# Video 20 - NPV: Timing of Cash Flows

*The following is a supplementary transcript for tutorial videos from*

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

Today, we are going to be discussing one popular method of making investment decisions: net present value (NPV, for short). NPV can indicate whether a project is financially feasible by discounting its future cash flows, using an investor's cost of capital, to their present value. We already know how to calculate the present value of annuities, perpetuities, and single payments, but in reality, most projects are messy. They involve uneven cash flows occurring at different throughout the life of the project.

Video at 00:32

Today, we will learn how to apply these formulas to more complex financial decisions. So first, we will go over what NPV is, and how we can calculate it. Second, we will talk about how to set up a timeline in order to discount the cash flows over the life of the project. And lastly, we will look at how to apply all of this to an example.

Video at 00:54

To calculate net present value, calculate the present value of a project's future cash inflows, and subtract its future cash outflows, plus any initial investment costs.

net present value (in today's dollars) = PV cash in - (PV cash out + initial outlays)

= gains - losses

Basically, we factor in everything we gain from the project and everything we spend, and express all of it in today's dollars. Typically, we will have one large upfront cost at the beginning of the investment, but sometimes, we will also see negative net cash flows during the life of the investment.

Video at 01:21

Once we determine a project's net present value, we can choose whether to accept or reject it. The rule of thumb is that, if NPV is positive, we should accept the project. A positive NPV means that all the revenues in today's dollars are greater than all of the costs in today's dollars. This means that the project is expected to add value to the firm, because we are earning more than

we are spending. So, a NPV of zero isn't bad; it means that we are earning exactly the minimum required rate of return, or in other words, we are breaking even.

Video at 01:52

In order to calculate the net present value of a project, we have to (1) estimate cash flows, (2) estimate the required rate of return, and (3) discount our cash flows to solve for net present value. In practice problems and tests, the information from steps 1 and 2 is given to you. In a real-life scenario, you will have to estimate these based on forecasts and market interest rates.

Video at 02:16

However, we still have to know how to use accounting figures, like net income, to determine our cash flows. Remember that net cash inflow does not always equal net income. We discussed this in more detail in the video "Differentiating Sunk Costs and Opportunity Costs". For now, let's focus on step 3, solving for NPV.

Video at 02:36

So remember, the theory of NPV is very simple: we are just applying our time value formulas. The trick to mastering NPV problems is staying organized; I recommend using a timeline so you can keep track of all the cash inflows and outflows. Once we have a timeline, we can develop a plan for calculating NPV efficiently, using a combination of time value of money formulas. Let's walk through the steps of dissecting a problem together. Pause the video and read over this problem.

**Problem:** You have always dreamed of opening a corn-themed food truck called *Corn to be Wild*. To do this, You need to immediately purchase a $20,000 truck, a $4,000 grill, and invest $5,000 in working capital for your crops. Each year, you will invest an additional $100 for advertising. In 3 years, you must pay $1,000 to renew your food sales license. You already plan to renew your food sales license this year for an upcoming catering gig. In addition, you estimate that the food truck will have operating revenues and costs as per the table below. After 7 years, you plan to retire. You think you will be able to sell the truck for $5,000, after which you will get back your working capital investment. You want to know whether you should take on the project. You know that you can earn a 9% return on your money if you instead decide to invest in your friend's food truck business that is of similar risk as your dream food truck.

| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|------|---|---|---|---|---|---|---|
| Revenue | 2,000 | 4,000 | 5,000 | 5,000 | 6,000 | 7,000 | 10,000 |
| Costs | 500 | 500 | 1,500 | 1,500 | 2,500 | 3,500 | 2,000 |

Video at 03:05

Note that the required rate of return that we use to calculate the present value of the project's cash flows is not always the required rate of the investor or company. This is because the

discount rate we use for NPV reflects the time value of money and riskiness of the project, which may be a different level of riskiness than the investor's personal discount rate. For example, if, rather than starting your dream corn-themed food truck business, your next best alternative is putting your money in a savings account that earns 2%. Your personal rate of 2% here isn't appropriate to discount the far riskier cash flows of a food truck business.

### Video at 03:39

Let's make a timeline for this problem, then we can begin sorting our cash flows along this timeline. Cash flows that occur in the same year can be consolidated, since we will discount them by the same number of periods. First, let's determine the time horizon for this project. The problem tells us that the project will last 7 years, and so we are concerned with cash flows that occur between now (which we will call year zero) and the end of 7 years. And now, we can fill in our timeline.

### Video at 04:07

I like to start with the one-time inflows and outflows, and then deal with the ongoing operating cash flows at the end (Figure 1). First, let's look at the project's initial cost. At the beginning of the project (year zero), we must spend $20,000 on the truck, plus $4,000 on the grill, and must invest $5,000 into working capital (total initial cash outlay of -$29,000 in today's dollars).

### Video at 04:26

We need to have some working capital available to fulfill our day-to-day operations, like having enough inventory on hand, or satisfying our short-term debts, but we can usually expect that some of this will be recovered at the end of the project. In this situation, we receive all of it back at the end of the project. Be careful not to miss this detail just because there is no number listed. Writing out numbers as words or eliminating the numbers altogether are common tricks to look for in NPV problems.

### Video at 04:53

But, remember that the $5,000 we spend today and the $5,000 we get back in seven years are not equal, because of the time value of money. After all, we lose the ability to use the money for other productive purposes when it is tied up in this project.

Video at 05:06

We must also consider the $1,000 cost to renew the food sales license after three years. This cost will be lower than $1,000 in today's terms due to the time value of money. We don't need to worry about the cost of this year's license, since this is a sunk cost, not an incremental or differential cost, meaning that, regardless of whether or not we take on this project, you will end up paying for the license, so we don't need to factor it into our decision. And lastly, let's include the $5,000 we expect to receive at the end of the seven years when we sell the truck.

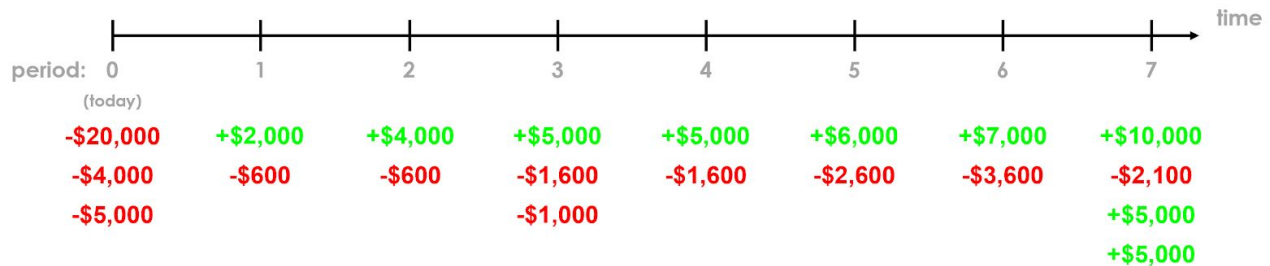| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|------|-----|-----|-----|-----|-----|-----|------|
| Revenue | 2,000 | 4,000 | 5,000 | 5,000 | 6,000 | 7,000 | 10,000 |
| Costs | 500 | 500 | 1,500 | 1,500 | 2,500 | 3.500 | 2,000 |
| Costs + Ads | 600 | 600 | 1,600 | 1,600 | 2,600 | 3,600 | 2,100 |



**Figure 1**

Video at 05:38

Now, let's look at our operating cash flows. Because the advertising expense occurs every year, we will factor this into our annual operating cash flows. We will combine the revenues and costs for each year to get our net cash inflows. For year 1, we will earn $2,000 and spend $500 on our operations, plus $100 on advertising. This leaves us with a net inflow of $1,400. We get a net inflow of $3,400 in year 2, $3,400 in year 3, $3,400 in year 4, $3,400 in year 5, $3,400 in year 6, and $7,900 in year 7.

Video at 06:17

So now that we've mapped out our cash flows, we can make a plan of attack for discounting these cash flows to their present values. Of course, you can take the net cash flow from each period and discount them individually back to year zero, but there is a more efficient method. I like to see whether I can save time by discounting multiple cash flows at once, using an annuity formula, and discount any leftover cash flows individually using the present value formula.

Video at 06:42

From years 2 to 6, we have net cash inflows of $3,400. I'm choosing not to combine the $1,000 outflow in year 3, so I can treat this as an annuity with fixed payments of $3,400. We can discount all the cash flows to year 1 (remember that the annuity formula gives the present value one period before the first cashflow)

annuity of $3,400 from years 2 to 6: $PV_1 = \$3,400 * \left[\frac{1-(1.09)^{-5}}{0.09}\right]$

Now, we can discount the whole thing to year zero by dividing the cash flows in year 1 ($13,224 $PV_1$ + $1,400 net operating cash flow = $14,624) by 1.09.

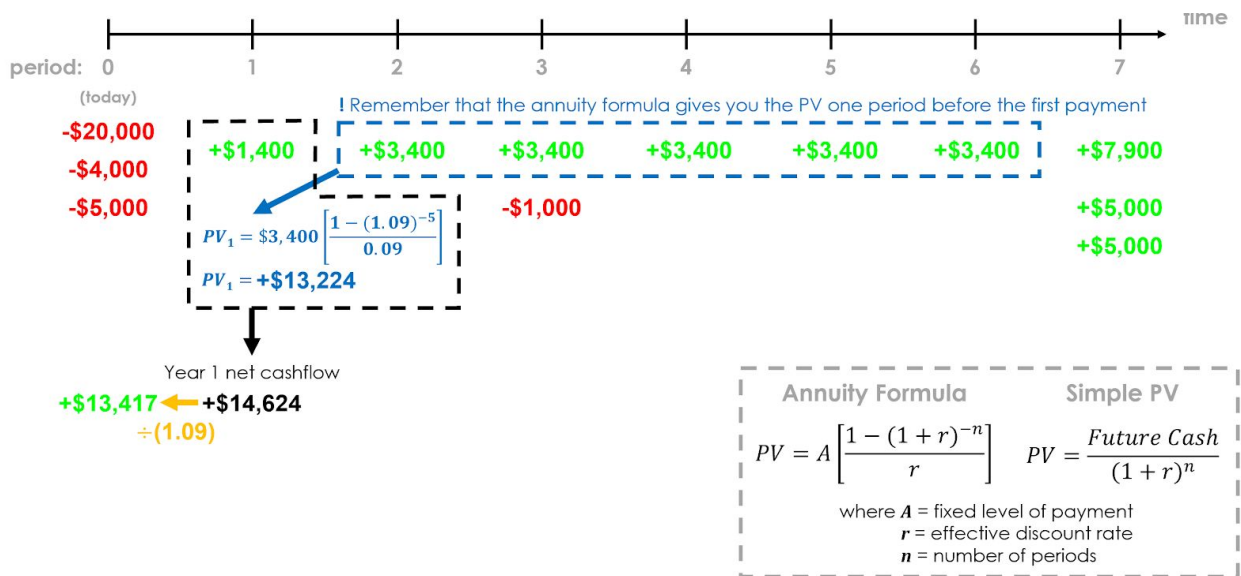cash flows from year 1: $PV_0 = \frac{\$14,624}{1.09} = \$13,417$



**Figure 2**

Video at 07:09

Next, let's present value the loose ends (Figure 3). We will sum the cash flows in year 7 ($7,900 net operating cash flow + $5,000 recovered net working capital + $5,000 truck salvage value = $17,900), and divide the sum by $(1+0.09)^7$.

cash flows from year 7: $PV_0 = \frac{\$17,900}{1.09^7} = \$9,792$

Video at 07:19

We will discount the $1,000 cash outflow in year 3 by dividing it by $(1+0.09)^3$.

cost to renew the food sales license in year 3: $PV_0 = \frac{\$1,000}{1.09^3} = -\$772$

Remember to keep the negative sign, representing a cash outlay, as paying for this license lowers our NPV.

Video at 07:34

Now that all of our cash flows are in present value terms, we can combine them and subtract the initial cost, which is already expressed in today's dollars, because these costs occur in the present. Now, we are left with the net present value of -$6,563.

> net present value (in today's dollars) = PV cash in - (PV cash out + initial outlays)
>
> = ($13,417 annuity + $9,792 year seven) - ($772 license + $29,000 initial outlays)
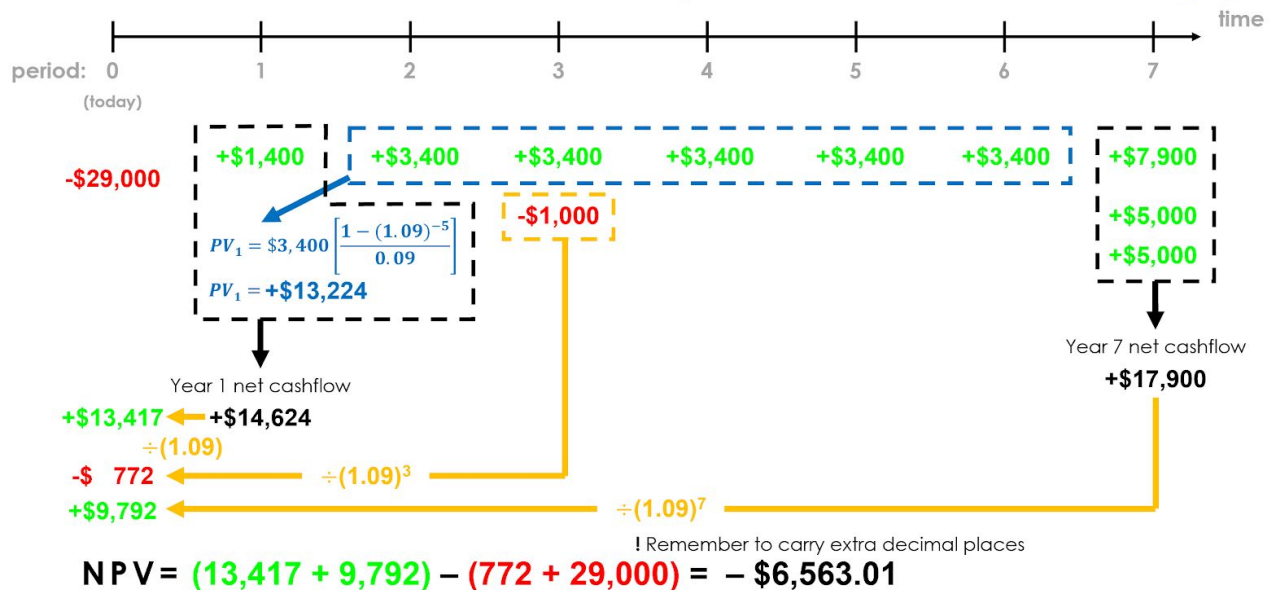>
> = -$6,563.01



**Figure 3**

Video at 07:50

This is how much more the project generates in cash outflows (in today's dollars) than in cash inflows (in today's dollars) at our given interest rate. This rate factors in the risk, opportunity cost, and inflation, so anything under zero means that we haven't covered our cost of capital; therefore we should not move forward with this project. If we take on this project, the value of our company is expected to fall by $6,563. The share price will fall accordingly, as well. Perhaps this strange corn dream is not as a-maize-ing as we thought.

Video at 08:24

Because the aim of an investment is to increase shareholder wealth, as a general rule, we should accept any project with a positive NPV. Of course, the company may have strategic reasons for taking on an investment with a negative NPV, such as complying to government regulations, or protecting the environment.

Video at 08:42

We typically make the important assumption that a has unlimited funds to take on these projects, either through borrowing or using its existing equity. The cost of borrowing is already reflected in the required rate of return; however, if we have limited funds to spend we may want to select the investments that maximize our NPV per dollar spent. We can compare projects by looking at their profitability index:

$$\text{profitability index} = \frac{present\ value\ of\ future\ cash\ inflows}{project's\ initial\ cost}$$

Video at 09:10

Alternatively, if we're forced to choose only one project, we want to select the one that maximizes our NPV in dollar terms to increase the value of the company by as much as possible.

Video at 09:21

Ultimately, NPV is an effective evaluation tool, because it uses relevant future cash flows (unlike methods that use accounting numbers), it adjusts for the time value of money, it adjusts for risk, it provides information about whether we are creating value to the firm, and it provides a single number that we can use to compare between investments.

Video at 09:41

So, to recap: today, we went over NPV, and how we can set up timelines to dissect and solve NPV problems. Remember that there is no one right way to solve an NPV problem; it's just important to stay organized and to discount your cash flows in a way that's fast and makes sense for you. Thanks for watching!