Video 24 - Alternatives to NPV: Payback Periods and Average Accounting Return

The following is a supplementary transcript for tutorial videos from

https://blogs.ubc.ca/financefundamentals/

Welcome back everyone. Today, we are going to compare some of the different methods we can use to evaluate an investment: net present value, internal rate of return, payback periods, and the profitability index. By now you have already learned how to calculate NPV and IRR ("NPV: Timing of Cash Flows" and "Evaluating Projects: Interpreting the Internal Rate of Return"). These are the two most common methods we use to evaluate investments. So today, we will begin by going over two other methods we can use. First, we will learn how to calculate an investment's payback period; second, we will learn how to calculate an investment's profitability index; and lastly, we will discuss when each investment criteria is most appropriate by comparing the pros and cons of the four methods.

Video at 00:51

Let's start with the payback period. The payback period tells us how long it will take for us to recover a project's initial cost. For example, if I buy a coconut tree for $100, and each year I can sell my coconut harvest for $25, it will take me four years to recover the $100. Around now, you might be thinking "Wait...that's it? That was so simple!" And that's because well, it is. If doing an NPV calculation is like reading a book, then calculating the payback period is like reading the Sparknotes version. It is much faster, but as you learned when you failed your high school English essay, it is not nearly as comprehensive.

Video at 01:34

For one thing, the payback period fails to adjust our cash flows for the time value of money. As we already know, the $25 we receive in 4 years is actually worth less than the $25 we receive today, due to factors like inflation and opportunity cost. The second issue with a payback period is that it ignores risk, which is also related to the time value of money. Cash flows you receive further into the future are less certain and predictable, and thus riskier than cash flows today. Normally, we discount our cash flows using a rate that factors in our return on risk. And third, the payback period ignores what happens after we recover our investment.

Video at 02:15

Going back to our coconut example, suppose we are trying to decide between two coconut trees: Meryl S-tree-p and Tree Willy. Both trees will produce $25 harvests from year 1 to 4, but starting in year 5, Meryl S-tree-p will start winning Oscars and bring in an additional $1 million per year, and in year 5, Tree Willy will be killed by poachers and produce no more fruit. If we only compare the payback periods of these two investments, we will be indifferent between these two choices, as both investments yield the same payback period of 4 years, and yet one is clearly more profitable than the other. Without doing any calculations, we can already tell that the NPV of Meryl Streep is much higher.

Video at 03:01

Some investors have proposed a solution to the first two problems: discounting our cash flows. That way, we can factor in the time value of money and our risk. For example, if my personal interest rate is 10%, then the present value of each $25 cash flow from selling coconuts each year would look like this.

Figure 1

After year 5, I will have earned $94.77 in present value terms. Thus, I will have fully paid back my initial $100 investment during year 6. Assuming we earned this money evenly throughout the year, we can take the remaining amount, $5.23 ($100 - $94.77), divided by the total amount earned in year 6, $14.11, multiplied by 365 days. Thus, we will recover our initial investment after 5 years and 135 days:

$$payback\ during\ year\ 6\ =\ \frac{\$5.23\ remaining}{\$14.11\ PV\ of\ year\ 6}\ \times 365\ days\ per\ year\ =\ 135\ days\ into\ year\ 6$$

Video at 03:54

However, most people see this discounted payback period as a bad compromise. It takes as much effort as the NPV calculation, and yet, we still have the problem that cash flows after the

payback period are ignored. Instead, if we're looking for something quick and easy we can do on a napkin, we will just use the regular old payback period calculation, and if we are looking for something more comprehensive, then we might as well apply the NPV approach.

Video at 04:21

Next, let's talk about the profitability index. A project's profitability index tells us the value created by a project, expressed in today's dollars, per dollar we invest today. To calculate it, we take the present value of our future cash flows divided by the initial project cost:

$$profitability\ index\ (PI) = \frac{PV\ future\ cash\ flows}{initial\ project\ cost}$$

We can think of this as expressing our NPV in relative or ratio form, rather than in absolute dollar terms. This gives us a ratio that tells us how efficiently our money is being put to use. How much can we earn per dollar we spend? That is, which investment is the best pound-for-pound fighter.

Video at 05:00

For example, if the present value of an investment's future cash flows is $10,000, and its initial cost is $5,000, then its profitability index=2. For every dollar we spend, we earn $2 when we adjust for risk and the time value of money. If the profitability index=1, this means that the present value of our returns is equal to the initial cost, which is the same as saying that our NPV=0, and the IRR = our required rate of return, so we would just break even. Thus, we would be indifferent between accepting and rejecting the project.

Video at 05:38

Understanding a project's profitability is helpful when we have a limited amount of cash to spend, as we would like to get the most bang for our buck. For instance, suppose I have an allowance of $5. I could use the money to put on a lemonade stand, run a car wash, or start a dog-walking business. The initial cost of each is $5 for the lemonade stand, $3 for the car wash, or $2 for the dog-walking business. My future cash flows are summarized in the table below. My personal discount rate is 4%. Pause the video and see if you can decide which project, or projects I should invest my limited funds into.

future cash flows

$5	year 0	year 1	year 2
	-5	10	9
	-3	7	6
	-2	3	6

Figure 2

Video at 06:16

Let's start this problem by discounting our future cash flows into present value terms. Because we are dealing with uneven cash flows, we cannot use a shortcut like the annuity formula to discount these cash flows altogether. Next, let's add these discounted cash flows and subtract the initial costs. This gives us a net present value of $12.94 for the lemonade stand, $9.28 for the carwash, and $6.43 for the dog-walking (Figure 3). If we only look at the net present value, the lemonade stand seems like a better investment. However, these three investment options require different initial costs. To see which option has the highest return per dollar invested, we should take a look at the profitability indexes.

Video at 07:03

We will calculate this by taking the present value of their cash flows, divided by the initial cost, which yields 3.59 for the lemonade stand, 4.09 for the carwash, and 4.22 for the dog-walking. Thus, dog-walking maximizes our return per dollar spent, giving us a gross return of $4.22 for every dollar we spend. Let's start by investing in dog-walking, but we still have $3 left over ($5 allowance - $2 initial cost). Let's assume we can choose to invest in either of the remaining two investments, and we earn a return proportional to the initial cost we contribute. In this case, we will want to choose the investment with the next highest return per dollar spent. In this case, it is the car wash, with a profitability index of 4.09. Notice that when we invest our $5 in these two investments, we earn a total return, or NPV from all of our investments of $15.71 ($9.28+$6.43). This is higher than the $12.94 we could have earned from just the lemonade stand. Notice how our goal is to maximize the total return of our portfolio, rather than a single investment. This will allow us to get the most value out of our $5.

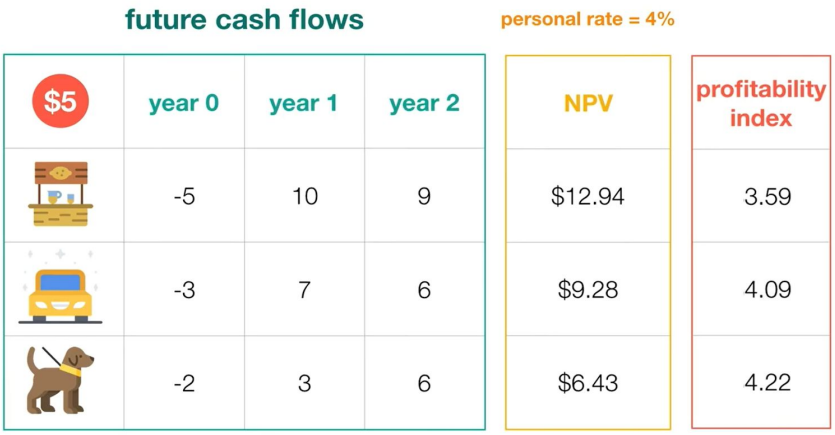

Figure 3

Video at 08:16

But what if we can choose only one of these three investments. Suppose you only have room for one business headquarters on your front lawn, or you don't have enough friends to help you manage more than one business. In this case, we should choose to open the lemonade stand and earn $12.94, which is more than we could earn under the two other alternatives individually ($9.28 or $6.43). Thus, when our options are mutually exclusive, meaning that we cannot pick more than one investment option, we prefer to use the NPV evaluation method to select the one investment option that earns us the most in absolute terms.

Video at 08:51

Note that we don't use accounting numbers to calculate the return on our investment. Numbers used in financial statements follow accrual-based accounting, which doesn't always match our actual cash flows. For example, we may order lemons from a friend and promise to pay him in 3 months. Accounting would recognize the lemons expense at the time we received the lemons, while in finance we only care about when the cash is paid (3 months after receiving the lemons). We would need to add back the cost of the lemons to our accounting operating income, to arrive at our actual operating cash flows. In this way, we may have to work backwards from our financial statement information, in order to find the relevant cash flows. Remember to exclude sunk costs and include opportunity costs in these relevant cash flows.

Video at 09:37

Now that we know how to calculate the payback period and the profitability index, we can compare these alternatives to what we know about NPV and IRR (Figure 4). Compared to the

other three investments, payback period is simply not on the same level. It fails to account for the time value of money, risk, and cash flows that occur after the initial cost has been recovered. Conversely, these are all strengths of the other three methods. However, we should still keep the payback method in our toolkit, since it is quick and easy to do. You may use it as an initial test of feasibility before you dive into more complex calculations.

Video at 10:15

NPV tells us how much value an investment will add to the company in today's dollars. Recall that we calculate NPV by present valuing our future cash flows and subtracting our initial cost. Aside from the benefits we already mentioned, NPV is simple to interpret. Any project with an NPV>0 should be accepted. It is also good for evaluating mutually exclusive investments where we want to maximize our return in absolute terms, today's dollars, and by extension the expected increase in stock price. However, NPV can be difficult to apply when we don't know the cost of capital we should use. Perhaps this project is a more volatile industry than the company's main operations and so, they cannot use their usual cost of debt. Because we use NPV to calculate our profitability index, this problem would impact it as well. But really, the only time NPV can't help us is when we have limited funds to spend. That is, we want to know which investment maximizes our return per dollar spent. In this case, we should use the profitability index instead.

Video at 11:22

The profitability index tells us how much we can earn per dollar we spend. It is most helpful when we have limited cash to invest. Like IRR, the profitability index is not useful when we are deciding between mutually exclusive projects. That is NPV's time to shine.

Video at 11:36

Unlike the profitability index, IRR tells us the actual percent return on our investment. Instead of using a cost of capital to discount our cash flows, we solve for the interest rate that would set our NPV=0, where the profitability index=1. We should accept any project with an internal rate of return that exceeds our required rate of return. In this case, the NPV would be greater than 0 and the profitability index would be greater than 1. Simply put, the present value of our cash inflows would exceed the present value of our cash outflows. Expressing our return in interest rate format makes it easy for investors to understand. We also don't have to estimate a

company's cost of capital accurately to communicate an investment's merit. Different companies can look at the same IRR and evaluate it against their own costs of capital. If the IRR is high enough, companies may not even need to calculate their cost of capital to know that the investment is worthwhile. However, IRR has some additional problems that arise when a project has both positive and negative future cash flows. In these cases, there can be more than one interest rate that would give us a net present value of 0 (“Evaluating Projects: Interpreting the Internal Rate of Return”). Take a moment to compare these four methods for yourself. Try to think about when you might use each one.

	payback period	NPV	profitability index	IRR
pros	• quick & easy	• time value of money • risk • cash flows • shows $ value added • mutually exclusive investments	• time value of money • risk • cash flows • good when there is limited cash to spend	• time value of money • risk • cash flows • simple screenshotting tool • don’t need accurate cost of capital
cons	⊘ time value of money ⊘ risk ⊘ cash flows	• difficult if we don’t know the cost of capital used • limited cash to spend	• difficult if we don’t know the cost of capital used • mutually exclusive investments	• mutually exclusive investments • there can be multiple IRR's that give NPV=0

Figure 4

Video at 13:04

Today, we went over two alternatives to NPV and IRR. First, we discussed the payback period method and then we talked about the profitability index. Lastly, we put all of this together with our knowledge of NPV and IRR in order to compare the pros and cons of each method. This comparison helps us to see why NPV is such a powerful and frequently used tool. However, we should not write off the other methods, which each have their own strengths. With practice, we will learn which method to use in different situations.