[SQUEAKING]

[RUSTLING]

[CLICKING]

RICHARD DE NEUFVILLE: I want to tie all this in with the discount rate here. Now, when the demand for capacity is growing, say, for electricity, you have two choices. You can build a big plant now for many years ahead. But I'm going to, I'm going to build a plant for the next 20 years.

My father had this experience working, actually, in India when they were building the original steel mills about 30 or 40 years ago. The whole pressure was build big plants. Get them really efficient. That's one approach.

And the other approach is to build small now and some more smaller units later on, as you phase the capacity according to the growth of the market. So the choice A is based on economies of scale.

And the choice B has this particular feature, which I want to emphasize here, is that if you decide to build the capacity when you need it, that is, not all now-- because if you're building for the next 10 years or 15 years, but maybe in three or four years-- that extra addition, if your money is expensive, you have a discount rate of 10% or 8% or whatever it might be.

Might be say, oh, three years later if I build that same plant, I don't pay 100 units, 100% of what I paid the first year. Well, your check may be 100%, but the present value of it would be discounted over three years and come in, roughly speaking, for orders of magnitude, would be 30% less. Or if the discount rate was 8%, be about 25% less.

So the point is, that by deferring the costs, you counterbalance the effect of economy the scale. The argument is, if I build it big, it's cheaper per unit. But if you delay the investments, those other additions occur later in time, and their cost is discounted, so that the advantage of building large in the beginning are counterbalanced.

So the discount rate counterbalance the economies of scale. That is, what you might gain by using economies of scale in the productivity of the plant in principle, you can lose by the economics.

Now, if you consider that economies of scale is a driver of the engineering design, recognize the same point that many engineering designs-- what is the best technical design-- don't really factor in the economics of it.

They'll look at it, say, all right, you asked me to provide capacity. This is the cheapest way to do it. So this ties in, this discussion ties in with the MIT text simple case that I gave you on a homework, too, that I've given you, that you're turning in soon, that if you look at it, I've given you some particular numbers.

And, of course, your numbers depend on your special factors, your own. But very often the things with the economy the scale just isn't a good design on an economic basis. From a productivity basis, purely technically, it looks great. From an economic basis, it may not.

There's that counterbalancing. The discount rate counterbalances the economies of scale. Now this is compounded by this thing of learning. What is this thing? So learning is an empirical observation.

The production of more units gives a lower unit cost. Why is this? Well, for those of you who have ever gone camping and have had to raise a tent, the first time you put your tent together, you probably took a long time.

You had to figure out where part A went to part C and so forth, and you hadn't done it before. And by the time you've done it 10 or 15 times, you can probably do it much faster. That is, you've learned something about it.

So it's a common kind of industrial analysis to compare the cost of producing a unit, whether it's a ship or a car or an oil platform, by looking at, what was the cost of the first design? Was the cost of the second one like the first, the third, and so forth.

And it's called learning on the basis, on the idea, that you've learned something, how to do it better. It also may reflect, frankly, not just learning, but also that you've changed the design, somewhat. You've tweaked it somehow so it's now more efficient.

But collectively, it's known as a learning phenomenon. And this can be very important. I was working with BP at one time. And for reasons, which was counter to their culture, when they were doing some drilling in Azerbaijan, their standard practice was to have bespoke designs, designs particularly suited to the location, the depth of water, da, da, da da, da, and that didn't work for a variety of reasons.

So they actually implemented three platforms, which were copies of each other. And what they found was huge savings through this learning, in that case, particularly.

Because by the time the teams came to do the second and third one, they knew better how to sequence their use of labor and materials, when to time things, how to time things, what was the better way of putting the pieces together, just like learning how to put up a tent when you go camping.

So this effect, which basically says if you build modules that are the same, you can make it less expensive, adds on, increases, the effect of the discount rate, insofar as it makes future investments of a series of modules cheaper.

So it is another add-on to the importance of the discount rate, in terms of counterbalancing economies of scale. So this is-- I've just said it, and I'm calling it again. "Learning" is in quotes because it's not only learning, you may have some technological improvements over time.

Also, you didn't have to have that piece as thick as the other ones because you found out you didn't need it, and so forth. So there are various ways you can improve on the design.

But it reflects the empirical understanding, and an observable understanding, as you make the same thing again and again, you can do it less expensively. And this can be quite important.

Now the next one here is this notion of competitive gaming. It's not so easy to define directly, but it basically says, sometimes it's important to make a decision, make a commitment in advance, as a signal to competitors.

So the example I relate to here, is when Cortez invaded Mexico and he came there by ship, he deliberately burned the ship so he could not go back. The implication being, I am committed. If you work with me, I will be here because I am not going anywhere else.

I'm not going to decide to go home and leave you alone. If you revolt against the Aztec rulers, I'm going to be here because I can't go anywhere else. So it's attributed, by some people, that this was an important aspect, competitive aspect, of saying, we are not going to have any flexibility.

We are going to commit right now. It's important. And I'm now working with a company in Morocco, which produces phosphate and their view is somewhat similar. They are committed to add on capacity to their production.

And it's a signal to everybody else that we intend to be the big producers on the block. We intend to be the world's dominant producers. And if you want to build your capacity and compete with us, you're going to lose because we're going to have more of it.

We're going to be cheaper, and we're going to dominate. So that kind of thinking, or variance on this kind of thinking, suggests, illustrates, tries to illustrate the point, that eliminating flexibility can be a good thing.

So the tendency of these principal drivers, which I just referred to, are the following. First, uncertainty emphasizes flexibility, economies of scale, against, the discount rate is for, the learning is for, and the competitive gaming is against.

So this is where I want to let you think about it, that when you're thinking about where are the pros and cons for having economies of scale, there are a number of issues to take into consideration.

It's not all, if there's uncertainty, you have to have a flexibility. Maybe, maybe not. You have to do the calculations and explore it to get it right. But it's not clear what the answer has to be. There's not one possible answer.