More Complex Valuation and DCF Analysis: The Mid-Year Convention and Stub Periods

Hello, and welcome to the next lesson in this Jazz Pharmaceuticals Valuation and DCF case study. We're going to turn our attention to more about the discount rate and how to actually use it to discount the cash flows in this lesson.

You can see I've added this area for the assumptions and output of the DCF analysis right on top of the unlevered free cash flow projections down here. In addition, I've also added some lines in this tab for the unlevered free cash flow for the remainder of the year, the present value, the discount rate, something called the cumulative discount factor, and then these discount periods toward the bottom.

And I have this tab for the H1 Results for the company as well. We won't be using this in this lesson, but in the next one, we'll get into this and explain why it is useful here.

In the Steel Dynamics case study previously, discounting the cash flows was pretty easy because we just use the built-in NPV function. And that function works well when the discount rate is constant, and you have the set of cash flows all laid out sequentially.

[01:01] There are a couple of factors that make it more complicated this time around. First, the discount rate here will change over time, so we cannot use the NPV function anymore. And we can't even use the method of dividing by one plus the discount rate raised to the power of the year number, because that assumes the same discount rate each year. So, we need to calculate it differently.

Also we're valuating the company midway through the year, and so we need to adjust some of the periods here and also subtract out the cash flow that has already been generated.

And then finally, we have the mid-year convention to think about, which is optional, but I'm including it because many banks and other valuation groups do follow this practice. On average, the cash flows arrive midway through the year. So, it's more accurate to adjust for that and use numbers like 0.5 and 1.5 and 2.5. rather than 1, 2, and 3.

There's a lot going on here, and in my experience, this is a somewhat confusing topic, so we're going to divide this into two parts and look at the last two issues here first, so the valuation being midway through the year and the mid-year convention.

[02:04]
And then we'll look at the first issue here, the changing discount rates, more fully in the next lesson, and sort of combine all these concepts here.

I don't think any of these is difficult on its own, but I think when you combine all these, it gets a little bit confusing. So, we're going to spread this out over these two lessons.

We'll start with the assumptions here, then we'll set up the discount periods, and then we'll go through the mid-year convention, and then you will get some practice exercises just to clarify the main points in this lesson before moving on and making it more complicated when we introduce the changing discount rates next.

Going to the assumptions first, you know from the WACC analysis before that these companies all have different discount rates, and we got a range of values for Jazz as well.

Overall, though, we think that the company is on average riskier than the median or average company in this set. So, we are going to start the discount rate at a higher level. I'll say 7%, initially. And we'll make it fall to 5.4% by the end.

So, I'll say the difference by the end is just the 7% minus the 1.6%, which gives us the 5.4%. It's in line with the median of the set right here, and also very close to the average for the range that we calculated for Jazz.

It's also useful to have the number of years in the explicit forecast period. So, I can use the YEAR function and go over here and go to fiscal 2030 and then subtract the year for fiscal 2020. And we'll be using this possibly in some of the formulas later on.

And then one final thing we want to look at here is the stub period fraction, because the valuation date here is August 31, 2021, which means that about one-third of the year remains and two-thirds of the year have already passed.

There are different ways to calculate this, but I think it's easiest to use the DAYS function. So, we start with the end date, which means that we want the December 31, 2021, date, and then the start date will be the valuation date.

Now, this will give us the number of days in between, but we want the fraction of the year. So, we need to take this and then divide by another DAYS function where the end date is the next
fiscal year, and the start date is the last fiscal year, so December 31, 2020. So, now we have this.

And as expected, it means that just over one-third of the year, 0.334 of the year, remains between now and December 31.

We have some of our basic assumptions there set up. Let's now go into the discount periods and I'll explain why we need these.

Now, you'll remember that in the simpler case study, we just ignored this altogether. We didn't have discount factors or discount periods or anything like that. We just used the NPV function and said, "Let's take a 10% discount rate and then apply it to all these annual cash flows." And boom, there we go. We get our present value of unlevered free cash flow right here based on that function.

It's more complicated here because of the issues with the changing discount rate. If you think about it, when you calculate the present value based on this formula, \( \frac{FCF}{(1+Discount\ Rate)^{Year\#}} \), that assumes the same discount rate every single year.

But if the discount rate is changing, then you need to change this formula, and the denominator needs to be \( \frac{1}{(1+Year\ 1\ DR)\*(1+Year\ 2\ DR)\*(1+Year\ 3\ DR)\*(1+Year\ 4\ DR)} \). And you need to do that for each year where you actually calculate the present value.

It's cumbersome to write out this formula in each cell that requires it. It's a lot of repetition, so it's smarter to create a rule for the cumulative discount factor and to start it at \( \frac{1}{(1+Year\ 1\ DR)} \), and then you multiply by \( \frac{1}{(1+Year\ 2\ DR)} \) after that, and then you multiply by \( \frac{1}{(1+Year\ 3\ DR)} \) after that. And so you keep doing that to get each successive term. And so you track it over time to avoid the need to constantly repeat this formula.

The tricky part, though, is that it's not quite as simple as just setting up one cumulative discount factor and just multiplying, as we are right here, because we're not dealing with one, two, three, four, five, and whole numbers like that anymore since two-thirds of projected Year 1 has already passed.

Now, by itself, this is not that difficult. We can just use 0.334 in Year 1, and then 1.334 in Year 2, 2.334 in Year 3, and so on.
So, in short, this formula above, instead of just multiplying by all these terms, we need to raise the first one to the power of this 0.334, then we need to multiply by one plus the Year 2 discount rate, one plus the Year 3 discount rate, one plus the Year 4 discount rate.

Now, to set this up, we can start by creating this row for the normal discount period.

[06:58]

Here, for fiscal 2021, we're going by the amount of time that is left in the year, so about one-third. We can link the stub period fraction right there.

And then each period after that, we'll just take this number and then add one. And so now we have that. And now we have an idea of how much time has passed from the start of this analysis to the end. About nine years and one-third, or 9.334 years.

And that's really all we have to do here. I'm setting it up now because it will affect our terminal value and present value of terminal value calculation later on. It's also going to affect the sum of the present value of the free cash flows here, among other things. So, we need this for some of our setup later on, but we're not going to directly use it right this second.

Now, the other thing that makes this more complicated in addition to the stub period is something called the mid-year convention. By itself, this is not really that difficult. All this says is that instead of using 1, 2, 3, 4, we should use 0.5, 1.5, 2.5, 3.5, because we want to show how the cash flows arrive midway through each year on average.

[08:02]

So, if there's no seasonality, and there's no massive growth, the company generates cash flow every day of the year, and so the average arrival date for that cash flow is June 30 of the calendar year.

It gets tricky, though, when you combine the mid-year convention with the stub period. Now, your intuition here might be to say, "Okay. Well, we have the normal discount period, so all we do for the mid-year discount period is take all these and divide by two." So, we take the first one and divide by two, and then we keep doing that for all these others.

And you'd only be correct in the case of the first year here. So, in the first year, yes, if one-third of the year remains and we say that the rest of the cash flow arrives on average on October 31 of this year, then yes, we can just divide this by two and represent that date midway between August 31 and December 31 of the year.
After this, though, no, it's not just dividing it by two as a lot of people seem to think. It gets more complicated and I'll show you why. Not exactly more complicated, but slightly different from that.

[09:06]

After this first year, you don't just divide by two, because we're concerned with the arrival date of the cash flows in each future year, not with what comes before it. So, in Year 2, for example, we want to take the 0.334 . . . That represents all the remains of Year 1. No cash flows for Year 2 arrive in that period. And then we add 0.5 to get 0.834. Why? Because no Year 2 cash flows arrive in Year 1. We have to wait one-third of the year, and then when that cash flow in Year 2 arrives, it does so midway through Year 2, and that's what the 0.5 here represents.

And then if you go out further after that, Year 3 becomes 0.334. Then you add one whole year for Year 2 because none of the Year 3 cash flows arrive in this Year 2. They arrive midway through Year 3. So, you add the 0.5, and so it's 0.334 plus 1.0 plus 0.5, and that gets you to 1.834.

[10:02]

Let's see how this works in practice.

With the second year here, we can take the stub period from Year 1, and then we can add 0.5. And then after that, we can take the stub period, we can add one whole year for Year 2, and then we can add 0.5 for this year. And then after this, we can take the stub period plus one for Year 2, plus one for Year 3 because no Year 4 cash flows arrive then, and then 0.5 for this year.

Now, you can see the pattern here already, which is all you do is you take the normal discount period and then you just subtract 0.5 to represent the fact that the cash flows arrive on average earlier than one and one-third years into the future. They actually arrive more like 0.834 years into the future, if you assume a mid-year arrival date in Year 2, Year 3, Year 4, and so on and so forth. And that's the idea here.

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Again, we're not using this directly for now, but this will come up when we calculate the cumulative discount factor and the present value of unlevered free cash flow. These numbers will also affect the terminal value and present value of terminal value calculations later on.
So, that's the idea here. I want to go to Step 4 now and go through some practice exercises. Because I realize this concept may be a little bit confusing, and so I want to give you a chance to practice this yourself.

You can pull this up, and what I want you to do here is to calculate the normal discount period and the mid-year discount period for these three dates, April 30, 2021, September 30, 2021, and then February 1, 2021.

In all cases, assume that we're in 2021 and these are the valuation dates. The end of the year is December 31, 2021.

And you can start by calculating the stub year fraction, the normal discount period, and the mid-year discount period. It's going to be the same in each case, but I think it helps to see some numbers here and to get a sense of what this actually looks like in real life.

So, pause this video right now and try this exercise yourself. When you're done, come back, unpause this, and then we'll go through this together.

[12:05]

Okay. So, let's start by calculating the stub period fractions here. I'm going to use the DAYS function in Excel. And the end date is always going to be the projected Year 1 right here. The start date is going to differ.

You may have to enter this a little bit differently depending on your date and time and region settings. But for my US English setup, I'm going to enter 4/30/2021. If you enter the date in a different format in your region, you may have to enter it differently here as well.

And then we take DAYS and then we divide by the projected Year 1 for the end date. And then for the start date, the last historical year right here.

And we can actually just copy this down for the others and make some minor changes. For the September 30 one, we can change this to September 30, 2021.

And then copy this down again. And for February 1, we can change this to 2/01/2021.

[13:02]

And so we have all these stub periods. About two-thirds of the year here, about 25% of the year here, and around 90%, just over 90%, of the year here for February 1.
For the normal discount period, let's start with the stub period in each case. And then after that, it's fairly simple. We just take this and then we add one in each year. So, by the end, we get to 9.61.

For this one, we'll add one once again.

And then for this last one, we'll add one in each year and copy this across. And so we have that.

Now, for the mid-year discount, in the first year, since we are concerned with the cash flows in this year, yes, we take this number and divide by two in each case. So, according to the mid-year convention, each of these is just divided by two.

[14:02]

And then after that, contrary to what you might expect, you don't just take this and divide by two. That's wrong. You take this and subtract 0.5.

You're doing this because 0.671 of the entire year passes, that's fine. You don't get any cash flows for Year 2 in that fraction of the year. But then in Year 2, you assume that the cash flows arrive midway through. And so it's equivalent to saying 0.671 plus 0.5, and that gets us to the same result right there.

Then after that, you keep doing the same thing. In each case, you just take the normal discount period and subtract 0.5 and that gets you when the cash flows arrive in that specific year factoring in the fact that you don't get any cash flows for Year 5 in Years 1 through 4 here.

And then we can do the same thing in all these others. We just take the normal discount period and subtract 0.5. And then the same thing down here. And so we have that.

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And that's really all there is to it. It's not a complicated exercise, but I wanted to give you some practice actually seeing this and seeing what these might look like in real life, because it is a little bit counterintuitive and it's a little bit more difficult than you might think at first glance.

With all that said, let's do a recap and summary now.

We have a couple of complications here with discounting the cash flows. We have a changing discount rate, a valuation midway through the year and the stub period, and then the mid-year convention.
And to be clear, none of this is required. The case study document makes a reference to a possibly changing discount rate, but it doesn't say anything about the rest. So, these features are very much optional, but I'm including them because they are common at banks.

We started by setting up the assumptions and actually calculating the stub period over here on the side, as well as the starting and final discount rate.

Then we set up the discount periods and I explained why it's especially important to do it here.

If you have a constant discount rate, it doesn't matter. You can just use the NPV function. But when the discount rate changes, it really helps to have this cumulative discount factor. And to set it up and calculate it properly, you want to have the discount periods.

Overall, it's pretty simple. You start with the stub period fraction, and then you just add one, and you get the period numbers like that.

For the mid-year one, you take the stub period fraction and divide by two. And then for all the rest, you just subtract 0.5 in each case to get the mid-year discount period.

Once we did that, then we went through the practice exercises and you saw what this looks like in a few different cases.

That's about it. Coming up next, we will add to the complexity here and we'll set up the discount rate changing over time, we'll calculate the cumulative discount factors, and then use all that to calculate the present value of the unlevered free cash flow right here. And you'll see how these additions affect the results a little bit, but don't really make a massive difference, which is why I consider these optional. Good to know, but not essential, especially not in a super time-pressured case study.