



IRR vs. NPV

Timberland owners are constantly facing questions of which investment will be the best to make. Genetically improved seedlings will grow faster and produce higher volumes (or earlier harvests) than "unimproved" seedlings, but they cost more. Fertilizing a stand at age 3 will improve growth rates, but it costs something to apply that fertilizer.

Capital Budgeting Decision Methods

The question of which method to use in making capital budgeting decisions has filled whole volumes of the financial and economic literature. Here we present a short history and a quick review of current thinking.

Payback

In ancient times (pre-1980), the Payback method was usually used in making capital budgeting decisions because it is easy to compute.¹ The cash flows are not discounted. Cash flows that occur after the payback period are generally ignored. More sophisticated methods were difficult without computers.

A drawback to the Payback method is that it ignores the magnitude of the returns. If the choice of seedling does not change the rotation age, the Payback method does not provide a method of choosing between improved and unimproved seedlings because the timing of the cash flows would not change--if both stands would be

harvested in year 25, then the payback period for both investments is 25 years² and the Payback method does not tell us which project is better.

With the advent of personal computers, the Payback method has generally been replaced by two other tools.

Net Present Value

Thirty years ago I was working for a timberland-owning paper company that was just making the transition from using Payback to using Net Present Value (NPV) as a means of making capital budget decisions. The NPV method provides a clearer picture (than the Payback method) of the difference between the improved/unimproved seedlings: if the increased volume from the improved seedlings more than offsets the additional cost of the seedlings, they will be planted because the NPV for the improved seedlings will be positive. If the additional volume does not offset the additional cost, then the unimproved seedlings will show a higher NPV. Since the objective for most investment is to maximize wealth, investments with higher NPVs are preferable to investment with lower NPVs.

Foresters are taught at a young age to use NPV in their capital budgeting decisions.³ Forestry investments were difficult to justify under the payback method because the payback period for a forestry investment could be twenty or thirty or fifty years and other investments might pay off in two or five years.

¹ For our younger readers who may not have been subjected to this method in school, the payback period is the number of years needed to recoup the original investment: if you invest \$1 million and get back \$500,000 each year, the payback period is 2 years. If the investment returns \$250,000 each year, the payback period is 4 years. A project with a shorter payback period will be ranked higher than a project with a longer payback period.

² This assumes the revenues received from the timber harvest are greater than the costs incurred over the years for both investments.

³ Foresters have been using the NPV approach in one form or another since Faustman's work in 1849.

It was possible to calculate NPVs even before computers were invented--but it was an extremely slow and cumbersome process. The cash flows for each year had to be discounted manually. The formula for the present value of the cash flows in a given year is simple enough:

$$PV = FV/(1+i)^n$$

where: PV is the present value
FV is the future value
i is the discount rate
n is the year

The tricky part here is the $(1+i)^n$ factor. In year 2, that calculation is $(1+i)*(1+i)$ --easy enough with pencil and paper. But in year 15 it becomes $(1+i)*(1+i)*(1+i)*(1+i)...$ etc. (multiplied out 14 times). That is tedious with pencil and paper, and even more tedious if the cash flow is occurring in year 50.

As far back as the very early 1900s foresters were aided by books of tables where those factors were all calculated for them: look down the table to the row for the year and across the table to the column for the discount rate and where the row and column cross is the value of the $(1+i)^n$ factor to be used in the calculation. But there are limitations to these books of tables--you can only use the discount rates they supply.

Sensitivity analysis under these conditions was virtually non-existent. Any change in cash flows required recalculation of all the present values for any years in which the cash flows changed. Changing the discount rate required looking up new discount factors for each year.

Spreadsheets have made NPV calculations easy. Microsoft's Excel, for example, comes with several built-in functions for calculating the NPV of an investment. But care is needed in using these functions, as they can produce a wrong answer just as quickly as a correct answer and the calculation is a black box. For example, the function may treat the timing of the cash flows differently than the user expects. In ancient times it was assumed that the investment and other cash outflows took place at the beginning of the year and all cash inflows

(revenues) took place at the end of the year. This means a cash inflow in a given year was effectively discounted one more year than a cash outflow in the same year. But the Excel NPV function treats all cash flows (in or out) as if they occurred at the same time.

IRR

The Internal Rate of Return (IRR) is another currently popular method of making capital budgeting decisions. A project with a higher IRR will be ranked higher than a project with a lower IRR. The IRR represents the discount rate at which the NPV is forced to zero.

The IRR was nearly impossible to calculate in the old days, because it required iterations of NPV calculations.⁴ If a 7 percent discount rate provided a positive NPV, then you knew the IRR was higher than 7 percent. If you then spent the time to recalculate the NPV using an 8 percent discount rate and the NPV turned out negative, you now knew the IRR was somewhere between 7.0 and 8.0 percent. You could then continue to try different discount rates until the NPV was zero.

As with NPV calculations, spreadsheets have made the IRR calculation easy. One problem the spreadsheets have not solved is that the IRR calculation can produce more than one answer if the cash flows become negative in the future.

IRR vs. NPV: Which is Best?

Periodically (generationally?) the question arises as to which method is best.

Simplistically, if the goal is to maximize value, the NPV is the preferred method because it explicitly provides an expected value, while the IRR does not.

The literature tends to agree that both methods provide the same ranking if projects are independent of each other and of the same length and magnitude.

⁴ Gregory (1972) noted that "Programs for computing internal rates of return are available at almost any computing center" (p. 288).

If these conditions do not apply, then the two methods produce different/conflicting rankings. A common (overly simplified) example for projects of different magnitudes runs something like this:

Assume there is \$50 million to invest and there are two projects from which to choose.

- Project A involves an investment with an NPV of \$1 million and has an IRR of 9%.
- Project B involves an investment with an NPV of \$55 million and has an IRR of 7%.

Clearly Project A has a higher internal rate of return, but it only produces an NPV of \$1 million. If the objective is to make a significant investment in timberland, it does not help much as it leaves most of the funds sitting in cash. Project A does little to increase total value for the investor. The investor would have to find dozens of similar projects to fully invest the funds. Project B puts most or all of the funds to work for the investor and makes a large contribution to value. While this is a highly biased and overly simple example, it does show the problem of focusing on the return and not the value.

An advantage to the NPV method is that not commonly recognized is that different discount rates can be used in the analysis. This allows different levels of risk to be applied to future cash flows. For example, a higher discount rate could be applied to carbon credit revenues as these are more uncertain than timber harvest revenues. These different discount rates cannot be used if the Excel NPV function is used to calculate the NPV, but can be used if individual cash flows are discounted separately by year.

Forest Economics Recommendations

Within the forestry and timberland community, the NPV is usually described as the better method, while the IRR is described as simpler and easier to understand.

Gansner and Larsen (1969) said the NPV method was better because:

- "Using the appropriate discounting rate the investor can calculate a correct and

unambiguous present value which can be used to judge the financial merit of this investment."

- "...when the problem is to choose between mutually exclusive productive investment alternatives, the internal rates of return to these options will not rank them consistently with their present values. A choice cannot be made without knowing the appropriate discounting rate."⁵

Davis and Johnson (1987) said:

- "The internal rate of return...has theoretical and practical limits to its application. ... The disadvantages are many, and careless use of the internal rate of return can give bad decision guidance."⁶

Bullard and Straka (2003) wrote

- "...choosing investments with the highest NPV ensures that the present value of all future net income is maximized....Maximum NPV corresponds to maximum wealth. Choosing between mutually exclusive investments based on [IRR], however, will not guarantee that wealth is maximized."⁷

Zinkhan and Cabbage (2003) wrote:

- "Net present value is generally recommended as being superior in most textbooks....Selecting the projects with the highest total LEV⁸ with a given limited budget will generate the most net returns for that amount of capital."⁹

And from Clutter, et al (2006):

- "The most common measures of financial performance are net present value and internal rate of return. Internal rate of return is the more common measure while net present value is generally preferred by academics when making such financial decisions."¹⁰

⁵ Gansner and Larsen, 1969, p 5.

⁶ Davis and Johnson, 1987, p. 317

⁷ Bullard and Straka, 2003, p. 4.28

⁸ The Land Expectation Value (LEV), a special form of NPV, is the NPV of a perpetual series of timber crops.

⁹ Zinkhan and Cabbage, 2003, p. 79

¹⁰ Clutter, et al, 2006, p. 2

Business and Economics Recommendations

But it is not just the forest economists that think the NPV is preferable to the IRR as a ranking tool.

Paul A. Samuelson, the MIT economist whose textbook *Economics* has been read by undergraduates in economics courses for over 60 years, spent time in an article on the economics of forestry discussing the flaws in relying on the IRR (Samuelson, 1976).

He notes that he and others have "debunked" maximizing the IRR, but "...but the corpse will not stay buried".¹¹

The "newest" finance textbook in my library will be 20 years old this year, but even way back then the authors stated flatly:

- "...the NPV method is better than the IRR...".¹²

Summary

The literature generally agrees that the NPV method is preferable to the IRR, but we will close with a quote from Klemperer's (1996) *Forest Resource Economics and Finance*:

- "...even when conditions make the NPV guideline...seem appropriate, analysts should always give the investor other project measures such as IRR, payback period and capital requirements over time. These are all relevant. ...capital budgeting is an art that can't always be boiled down to a simple decision rule."¹³

Forest Research Notes, Vol. 8, No. 1

Copyright © 2011, Jack Lutz

Jack Lutz, PhD
Forest Economist
Forest Research Group
385 Central Street
Rowley, MA 01969
978-432-1794
207-717-5858

jlutz@forestresearchgroup.com
www.forestresearchgroup.com

References

- Brigham, Eugene and Louis C. Gapenski, 1991, *Financial Management: Theory and Practice, 6th edition*, The Dryden Press, Chicago
- Bullard, Stephen H. and Thomas J. Straka, 1998, *Basic Concepts in Forest Valuation and Investment Analysis*, Clemson University
- Clutter, Mike, Mike Kane, Bruce Borders, Pete Bettinger and Jacek Siry, 2006, *A Method for Calculating the Internal Rate of Return on Marginal Silviculture Investments*, University of Georgia, Plantation Management Research Cooperative, Technical Report 2006-3.
- Davis, Lawrence S. and K. Norman Johnson, 1987, *Forest Management, 3rd Edition*, McGraw-Hill Publishing Company, New York
- Gansner, David A. and David N. Larsen, 1969, *Pitfalls of Using Internal Rate of Return to Rank Investments in Forestry*, USDA Forest Service, Northeastern Forest Experiment Station, Research Note NE-106.
- Gregory, G. Robinson, 1972, *Forest Resource Economics*, The Ronald Press Company, New York
- Klemperer, W. David, 1996, *Forest Resource Economics and Finance*, McGraw-Hill Publishing Company, New York
- Mills, Thomas J. and Gary E. Dixon, 1982, *Ranking Independent Timber Investments by Alternative Investment Criteria*, USDA Forest Service, Pacific Southwest Forest and Range Experiment Station, Research Paper PSW-166
- Samuelson, Paul A., 1976, *Economics of Forestry in an Evolving Society*, Economic Inquiry, XIV, 466-492.
- Zinkhan, F. Christian and Frederick W. Cabbage, 2003, *Financial Analysis of Timber Investments*, in: Sills, E.O. and K.L. Abt (eds), Forests in a Market Economy, Kluwer Academic Publishers, Boston. 379 pages.

¹¹ Samuelson, 1976, p. 145.

¹² Brigham and Gapenski, 1991, p. 328

¹³ Klemperer, 1996, p. 188