ABSTRACT

The most common way to handle risk in discounted cash flow analyses is to increase the discount rate above the risk-free rate. Since most investors dislike risk, or variability in returns, a higher discount rate will correctly reduce the present value of risky revenues, thus reflecting the disutility from risk. However, some analysts have suggested that, for risky costs, exactly the opposite should occur: The discount rate should be reduced, thus increasing the present value of risky costs to reflect the disutility from variance in costs. Others support the standard practice of using the same risk-adjusted discount rate for risky revenues and costs. This paper reviews the conditions under which it would or would not be appropriate to reduce the discount rate for risky costs and discusses policy implications.

INTRODUCTION

In calculating present values of future risky cash flows, most investors use a risk-adjusted discount rate (RADR) higher than the risk-free rate. While this approach raises many theoretical questions, it is widely used because usually not enough information is available to apply more sophisticated methods of risk analysis. For example, the U.S. Office of Management and budget (OMB) recommends that Federal agencies evaluating investments should use a 10 percent real interest rate to discount expected values of risky future benefits and costs (USOMB 1972). Based on Simon's (1990) long-term projection of a real risk-free rate of return of 3 percent, OMB's 10 percent includes a 7 percent "risk premium." This paper addresses the possibility that such discounting may often under-estimate the present value of future risky costs.

Cash flow risk is defined as variance in the cash flow, compared to a risk-free payment which occurs with certainty at a predictable level and time. In computing present values, the cash flow being discounted is the "expected value," or the average amount which could be expected with many repetitions of the investment. Following results of previous empirical
research, this discussion assumes that most investors are risk-averse and would prefer a sure cash flow to a risky one of the same expected value (see, for example, Halter and Dean 1971, Wilson and Eidman 1983, Litzenberger and Ronn 1986).  

Risk-averse investors use RADRs above the risk-free discount rate in order to reduce present values of risky revenues to account for the dissatisfaction brought by risk. This reasoning suggests increasing a risky cost's present value to account for disutility from risk. Thus, some analysts recommend risky costs should be discounted with RADRs lower than the risk-free rate. Risk-free costs -- for example, loan payments -- should be discounted with a risk-free rate, as should risk-free revenues.

Future costs can therefore be under-estimated by the "standard practice" of discounting revenues and costs with the same risk-adjusted discount rate higher than the risk-free rate. Also, confusion exists on the relevance of correlation between risky costs and revenues. If revenues exceed costs in any year, and revenues and costs are perfectly and positively correlated, the standard practice in discounting is appropriate because revenues will always offset costs. But in the usual case were costs are uncorrelated with revenues, some analysts recommend a lower discount rate for costs than for revenues.

THE ARGUMENTS IN DISCOUNTING RISKY COSTS

Lewellen (1977) noted that costs which have a perfect positive correlation with revenues or with the market in general, can simply be offset by revenues in the year they occur. In such cases, net revenues can be discounted with a RADR above the risk-free rate, which is the standard practice of discounting costs and revenues with the same RADR. But Celec and Pettway (1979), argue that perfect correlation of costs and revenues (for example income taxes and income) is the exception rather than the rule. They thus recommend that in most cases, risky costs should be discounted with RADRs lower than those used for revenues. This conclusion is now found in some finance texts (for example, see Brigham and Gapenski 1991).

In the environmental economics literature, Brown (1983) showed that not only should the RADR for risky costs be below that for risky revenues, but risky cost RADRs should actually

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1 Samuelson (1964) suggests that the large numbers of government projects and taxpayers provide a risk pooling effect where extraordinary losses and gains offset one another in any year. That view supports a risk-free discount rate for risky government projects. But decision makers or groups within government agencies often behave like risk-aversers. Moreover, Hirshleifer (1966) notes that setting the public discount rate below the private rate is like charging different prices for the same commodity. In that case, shifting dollars from public to private investment could improve welfare (Arrow and Lind 1970). While the issue of a government risk premium is unresolved, this paper assumes that public and private investors use the same risk premiums and follows Hirshleifer's (1964) view that public investors should behave as if they were risk-averse. This approach is further justified because most public agencies simulate risk-averse behavior by using discount rates which substantially exceed the risk free rate.
be less than the risk-free rate. He noted that the correct present value of a future risk-free cost is computed with a risk-free discount rate and that a risky cost of the same expected value and timing should have a higher (negative) present value for a risk-averse investor. He reasoned that this can only occur when the risk-adjusted discount rate for the risky cost is less than the risk-free rate. Prince (1985) responded by maintaining that Brown’s conclusion is consistent with subtracting costs from revenues and discounting net revenues with the same RADR, as long as revenues exceed costs. But Prince failed to note that his conclusion only holds for the special case where revenues and costs are perfectly correlated (the case of Lewellen, whom Prince did not cite). Preliminary searches show that neither Brown’s paper nor Prince’s incorrect interpretation have received much attention in the forest economics literature, although Price (1993) mentions their findings, and the issue is briefly discussed in Klemperer (1996).

One unresolved issue is how to measure the degree of correlation between risky costs and revenues. In a given period, if revenues offset costs, and both are perfectly correlated, the same discount rate can apply to revenues and costs. As correlation diverges, say by measure of the correlation coefficient, the discount rate for expected costs drops below that for expected revenues. We need to explore the implications of different degrees and measures of correlation between costs and revenues.

When risky costs include possible losses of unique ecosystems, the literature on the "endowment effect" may be relevant (Kahneman et al. 1990, and Shogren et al. 1994). This effect refers to people’s resistance to giving up non-market goods which have no perfect substitutes. This provides an added rationale decreasing the discount rate for risky environmental costs in order to boost their present value.

Certainty-Equivalent Analysis

For any investment scenario, the theoretically correct optimal management plan would be that which yielded the maximum net present value of the investor’s "certainty-equivalents" discounted with a risk-free discount rate. The certainty-equivalent of an uncertain expected revenue (cost) is that sure sum which would bring the investor the same utility (disutility) as the expected revenue (cost). For a risky revenue, it is well-known that a risk-averse investor will cite a certainty-equivalent which is lower than the expected value of the risky revenue (Robichek and Myers 1966). Following that reasoning, the same investor’s certainty-equivalent of a risky cost ought to exceed that cost’s expected value. If the correct present value of an expected risky cost is its larger certainty-equivalent discounted with the risk-free interest rate, that same correct present value could thus be obtained by discounting the cost’s expected value with a discount rate less than the risk-free rate.

A Loan Valuation Example

As an example of using different discount rates for costs and revenues, consider the impact of a 10-year, $100,000 loan on a project’s present value. If the real loan interest rate is 5% and includes a 4% projected inflation rate, the nominal loan interest is (1.05)(1.04)-1 = .092, or 9.2%. Using a capital recovery formula, annual nominal fixed loan payments are $15,719.50 per year.

Suppose the investor discounts project cash flows with an 8% real rate and projects 4% inflation, yielding a nominal discount rate of (1.08)(1.04)-1 = .1232, or 12.32%. Using the typical approach of discounting all cash flows with the same discount rate (e.g., the above 12.32%), the loan’s impact on project present value would be:
or the loan amount minus the present value of loan payments, using the nominal discount rate, since the loan payments are fixed in nominal terms.

However, The borrower’s present value of a fixed payment loan should be calculated with a risk-free interest rate, separately from present value of the risky cash flows. From the borrower’s view, loan cash flows are perfectly certain: the borrower knows that the $100,000 income will occur, and the firm has signed a contract to make payments. Suppose the risk-free real discount rate is 3%. This gives a nominal risk-free rate of (1.03)(1.04)-1 = 0.0712, or 7.12%, given the 4% projected inflation rate. From the borrower’s view, the loan adds the following present value to the timberland purchase, computing with the nominal risk-free discount rate:

$$100,000 - 15,719.50 \frac{(1.1232)^{10} - 1}{.1232(1.1232)^{10}} = 100,000 - 109,797 = -9,797$$

Although the NPV to the borrower is negative before taxes, the firm can save on its income taxes by deducting loan interest. Thus the net impact of the loan may not be negative. Another twist is that borrowing money makes the timberland venture more risky to the borrower, since there is now the obligation to pay off the loan, no matter what the income from the tract will be, thus increasing the risk of bankruptcy. That could boost the appropriate discount rate for the tract’s other cash flows, and reduce NPV to the buyer.

The literature is rife with disagreement about the effect of debt on a firm’s value. The key point to remember here is: When computing the present value of a loan, the borrower should not use the risk-adjusted discount rate (higher than the risk-free rate). For risky revenues, we increase the discount rate above the risk-free rate to decrease present value, thus reflecting the disutility from revenue variance. But there is no reason for the borrower to reduce the present value of loan payments by increasing the discount rate as was done in equation (1). This over-states NPV by understating the present value of loan payments. Since the borrower’s correct loan present value is minus $9,797, equation (1) over-states the loan NPV by the difference between the two values, or $22,130, ignoring tax impacts. Such errors can cause over-bidding for properties and over-valuation of leveraged assets in general. Investors who over-pay for assets will not earn their desired rate of return, adjusted for risk.

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2 See Modigliani and Miller (1958 and 1953).

3 It is incorrect to assume that, every year, income will offset the borrower’s loan payments and to just discount this net revenue with the risk-adjusted rate (RADR). That would be like discounting costs and revenues separately with same the RADR. But that view ignores the fact that loan payments are completely independent of revenues. Whether income is high, low, zero, or negative, loan payments are always due (unless a borrower declares bankruptcy). Discounting loan payments with a risk-free rate reflects the disutility from this unavoidable certainty of costs.
CONCLUSIONS

In forest investment analysis, the issue of discounting costs raises important questions which need more research. To what extent is incorrect discounting of future costs in forestry leading to inefficient decisions? What are some of the theoretical questions or unresolved issues in the area of discounting costs? How important are these issues in evaluating future damage to forest ecosystems?

As an example, consider the following hypothetical probability distribution for forest damage caused by fires in a region, ten years from now: the probability of $40 million damage is 20%, $80 million is 40%, $120 million is 30%, and $160 million is 10%. The expected value of damages (or expected cost) is \(0.2(40) + 0.4(80) + 0.3(120) + 0.1(160) = 92\) million. Discounting with OMB’s 10%, the present value of damages is \(92/(1.10)^{10} = 35.5\) million, which would be today’s willingness to pay to avoid the damage. But if we discount with a reduced rate, say, 2% (below the risk-free rate), to reflect the disutility from damage variation, the present value of expected damage is $75.5 million, or over twice as high. Such valuation discrepancies obviously have enormous policy implications. The cost discounting issue is important in government benefit/cost analyses, many of which use the above-mentioned 10% discount rate for both revenues and costs. Does this result in serious under-estimation of some risky costs?

Cost discounting theory suggests that borrowers’ loan payments should be discounted with a risk-free discount rate, since payments are risk-free, as shown in the earlier example. To what extent are analysts overstating the benefits of borrowing when they include loan payments in discounted cash flow analyses which use one RADR greater than the risk-free rate?

Given the variable risks involved in resource management costs, the long time horizons in resource planning, the large public and private investments made in natural resources, the potential for environmental damages, and the importance of future costs in most investments, the question of correct discounting of risky costs is extremely important, nationwide and worldwide. It behooves us to examine this issue more closely.

LITERATURE CITED


