[SQUEAKING] [RUSTLING] [CLICKING]

RICHARD DE NEUFVILLE: We don't have a way of calculating when's the optimal time. There are some methods for dealing with that, such as dynamic programming. But dynamic programming implies there's nothing you can do about it to affect future aspects. This is the so-called path independence function. And the whole point of having flexibility is precisely that you can do things so that that powerful method does not work for us.

And there are so many paths. If we think about 2,000 samples of what may happen, that's only 2,000 samples of what may be a million possibility of paths as a combination of the different probabilities at different times of prices and quantities and so forth. It's much too large to be searched.

So the procedure is to define what we know as decision rules, the a priori condition for when to exercise flexibility. These a priori conditions may be set by higher-level mandate. This is standard operating procedure. And here's what you do. Or it could be this is the way the management wants to behave. And this is what we are looking at as how they will behave.

So an example of it is the one we use for the parking garage, which was in the base case-- we tried various samples at other points-- that expand if the observed demand is greater than the capacity over two years, whereas this implies you don't do an advance. You wait until the demand is there.

And you just don't take into account there's a special event, a one-time event that may not be repeated. So you might want to wait until you're more sure that the demand is going to be there. So you might wait two years.

So it's not a stupid one. It's not obviously the best one. You can try different ones. But it's to say, this is the way we're going to think about the management behaving.

Now, this doesn't have to be a rule that applies over the entire period. For example, you might want to change it. If you have a 20-year lease on the land, which is the example appropriate to the Garage case, you might say, well, we're not going to expand in the last five years.

It will be enough time to pay off any investment so that the decision rule is OK for the first 15 years but not for the end of life, the last five years of it. So trying to mimic what would seem to make sense from a management point of view.

Once you have those, the automation of the implementation of flexibility is to say, as we go through-- as the computer goes through time from period 1 to period 2 to period 3, each period checks to see whether the decision rule is invoked. That is, have the conditions been met?

If the conditions have been met, for example, the capacity has been less than the actual demand, then you would say, all right, we're going to make the investment to build an extra floor. It's going to cost money. Going increase the capacity. You include that expense in the cash flow. You increase the capacity for the analysis or the next period when the situation or the capacity is expanded.

And so you can go through a simulation and maybe never the decision will be invoked. Maybe they'll invoke second year, third year, fifth year, eighth year. Could be invoked many times. And this process is very powerful in comparison with alternative features.

So it can analyze many flexibilities simultaneously, whereas simultaneously because you might have a decision about plant capacity. You may also have decisions about pricing. You may say, well, I'm going to increase my plant capacity. And I'm going to cut my price by 20% so I increase my market share or stimulate my market share. Or market's so good, I'm going to increase capacity. But I'm also going to raise prices.

So you can have not just one flexibility but a range of flexibilities that you can have and some that you may never have, never use. For example, if things are going well, you're not going to have the capacity to close the plant down. But if things are going badly, maybe that would be a flexibility you'd like to invoke under those circumstances so that the simulation enables you to look at lots of different kinds of flexibilities in lots of different situations.

Now, ultimately the question is, what's the value of this flexibility? Why should I go to the effort of creating this ability to change my system or to invoke it? Or how much do I get out of it? Maybe it's easy to-- it doesn't require any extra effort to be able to have a flexibility, for example, to close the plant. Maybe I don't have to do anything special in advance. But what's the value of having that thought?

So you get the outcomes or plan flexibility. For example, if we're doing it in monetary terms, it's NPV. It's expected NPV, the target curve. You get that with the flexibility. And then you compare them. And the value of the flexibility of the first order is the difference in the ENPV, the expectations of the different with and without the flexibility.

And when you compare the target curves, you show where that value comes from. Does it come from making it small at the beginning so we don't have losses? Is it coming from having greater capacity if needed? But you can see that we can develop that idea by comparing the target curves.

So the takeaway from this first portion is simulation defines the outcome distributions, the target curves, and consequently the value of flexibility. It is computationally efficient.

Secondly, we can deal with all kinds of uncertainties. It's not limited by some assumption that the distribution has to be this way or that way or like the dynamic program has to be path independent, et cetera.

A nice aspect of it also is that it's relatively easy to explain to the decision makers. Why? Because you say, well, look. We're looking at all the combinations to see what happens. You don't have any complicated math to explain. You don't have decision trees, which can be very complicated.

We don't have any high-powered theory, which is what's appropriate for a financial options analysis, which will be in the second half of the course. So the bottom line is that simulation can be a very good approach. It's powerful. It goes through lots of cases, and it's relatively easy.