IRR from an initial investment in Period 1 research increases from 63% to 83%, with no change in our other assumptions (*Exhibit VII* shows the relevant cash flows). Clearly management's ability to skew a payoff distribution in the company's favor can have an important influence on a project's desirability.

Exhibit VII **Expected Cash Flows if the Project Can Be Abandoned During Phase 1** in $ millions

Year	Expected outflow	Expected inflow	Expected net cash flow
1	– 18		– 18
2	– 18 × .8	79 × .6	33

Exhibit VII Expected Cash Flows if the Project Can Be Abandoned During Phase 1 in $ millions

DCF Analysis in Perspective

How much the misuse of DCF techniques has contributed to the competitive troubles of American companies is a matter of conjecture. It is clear, though, that incomplete analysis can severely penalize investments whose payoffs are both uncertain and far in the future. Given these perils, one might argue that DCF procedures should be avoided or should be accorded little weight in long-term investment decisions. We strongly disagree. It is foolish to ignore or to indict useful analytical tools simply because they might be used incorrectly or incompletely. Rather, analysts and decision makers should recognize potential problems and be careful to ensure that evaluations are performed correctly. Managers cannot treat a DCF evaluation like a black box, looking only at the output. They need to break open the box, examine the assumptions inside, and determine how those assumptions affect the analysis of a project's long-term profitability.

DCF procedures can help evaluate the implications of altered price, cost, or timing assumptions, but managers must first specify the correct assumptions. These procedures can also be used to examine the effects of different capacity expansion or R&D strategies under many scenarios. However, again managers must specify the strategies or scenarios to be examined. In short, discounting is only one step in evaluating alternative investment opportunities. This fact has frequently been lost in the arguments (pro and con) about the use of discounting procedures.

Blaming DCF procedures for shortsightedness, biased perceptions, excessive risk aversion, or other alleged management weaknesses does not address the underlying problems of American industry. However, understanding the pitfalls in the casual use of DCF techniques can both improve the analysis of capital investment projects and place these techniques in a more appropriate perspective.

It is important to remember that managers make decisions. DCF techniques can assist in that process, but they are only tools. Correctly used, these techniques provide a logical and consistent framework for comparing cash flows occurring at different times —an important aspect of virtually every investment project.

1. See for example, Robert H. Hayes and David A. Garvin, "Managing as if Tomorrow Mattered," HBR May–June 1982, p. 71.

2. James C. Van Horne, "A Note on Biases in Capital Budgeting Introduced by Inflation," *Journal of Financial and Quantitative Analysis,* Janaury 1971, p. 653.

3. See, for example, Alexander A. Robichek and Stewart C. Myers, "Conceptual Problems in the Use of Risk-Adjusted Discount Rates,"' *Journal of Finance,* December 1966, p. 727.

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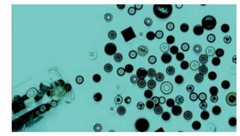

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