# Strategy as a Portfolio of Real Options

by Timothy A. Luehrman

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*Now we can "draw" a strategy in terms that are neither wholly strategic nor wholly financial but rather an insightful mix of both.*

# Strategy *as a Portfolio of* Real Options

by Timothy A. Luehrman

WHEN EXECUTIVES CREATE STRATEGY, they project themselves and their organizations into the future, creating a path from where they are now to where they want to be some years down the road. In competitive markets, though, no one expects to formulate a detailed long-term plan and follow it mindlessly. As soon as we start down the path, we begin learning – about business conditions, competitors' actions, the quality of our preparations, and so forth – and we need to respond flexibly to what we learn. Unfortunately, the financial tool most widely relied on to estimate the value of strategy – discounted-cash-flow (DCF) valuation – assumes that we will follow a predetermined plan, regardless of how events unfold.

A better approach to valuation would incorporate both the uncertainty inherent in business and the active decision making required for a strategy to succeed. It would help executives think strategically on their feet by capturing the value of doing just that – of managing actively rather than

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passively. Options can deliver that extra insight. Advances in both computing power and our understanding of option pricing over the last 20 years make it feasible now to begin analyzing business strategies as chains of real options. As a result, the creative activity of strategy formulation can be informed by valuation analyses sooner rather than later. Financial insight may actually contribute to shaping strategy, rather than being relegated to an after-the-fact exercise of "checking the numbers."

In financial terms, a business strategy is much more like a series of options than a series of static cash flows. Executing a strategy almost always involves making a *sequence* of major decisions. Some actions are taken immediately, while others are deliberately deferred, so managers can optimize as circumstances evolve. The strategy sets the framework within which future decisions will be made, but at the same time it leaves room for learning from ongoing developments and for discretion to act based on what is learned.

To consider strategies as portfolios of related real options, this article exploits a framework presented in "Investment Opportunities as Real Options: Getting Started on the Numbers" (HBR July–August 1998). That article explains how to get from conventional DCF value to option value for a typical project – in other words, it is about how to get a number. This article extends that framework, exploring how option pricing can be used to improve decision making about the sequence and timing of a portfolio of strategic investments.

## A Gardening Metaphor: Options as Tomatoes

Managing a portfolio of strategic options is like growing a garden of tomatoes in an unpredictable climate. Walk into the garden on a given day in August, and you will find that some tomatoes are ripe and perfect. Any gardener would know to pick and eat those immediately. Other tomatoes are rotten; no gardener would ever bother to pick them. These cases at the extremes – now and never – are easy decisions for the gardener to make.

In between are tomatoes with varying prospects. Some are edible and could be picked now but would benefit from more time on the vine. The experienced gardener picks them early only if squirrels or other competitors are likely to get them. Other tomatoes are not yet edible, and there's no point in picking them now, even if the squirrels do get them. However, they are sufficiently far along, and there is enough time left in the season, that many will ripen unharmed and eventually be picked. Still others look less promising and may not ripen before the season ends. But with more sun or water, fewer weeds, or just good luck, even some of these tomatoes may make it. Finally, there are small green tomatoes and late blossoms that have little likelihood of growing and ripening before the season ends. There is no value in picking them, and they might just as well be left on the vine.

Most experienced gardeners are able to classify the tomatoes in their gardens at any given time. Beyond that, however, good gardeners also understand how the garden changes over time. Early in the season, none of the fruit falls into the "now" or "never" categories. By the last day, all of it falls into one or the other because time has run out. The interesting question is, What can the gardener do during the season, while things are changing week to week?

In financial terms, a business strategy is much more like a series of options than it is like a series of static cash flows.

A purely passive gardener visits the garden on the last day of the season, picks the ripe tomatoes, and goes home. The weekend gardener visits frequently and picks ripe fruit before it rots or the squirrels get it. Active gardeners do much more. Not only do they watch the garden but, based on what they see, they also cultivate it: watering, fertilizing, and weeding, trying to get more of those in-between tomatoes to grow and ripen before time runs out. Of course, the weather is always a question, and not all the tomatoes will make it. Still, we'd expect the active gardener to enjoy a higher yield in most years than the passive gardener.

In option terminology, active gardeners are doing more than merely making exercise decisions (pick or don't pick). They are monitoring the options and looking for ways to influence the underlying variables that determine option value and, ultimately, outcomes.

Option pricing can help us become more effective, active gardeners in several ways. It allows us to estimate the value of the entire year's crop (or even the value of a single tomato) before the season actually ends. It also helps us assess each

tomato's prospects as the season progresses and tells us along the way which to pick and which to leave on the vine. Finally, it can suggest what to do to help those in-between tomatoes ripen before the season ends.

## A Tour of Option Space

Instead of a garden plot, visualize a rectangle we'll call *option space.* Option space is defined by two option-value metrics, each of which captures a different part of the value associated with being able to defer an investment. Option space can help address the issues an active gardener will care about: whether to invest or not (that is, whether to pick or not to pick), when to invest, and what to do in the meantime.

Let's briefly review the two metrics, which were developed in "Investment Opportunities as Real Options." The first metric contains all the usual data captured in net present value (NPV) but adds the time value of being able to defer the investment. We called that metric $NPV_q$ and defined it as the value of the underlying assets we intend to build or acquire divided by the present value of the expenditure required to build or buy them. Put simply, this is a ratio of value to cost. For convenience, here, we'll call it our *value-to-cost* metric instead of $NPV_q$, but bear in mind that *value* and *cost* refer to the project's assets, not to the option on those assets.

When the value-to-cost metric is between zero and one, we have a project worth less than it costs; when the metric is greater than one, the project is worth more than the present value of what it costs.

The second metric we'll call our *volatility* metric. It measures how much things can change before an investment decision must finally be made. That depends both on how uncertain, or risky, the future value of the assets in question is and on how long we can defer a decision. The former is captured by the *variance per period of asset returns;* the latter is the option's *time to expiration.* In the previous article, this second metric was called *cumulative volatility.*

Option space is defined by these two metrics, with value-to-cost on the horizontal axis and volatility on the vertical axis. See the graph, "Option Space Is Defined by Two Option-Value Metrics." The usual convention is to draw the space as a rectangle, with the value-to-cost metric increasing from left to right (its minimum value is zero), and the volatility metric increasing from top to bottom (its minimum value also is zero). Within the interior of the rectangle, option value increases as the value of either metric increases; that is, from any point in the space, if you move down, to the right, or in both directions simultaneously, option value rises.

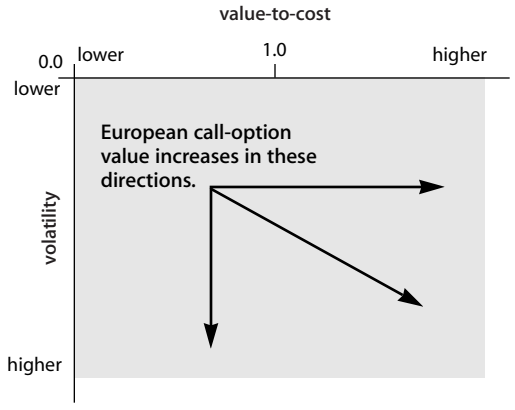
How does option space help us with strategy? A business strategy is a series of related options: it is as though the condition of one tomato actually affected the size or ripeness of another one nearby. That obviously makes things more complicated. Before we analyze a strategy, let's first consider the simpler circumstance in which the tomatoes growing in the garden don't affect one another. To do that, we need to explore the option space further.

In a real garden, good, bad, and in-between tomatoes can turn up anywhere. Not so in option space, where there are six separate regions, each of which contains a distinct type of option and a corresponding managerial prescription. We carve up the space into distinct regions by using what we know about the value-to-cost and volatility metrics, along with conventional NPV.

What's the added value of dividing option space in this fashion? Traditional corporate finance gives us one metric – NPV – for evaluating projects, and only two possible actions: invest or don't invest. In option space, we have NPV, two extra metrics, and six possible actions that reflect not only where a project is now but also the likelihood of it ending up somewhere better in the future. When we return to assessing strategies, this forward looking judgment will be especially useful.

### Option Space Is Defined by Two Option-Value Metrics

We can use the two option-value metrics to locate projects in option space. Moving to the right and/or downward corresponds to higher option value.




Value-to-cost metric = NPVq = $S \div PV(X)$
Volatility metric = $\sigma\sqrt{t}$

**Top of the Space: *Now* and *Never.*** At the very top of our option space, the volatility metric is zero. (See the diagram "Dividing Option Space into Regions.") That's so either because all uncertainty has been resolved or because time has run out. With business projects, the latter is far more likely. So projects that end up here differ from one another only according to their value-to-cost metrics, and it's easy to see what to do with them. If the value-to-cost metric is greater than one, we go ahead and invest now. If it's less than one, we invest never. Once time has run out, "now or never" completely describes our choices. It will be convenient to refer to regions by number, so let's number these extremes 1 and 6. Region 1 contains the perfectly ripe tomatoes; it is the *invest now* region. Region 6 contains the rotten ones; the prescription there is *invest never.*

**Right Side of the Space: *Maybe Now* and *Probably Later.*** What about projects whose value-to-cost metric is greater than one but whose time has not yet run out? All such projects fall somewhere in the right half of our option space but below the top. Projects here are very promising because the underlying assets are worth more than the present value of the required investment. Does that mean we should go ahead and invest right away? In some instances, the answer is clearly no, while in other cases, it's maybe. We want to be able to distinguish between those cases. The key to doing so is not option pricing but conventional NPV.

In terms of the tomato analogy, we are looking at a lot of promising tomatoes, none of which is perfectly ripe. We want to distinguish between those that, if picked right away, are edible (NPV > 0) and those that are inedible (NPV < 0). The distinction matters because there is no point in picking the inedible ones. Conventional NPV tells us the value of investing immediately despite the fact that time has not yet run out. If NPV is negative, immediate exercise is unambiguously suboptimal. In option terminology, we say that such an option is *out of the money:* it costs more to exercise it than the assets are worth. The exercise price ($X$) is greater than the underlying asset value ($S$), therefore NPV = $S - X < 0$.

The curve in our diagram separates options that are out of the money (NPV < 0) from those that are *in the money* (NPV > 0). For points above the curve in the diagram, NPV is positive; for those below the curve, NPV is negative. For points actually on the curve itself, NPV = 0.

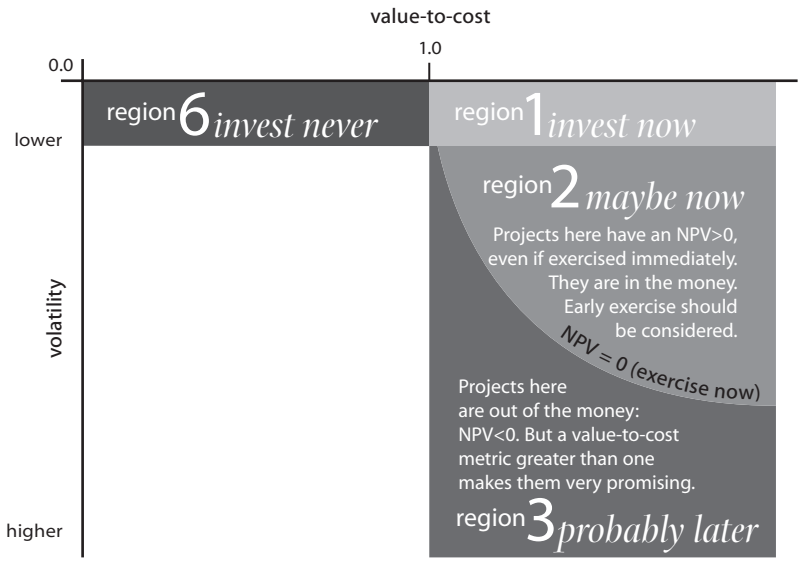
Projects below the curve, which we'll call region 3, are like the inedible tomatoes that we clearly don't want to pick right away. Even so, they are very promising because their value-to-cost metric is positive and time has not yet run out. I call this region *probably later* because, even though we should not invest yet, we expect to invest eventually for a relatively high fraction of these projects. In the meantime, they should be cultivated.

Projects that fall above the NPV = 0 curve are even more interesting. These options are in the money. They are like tomatoes that even though not perfectly ripe are nevertheless edible. We should be considering whether to pick them early.

It may seem contradictory to consider exercising an option early when all along I've argued in "Investment Opportunities as Real Options" that it is valuable to be able to defer the investment – to wait, see what happens, and then make an optimal

## Dividing Option Space into Regions

The curve may be derived by holding the risk-free rate of return ($r_f$) and the standard deviation ($\sigma$) constant (from the Black-Scholes equation) as $t$ varies and solving for the value of the value-to-cost metric that corresponds to NPV = 0. For example, in the extreme case of $r_f = 0$, the curve is a vertical line corresponding to points for which the value-to-cost metric = 1. As $r_f$ increases, the slope of the curve decreases, bending to the right.



choice at the last possible moment. If there is value associated with deferring, why would we ever do otherwise? Sometimes, especially with real options, value may be lost as well as gained by deferring, and the proper decision depends on which effect dominates.

The financial analog to such a real option is a call option on a share of stock. If the stock pays a large dividend, the shareholder receives value that the option holder does not. The option holder may wish to become a shareholder simply to participate in the dividend, which otherwise would be forgone. Think of the dividend as value lost by deferring the exercise decision.

In the case of real options, where the underlying asset is some set of business cash flows, any *predictable* loss of value associated with deferring the investment is like the dividend in our stock example. Phenomena like pending changes in regulations, a predictable loss of market share, or preemption by a competitor are all costs associated with investing later rather than sooner and might cause us to exercise an option early. Or, to use the tomato analogy, we might pick an edible tomato early if we can predict that squirrels will get it otherwise. *Unpredictable* gains and losses, however, would not lead us to exercise our options early.

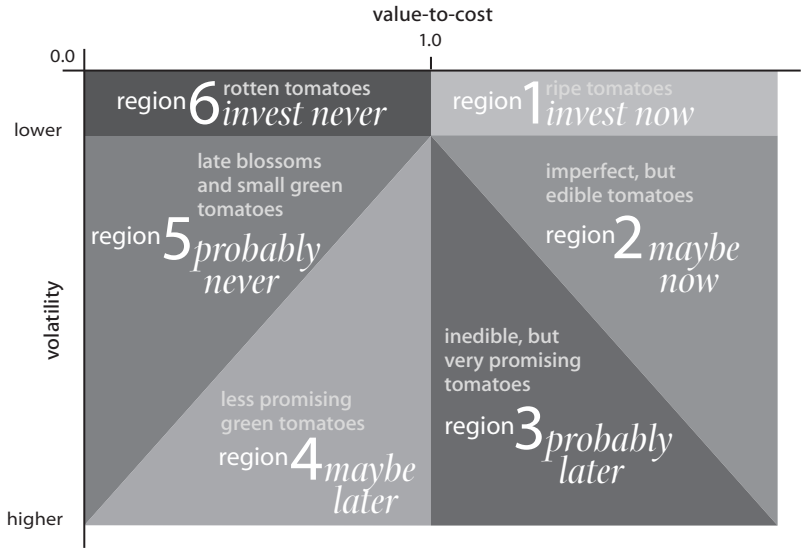
Options that are in the money (that is, those for which NPV > 0) should be evaluated to see if they ought to be exercised early. Immediate investment will not always be the optimal course of action because by investing early the company loses the advantages of deferring, which also are real. Deciding whether to invest early requires a case-by-case comparison of the value of investing immediately with the value of waiting a bit longer – that is, of continuing to hold the project as an option. I refer to that part of the option space as *maybe now* because we might decide to invest right away. Let's label it region 2.

**Left Side of the Space: *Maybe Later* and *Probably Never.*** All options that fall in the left half of the space are less promising because the value-to-cost metric is everywhere less than one, and conventional NPV is everywhere less than zero. But even here we can separate the more valuable from the less valuable. The upper left is unpromising territory because both the value-to-cost and volatility metrics are low. These are the late blossoms and the small green tomatoes that are unlikely to ripen before the season ends. I call this part of the option space *probably never,* and we can label it region 5.

In contrast, the lower section (of this left half of the space) has better prospects because at least one of the two metrics is reasonably high. I call it *maybe later,* and we can label it region 4. The diagram "The Tomato Garden" dispenses with fancy curves and simply divides the option space roughly into the six regions.

## The Tomato Garden

If we start on the right in region 1 and sweep through the space clockwise, projects become progressively less promising. In regions 1 through 3, the value-to-cost metric is greater than one, but only in regions 1 and 2 is conventional NPV positive, and only in region 1 is the exercise decision a foregone conclusion. In regions 4 through 6, the value-to-cost metric is less than one, but only in region 6 is the exercise decision a foregone conclusion.



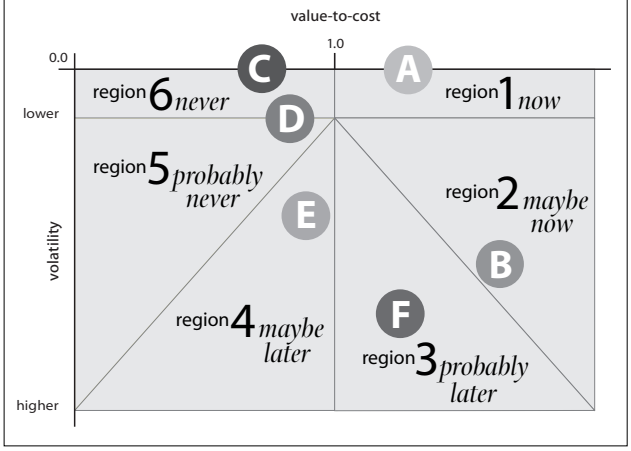

## When to Harvest

As an example of what we learn from the tomato garden, consider six hypothetical projects that are entirely unrelated to one another. The table "Vital Statistics for Six Independent Projects" shows the relevant data for these projects, which have been labeled A through F. Note that each of them involves assets worth $100 million. Two of them (A and B) require capital expenditures of $90 million; the other

## Vital Statistics for Six Independent Projects

| Variable | | A | B | C | D | E | F | Portfolio Value |
|---|---|---|---|---|---|---|---|---|
| $S$ | Underlying asset value ($ millions) | $100.00 | $100.00 | $100.00 | $100.00 | $100.00 | $100.00 | |
| $X$ | Exercise price ($ millions) | $90.00 | $90.00 | $110.00 | $110.00 | $110.00 | $110.00 | |
| $t$ | Time to expiration (years) | 0.00 | 2.00 | 0.00 | 0.50 | 1.00 | 2.00 | |
| $\sigma$ | Standard deviation (per year) | 0.30 | 0.30 | 0.30 | 0.20 | 0.30 | 0.40 | |
| $r_f$ | Risk-free rate of return (% per year) | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | |
| | | | | | | | | |
| NPVq | Value-to-cost metric | 1.111 | 1.248 | 0.909 | 0.936 | 0.964 | 1.021 | |
| $\sigma\sqrt{t}$ | Volatility metric | 0.000 | 0.424 | 0.000 | 0.141 | 0.300 | 0.566 | |
| | Call value ($ millions) | $10.00 | $27.23 | $0.00 | $3.06 | $10.42 | $23.24 | $73.95 |
| $S$-$X$ | Conventional NPV ($ millions) | $10.00 | $10.00 | -$10.00 | -$10.00 | -$10.00 | -$10.00 | $20.00 |
| | Region | 1 | 2 | 6 | 5 | 4 | 3 | |
| | Exercise decision | now | maybe now | never | probably never | maybe later | probably later | |

## Locating the Projects in the Tomato Garden




four require expenditures of $110 million. So A and B each has a positive NPV of $10 million. Each of the other four has an NPV of negative $10 million. The NPV of the entire portfolio is negative $20 million or, more reasonably, positive $20 million, since the four projects with negative NPVs can be included at a value of zero. Conventional capital budgeting offers only two prescriptions – invest or don't invest. Following those rules, we'd accept projects A and B and reject all the others.

Although their NPVs are tightly clustered, the six projects have different time and volatility profiles, and hence different values for their value-to-cost and volatility metrics. Consequently, each is located in a different region of the option space. (See the diagram "Locating the Projects in the Tomato Garden.")

A is a *now* project that falls in region 1; C is a *never* project in region 6. For both of them, time has run out, so the volatility metric is zero. Project B is very promising: its NPV is positive, and its value-to-cost metric is greater than one. B plots in region 2, and we should consider whether we ought to exercise our option on this project early. However, unless there is some predictable loss in future value (either a rise in cost or a fall in value), then early exercise is not only unnecessary but also suboptimal. Project F's value-to-cost metric is greater than one, but its NPV is less than zero. It falls in region 3 and is very valuable as an option, despite its negative NPV. That's because it will not expire for two years and has the highest volatility of the whole group. Hence, project F's prognosis is *probably later.*

Project E has less going for it than project F. It is in region 4 and deserves some attention because, with a year to go and the moderate standard deviation of its underlying asset return ($\sigma$ = 0.3 per year), it just might make it. That's why it is classified as *maybe later.* Project D is much less promising (a *probably never*) because a decision must be made in only six months and, with a low volatility, there's not much likelihood that D will pop into the money before time runs out.

Because it can account for flexibility and uncertainty, the options-based framework produces a different assessment of this portfolio than the conventional DCF approach would. Most obviously, where DCF methods give the portfolio a value of $20 million, option pricing gives it a value of about $74 million, more than three times greater. Just as important, locating these projects in the tomato garden yields notably different exercise decisions.

Instead of accepting two projects and rejecting four, our option analysis leads us to accept one, reject one, and wait and see about the other four. And as we wait, we know how each project's prospects differ. Moreover, we don't wait passively. Having only limited resources to devote to the portfolio, we realize that some wait-and-see projects are more likely to reward our active cultivation than others. In particular, we can see that projects E and F together are worth about $34 million (not negative $20 million or even $0) and should be actively cultivated rather than abandoned. At the very least, they could be sold to some other gardener.

## A Dynamic Approach

Cultivation is intended to improve the crop, but it has to work within boundaries set by nature. In option space, as in nature, there are basic laws of time and motion. The most basic is that options tend to move upward and to the left in the option space as time passes. Upward, because the volatility metric decreases as time runs out. To the left, because, as a present-value calculation, the value-to-cost metric also decreases over time if its other constituent variables remain constant.

To illustrate, consider project F. Its volatility metric is 0.566, and its value-to-cost metric is 1.021. Now let a year pass, and suppose none of project F's variables changes except for *t*, which is now one year instead of two. Were we to recompute the metrics, we would discover that both have declined. The volatility metric falls from 0.566 to 0.400, which moves F upward in option space. And its value-to-cost metric declines from 1.021 to 0.964 – that is, $100 \div [110 \div (1+0.06)^1]$ – which moves F to the left. In fact, project F moves from region 3 (*probably later*) to the less promising region 4 (*maybe later*). Despite its initial promise, the only way project F is going to wind up in the money (that is, in region 1 or 2) and eventually get funded is if some force pushes it to the right, overcoming the natural tug to the left, before time runs out. Only two forces push in that direction: good luck and active management.

Neither force should be ignored. Sometimes we succeed by putting ourselves squarely in the way of good fortune. Other times we have to work at it. Managers actively cultivating a portfolio of opportunities are, in effect, working to push options as far as possible to the right in the space before they float all the way to the top. How is that done? By taking some action that increases either or both of our option-value metrics. Of the two, the value-to-cost metric is perhaps the more obvious one to work on first because managers are more accustomed to managing revenues, costs, and capital expenditures than volatility or time to expiration.

Anything managers can do to increase value or reduce cost will move the option to the right in our space. For example, price or volume increases, tax savings, or lower capital requirements, as well as any cost savings, will help. Such enhancements to value are obvious with or without a real-options framework. What the framework provides is a way to incorporate them visually and quantitatively into option value through the value-to-cost metric.

The real world seldom gives managers the luxury of isolating one variable and holding all others constant. Managers cannot simply declare, "Let's raise prices to increase the value of our project." More likely, they will invent and evaluate complex proposal modifications driven or constrained by technology, demographics, regulations, and so on. For example, one way to cultivate a market-entry option might be to add a new product feature. That may entail extra investment (raising *X*), but it will also help differentiate the product in the local market, permitting higher prices (raising *S*) but also adding extra manufacturing costs (lowering *S*), some of which are fixed. The net effect on the value-to-cost metric is what counts, and the net effect is unclear without further analysis.

The options-based framework gives us a different assessment than the conventional DCF approach would.

Evaluating the project as an option means there is more, not less, to analyze, but the framework tells us what to analyze, gives us a way to organize the effects, and offers a visual interpretation. Observing the change in the option's location in our space tells us both whether its value has risen or fallen and whether it has migrated to a different region of the tomato garden.

There are still more considerations even in this simple example of adding a product feature. Extra fixed costs mean greater risk, which might lower the value of the project (due to the need to discount future cash flows at a higher risk-adjusted rate) and cause its value-to-cost metric to drop further. But the extra fixed costs also represent operating lever-

age that raises the volatility metric. That augments option value. We could hypothesize further that adding an extra feature will stimulate a competitor to match it. We, in turn, might be forced to introduce the next generation of our product (on which we hold a different option) earlier than we otherwise would have.

In general, actions taken by managers can affect not only the value-to-cost measure but also the volatility metric. In this example, both elements of the volatility metric – risk and time to expiration – are affected. And for more than one option. There is a spillover from one option to another: adding a feature reduces the length of time a subsequent decision can be deferred. For other situations, there are a myriad of possible spillover effects.

## Nested Options in a Business Strategy

Once we allow options in a portfolio to directly influence other options, we are ready to consider strategies: series of options explicitly *designed* to affect one another. We can use "nests" of options upon options to represent the sequence of contingencies designed into a business, as in the following simplified and hypothetical example.

Three years ago, the WeatherIze Corporation bought an exclusive license to a technology for treating fabric to retard its breakdown in extreme weather conditions. The idea was to develop a new line of fabric especially suitable for outdoor commercial awnings, a market the company already serves with a less durable product. Now WeatherIze's engineers have developed their first treated fabric, and the company is considering making the expenditures required to roll it out commercially. If the product is well received by awning manufacturers, WeatherIze will have to expand capacity within three years of introduction just to serve awning producers.

The vice president for business development is ebullient. He anticipates that success in awnings will be followed within another two years by product extensions – similar treatment of different fabrics designed for such consumer goods as tents, umbrellas, and patio furniture. At that time, WeatherIze would expand capacity yet again. The company envisions trademarking its fabrics, expanding its sales force, and supporting the consumer products made from these fabrics with cooperative advertising.

WeatherIze's strategy for exploiting the treatment technology is pretty straightforward. It consists of a particular sequence of decision opportunities. The first step of the execution was to purchase the license. By doing so, the company acquired a sequence of nested options: to develop the product; to introduce the product; to expand capacity for manufacturing awning fabric; and to expand again to make related, branded fabrics. Just now, having developed the product, WeatherIze is part way through the strategy and is considering its next step: spending on the product introduction. That is, it's time to exercise (or not) the next real option in the chain.

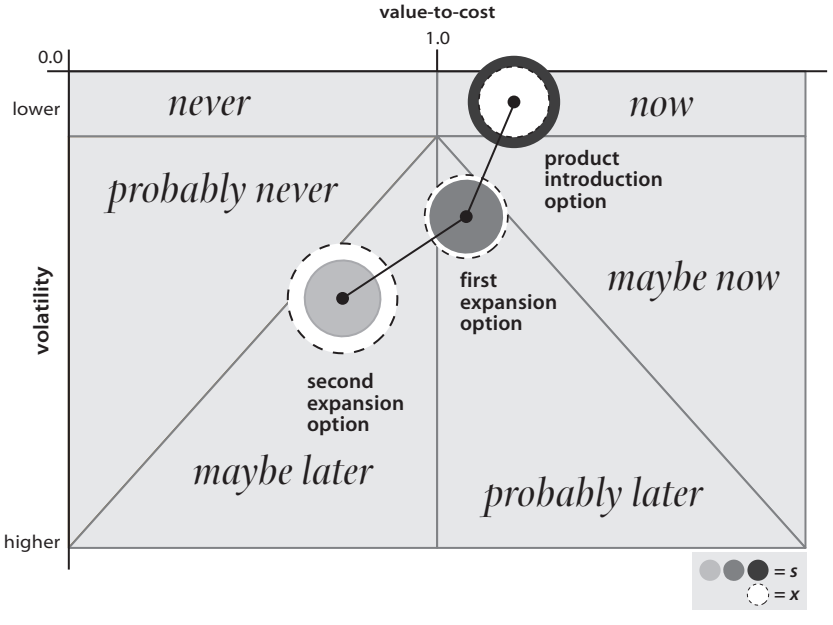
WeatherIze's strategy, at this point in time, is depicted in option space in the diagram "WeatherIze's Strategy as Nested Call Options." Each circle represents an option whose location in space is determined by its value-to-cost and volatility metrics. The size of each solid circle is proportionate to the underlying asset value (*S*) for each option. The area

### WeatherIze's Strategy as Nested Call Options

The value of WeatherIze's strategy is:

$$PV\left\{\text{product introduction} + \text{call value}\left[\text{(first expansion option)} + \text{call value}\ \text{(second expansion option)}\right]\right\}.$$

The value of the innermost call option must be estimated first because its value is part of the underlying asset value (*S*) for the next option in the nest.



within each dashed circle is proportionate to required expenditures (*X*). Thus a dashed circle inside a solid one represents an option that is in the money (*S* > *X*). A dashed circle outside a solid circle shows an option that is out of the money.

The line segments in the diagram indicate that the options are nested. The option to expand for awning production is acquired if and only if the option to introduce is exercised. As such, the underlying asset for the introduction option includes both the value of the operating cash flows associated with the product itself *and* the present value of the option to expand. Likewise, the option to expand a second time for commercial product production is acquired only if WeatherIze decides to exercise its first expansion option. The value of the whole strategy at this point is:

$$\text{PV}\left\{\text{product introduction} + \text{call value}\left[\text{(first expansion option)} + \text{call value}\ \text{(second expansion option)}\right]\right\}.$$

In effect, WeatherIze owns a call on a call.

The option to introduce the new awning fabric is in the money and about to expire. (WeatherIze will forfeit its license if it does not go ahead with the introduction.) As soon as this option is exercised, the picture changes. The top circle goes away; the bottom two remain linked and begin drifting upward. One of the most important factors determining whether they move right or left on their way up is how well the awning fabric does in the marketplace. But there are other factors as well. Anything that enhances the value of the second expansion option enhances the value of the first, too, because the value of the second option forms part of the value of the underlying asset value for the first option.

Suppose, for example, the risks associated with the consumer-product fabric's assets increase. Let's trace the effects in the diagram "What Happens If the Consumer Fabric Opportunity Becomes Riskier?" The most direct effect is on the second expansion option, which moves down in the space because its volatility metric rises. The second expansion option becomes more valuable. But the increased risk also affects the first expansion option for awning fabric. Its value-to-cost metric rises because the second expansion option is part of the underlying assets (*S*) of the first. In fact, a change in either metric for the second option must also change the value-to-cost metric (at least) of the first.

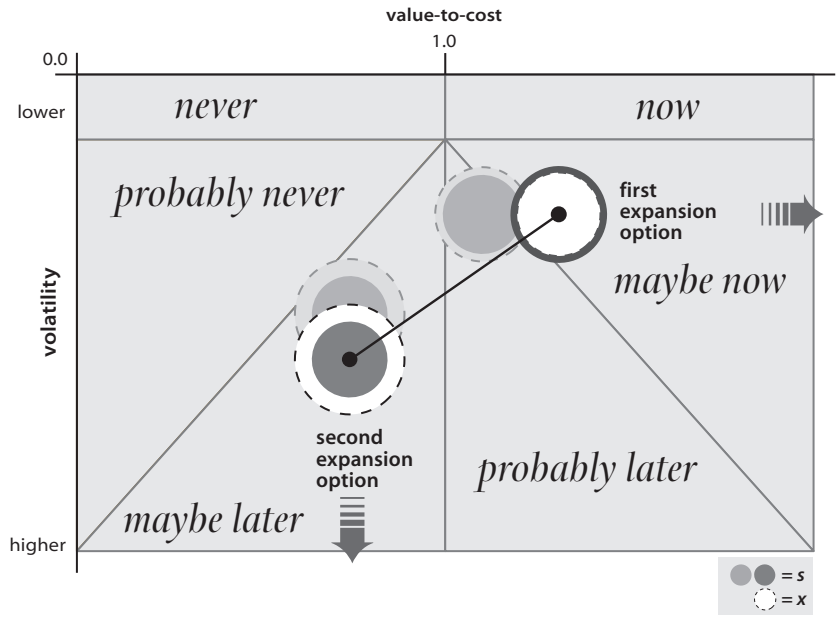
As another example, suppose a competitor introduces a substitute fabric in the consumer goods markets that WeatherIze had planned to target. Try to visualize what will happen. Not only will the locations of the options change but so will the sizes of the circles. The solid circle, or asset value (*S*), of WeatherIze's second expansion option will shrink, and both the first and second expansion options will move to the left. Further, the first expansion option's underlying asset value also should shrink.

Drawing simple circles in the option space also lets us compare strategies. For example, we have been assuming that WeatherIze would not introduce branded fabrics without first expanding its awning fabric capacity. Now suppose the company could do either first, or both simultaneously, but that a larger investment would be required to make branded fabrics if the awning expansion weren't accomplished first. We could also assume that profit margins on the branded goods would be higher if the company first gained more experience with awning fabric.

These options in WeatherIze's alternative strategy are not nested, and they are no longer in the same

## What Happens If the Consumer Fabric Opportunity Becomes Riskier?

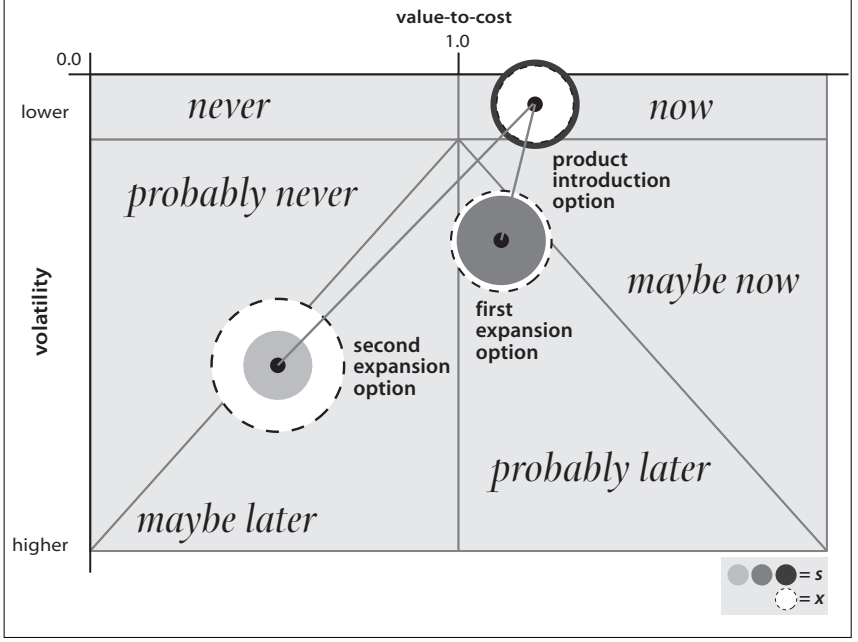
If the volatility of returns on consumer-product fabrics increases, the second expansion option moves down. This causes the first expansion option to move to the right because the second option is part of the underlying assets for the first.



locations. The diagram "Call Options in WeatherIze's Alternative Strategy" depicts the new strategy. Note that the second option, the branded-fabric option, is now farther left, its solid circle, or asset value (*S*), is smaller, and its dashed circle, or expenditures (*X*), is larger than it was originally. It is further out of the money but is now linked directly to the product introduction option. Given that the branded-fabric option is farther left under this new strategy and its solid circle is smaller, could we possibly prefer it? Yes, actually, provided it also moves down in the space – that is, if its volatility metric has increased. The pricing table in the real-options framework can tell us how far down it would have to go to compensate for any given move to the left. Finally, note that for the nonnested strategy, the value of both options directly enhances the value of the underlying assets associated with the initial product introduction. But it is no longer the case that any change in the second expansion option must affect the location of the first expansion option: each could, in fact, move around independently.

**Call Options in WeatherIze's Alternative Strategy**

The expansion options are no longer nested under the alternative strategy, but the second option has moved down and to the left. In addition, its solid circle is smaller and its dashed circle larger than it was originally.




Although the options are not nested, they are very much related. Suppose, for example, that the awning expansion option pops into the money and is indeed exercised first, before the consumer fabric option. The value of the latter would be enhanced because the underlying assets associated with it would be expected to produce better margins – the value-to-cost metric for the consumer fabric option rises.

To compare WeatherIze's alternative strategies, we compute the value of each strategy's introduction option. We can do that quantitatively using the real-options framework. In visual terms, we prefer the introduction option to be farther to the right and to have a larger solid circle. Whichever strategy accomplishes that is more valuable.

## Learning to Garden

I argued in "Investment Opportunities as Real Options" that companies should adopt option-pricing techniques as adjuncts to their existing system, not as replacements. If WeatherIze takes that approach, there is a good chance that the "tomato garden" will help the company create and execute a superior strategy.

Strategists at WeatherIze already were thinking several moves ahead when they purchased the license. They don't need a tomato garden to tell them merely to think ahead. But option pricing quantifies the value of the all-important follow-on opportunities much better than standard DCF-valuation techniques do. And the tomato garden adds a simple but versatile picture that reveals important insights into both the value and the timing of the exercise decisions. It gives managers a way to "draw" a strategy in terms that are neither wholly strategic nor wholly financial but some of both. Managers can play with the pictures much as they might with a physical model built of Legos or Tinker Toys. Some of us are most creative while at play.

As executives at WeatherIze experiment with circles in option space, it is important that they preserve the link between the pictures they draw and the disciplined financial projections required by the real-options framework. They need to remember that the circles occupy a certain part of the space because the numbers – the value-to-cost and volatility metrics – put them there. At the same time,

they need to prevent the exercise from becoming just another variation on "valuation as usual." This is the well-worn rut in which valuation analysis is used primarily to check numbers and as due diligence documentation for investments. Instead, the purpose should be to incorporate financial insights at the stage when projects and strategies are actually being created.

How does one become a good gardener? Practice, practice. I recommend starting by drawing simple combinations of projects to learn some common forms. What are the different ways you can depict a pair of nested call options? How can the pair move in the space? What are the ways to transform their configuration by changing the variables? Then move on to simple generic strategies. What does a given strategy look like when drawn in the option space? How does the picture change over time? How does it change when an option is exercised?

Next, practice translating real business phenomena into visual effects to update pictures. For example, how will the picture change if you add a direct mail campaign to your product introduction? Or how will the picture change if your competitor cuts prices when you enter a market?

Finally, try drawing your strategy and your competitors' side by side: How does the value and location of your options affect the value and location of theirs? How will they all move over time?

In most companies, strategy formulation and business development are not located in the finance bailiwick. Nevertheless, both activities raise important financial questions almost right away. Although the questions arise early, answers typically do not. For finance to play an important creative role, it must be able to contribute insightful interpretive analyses of sequences of decisions that are purely hypothetical – that is, while they are still mere possibilities. By building option pricing into a framework designed to evaluate not only hard assets but also opportunities (and multiple, related opportunities at that), we can add financial insight earlier rather than later to the creative work of strategy.

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