

A Scientific Approach to Managing Competition

Ever since the Belgian mathematician P. F. Verhulst formulated the natural-growth equation to describe species populations back in 1845, his ubiquitous S-shaped curve has made its way into everyday life. Early in the 20th century, Alfred Lotka of Johns Hopkins University and Vito Volterra of the University of Rome, working simultaneously but independently, generalized Verhulst's growth equation to model competition among different species. Today, the predator-prey mathematical formulation bears both men's names, and its usefulness has been extended to describe competition outside biology and ecology. Indeed, the Volterra-Lotka model has opened the way to effectively managing competition in the marketplace. A set of elementary marketing actions has emerged that provide guidance when searching for a commercial image or an effective advertising message.

An intriguing aspect of the marketplace is that the nature of competition can change over time. A technology, company, or product does not need to remain prey to another forever. Competitive roles can be radically altered with technological advances or with the right marketing decisions. External light meters, used for accurate diaphragm and speed setting on photographic cameras,

enjoyed a stable, symbiotic (win-win) relationship with cameras for decades. As camera sales grew, so did light-meter sales. But eventually, technological developments enabled camera companies to incorporate light meters into their own boxes. Soon, the whole light-meter industry became prey to the camera industry. Sales of external light meters diminished while sales of cameras enjoyed a boost, and the relationship passed from win-win to predator-prey.

Battle of the pens

The struggle between fountain pens and ballpoint pens had a different ending (Figure 1). The substitution of ballpoint pens for fountain pens as writing instruments went through three distinct stages. Before the appearance of ballpoint pens, fountain-pen sales grew undisturbed to fill the writing-instrument market. They were following an S-shaped curve when the ballpoint technology appeared in 1951. As ballpoint sales picked up, those of fountain pens declined in the period 1951 to 1973. Fountain pens staged a counterattack by radically dropping prices. But that effort failed. Fountain pens kept losing market share and embarked on an extinction course. By 1973, their average price had dropped to as low as 72 cents, to no avail.

Eventually, however, the prices of fountain pens began rising. The fountain pen underwent what Darwin would have described as a character displacement to the luxury niche of the executive pen market. In the early 1970s, the strategy of fountain pens became a retreat into noncompetition. By 1988, the price of some fountain pens in the United States had climbed to \$400. The Volterra-Lotka model indicates that today the two species no longer interact but each follows a simple S-shaped growth pattern. As a consequence, fountain pens have secured a healthy and profitable market niche. Had they persisted in their competition with ballpoint pens, they would have perished.

Handling competition

Character displacement is a classical way to diminish the impact of competition. Another name for this is Darwinian divergence, sometimes also encountered among siblings. In his book *Born to Rebel: Birth Order, Family Dynamics, and Creative Lives*, Frank Sulloway shows that throughout history, first-born children have become conservative and later-borns revolutionaries. First-born children end up conservative because they do not want to lose any of the only-child privileges they enjoy. But this forces later-borns into becoming rebellious, to differentiate themselves and thus minimize competition with a sibling and optimize survival in the same family.

The attack of a new species against the defenses of an incumbent one lies at the heart of corporate marketing strategies. Christopher Farrell, director of scientific affairs at Baxter Healthcare Corp. (Deerfield, IL), defined an attacker's advantage and a defender's counterattack in terms of the coupling parameters in the Volterra-Lotka model. A coupling parameter can be determined by data, and thus, it can assign a precise number to an attacker's advantage or a defender's counterattack. The attacker's advantage quantifies the extent to which the attacker inhibits the ability of the defender to keep market share. The defend-

MODE	DEFINITION	Coupling Parameter	
		A	B
Pure competition	Both species suffer from each other's existence.	-	-
Predator-prey	One serves as food for the other.	+	-
Mutualism	Symbiosis; a win-win situation.	+	+
Commensalism	A parasitic type of relationship in which one species benefits from the existence of the other, which nevertheless remains unaffected.	+	0
Amensalism	One species suffers from the existence of the other, which remains impervious to what is happening.	-	0
Neutralism	No interaction whatsoever.	0	0

Table 1. The six ways that two competitors, A and B, can influence each other's growth rate can be summarized in terms of positive, negative, and neutral coupling parameters, according to Kristina Smitalova and Stefan Sujan.

er's counterattack quantifies the extent to which the defender can prevent the attacker from stealing market share.

Under attack, the defender redoubles its efforts to maintain or improve its position. A high value for the defender's counterattack implies a face-on counterattack within the context "what they do, we do better." Kristina Smitalova and Stefan Sujan studied and classified the various coupling schemes by which two competitors might interact. They distinguished and labeled six ways in which two competitors can influence each other's growth rate, according to the sign of the two coupling parameters (Table 1).

Pure competition occurs between rabbits and sheep. Each one diminishes the growth of the other but not necessarily with the same importance (sheep multiply more slowly but eat more). Market examples are the competition among mobile-telephone companies and among different-size computer models.

An example of *predator-prey* interaction is the case of cinema and television. The more movies made, the more television benefits; but the more television grows in importance, the more cinema suffers. Films made for TV are not shown in movie theaters. Without the legal protection that restricts permission to broadcast new movies on television, television would

probably eat up the cinema audience.

A typical case of *mutualism* is software and hardware. Sales of each trigger more sales for the other, as in the early relationship between external light meters and cameras.

Add-ons and accessories such as vehicle extras illustrate *commensalism*. The more automobiles sold, the more car accessories will be sold. The inverse is not true, however; sales of accessories do not trigger auto sales.

Amensalism can be found with ballpoint pens and fountain pens. The onslaught of ballpoint sales seriously damaged fountain pen sales, yet the ballpoint-pen population grew as if there were no competition.

Neutralism arises in all situations in which there is no market overlap, as happens between fountain pens and ballpoint pens today. Another example is a sports store that sells both swimwear and skiwear. Although sales of one may rise when sales of the other go down because of seasonal variation, sales of one product do not generally affect sales of the other.

Coupling parameters

The S-shaped pattern evidenced in the evolution of a species population can in general be described with two parameters: one reflects the ability of the species to multiply (or a product's attractiveness), and the other reflects the size of the ecolog-

ical niche (or a product's market niche). But what happens if more than one species of competitor is present? Besides rabbits and sheep, cows also eat grass. Worse yet, what happens if there are also foxes on the range? Competition between rabbits and sheep is not the same as between rabbits and foxes. Faced with a finite amount of grass, sheep would probably lament the rapid multiplication of rabbits, whereas foxes would undoubtedly rejoice.

The main feature of the Volterra-Lotka equations is that they can deal with how one competitor influences the growth rate of the other. They do this by introducing a third parameter, the so-called coupling parameter. Sheep and rabbits have a negative effect on each other's population because they reduce each other's food supply. In contrast, foxes damage rabbit populations, while rabbits enhance fox populations. The coupling parameter reflects how much one species affects another—in other words, how many sales you will lose or win because your competitor won one. The magnitude of the parameter measures your ability to attack, counterattack, or retreat.

Advertising strategies

The Volterra-Lotka model has three parameters for each competitor—one reflecting the competitor's ability to multiply, the second the size of its niche, and the third the interference from the other competitor. Thus, there are three lines of marketing action, or six if we also consider the parameters of the other competitor (Table 2). To increase our prospects for growth, we can try to influence one or more of the following:

- the product's attractiveness (increase ours or decrease theirs),
- the size of the market niche (increase ours or decrease theirs), and
- the nature of the interaction (increase our attack or decrease their defense).

Each line of action affects one parameter at a time, but it is not obvious which change will produce the greater effect at a given time. It depends on the particular situation. The concrete actions may include performance improvements, price changes, image transformation, and advertising cam-

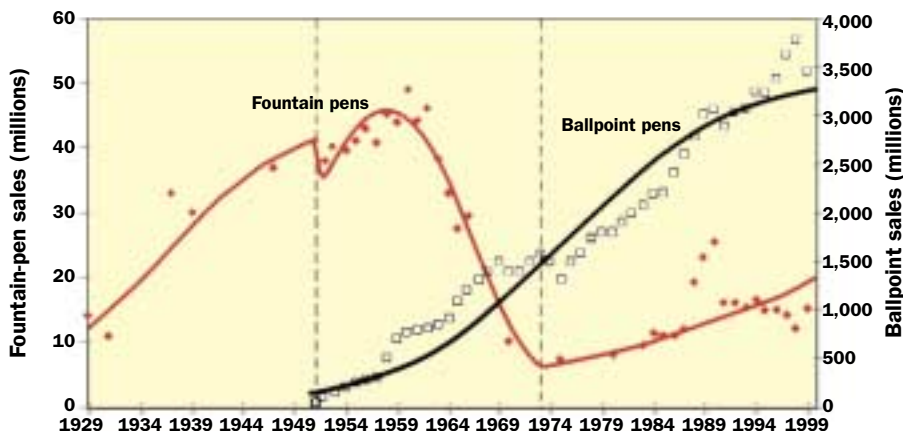


Figure 1. Fountain pen sales were following a classic S-shaped growth curve when ballpoint pens were introduced in 1951. Fountain pens counterattacked by undergoing a character displacement and entering a luxury niche between 1951 and 1973, and then they retreated into noncompetition.

	ATTRACTIVENESS	NICHE SIZE	COMPETITION
WE	Our products are good	You need our products	We are different
THEY	Their products are not good	You do not need their products	What they do, we do better

Table 2. Six basic advertising strategies to increase prospects for growth are defined by increasing or decreasing three parameters for your product or your competitor's product—attractiveness, niche size, and competition.

paings. Performance and price concern “our” products only, but advertising with an appropriate message can in principle influence all aspects

of competition, producing an effect on all six parameters. The question is how much of an effect a certain effort will produce.

Some advertising messages have proven significantly more effective than others. Success is not necessarily due to whim, chance, or other after-the-fact explanations based on psychological or circumstantial arguments. The roles and positions of the competitors determine which advertising message will be most effective. Actual messages are often elaborate, but in principle, all successful advertising campaigns have exploited some combination of these six elements.

Carpet wars

The effectiveness of advertising messages can be illustrated by a classical competitive technological substitution, that of synthetic fiber for natural fiber in the fabrication of carpets. For centuries, carpets were woven on a loom for which wool was well suited. But around the middle of the 20th century, a new tufting technique favored long, continuous filaments. At the same time, synthetic fibers such as nylon became available, and nylon-tufted carpets began replacing woven-wool rugs.

Solving the Volterra-Lotka equations for the carpet-sales data yields negative coupling constants for the two competitors, a typical situation of pure competition of the rabbit-sheep type. But the attacker's advantage was greater than the defender's counterattack, and so was its attractiveness. Therefore, the fate of the defender was eventual extinction. Today, woven-wool carpets represent less than 1% of carpet sales.

Could the makers of woven-wool carpets have secured a market niche the way fountain pens did? If so, what line of action should have they adopted? We can go back to 1979 and play out six scenarios exploring alternative lines of advertising—changing the six parameters one at a time by the

same amount—to test their results. It turns out that effective campaigns would have been those that emphasized attractiveness and differentiation with messages such as “Wool is good” and “Wool is different from nylon” as opposed to a counterattack along the lines: “Wool is better than nylon.” These conclusions could not have been arrived at by intuitive or other methods traditionally used by advertising agencies, and they could be completely different at another time or in another market.

Of crucial importance, of course, is the amount of effort required to achieve the targeted change. There is a way to estimate the size of the advertising investment needed. An advertising campaign along the line “Our product is good” affects the product's attractiveness just as a price cut does. The costs incurred from price dropping can thus be compared to those of an advertising campaign that achieves the same result. It should be noted, however, that if the survival of woolen carpets depended on price dropping alone, the price would have to be cut to zero.

Effective advertising

The Volterra-Lotka model accounts for the three fundamental factors that shape growth: the attractiveness of an offering, the size of its market niche, and its interaction with the competitor. When there is more than one competitor, the situation can be reduced to two by considering the major competitor only or by grouping all others together. Naturally, other factors influence growth, such as sales channels, distribution, market fragmentation, total market growth, market share, frequency of innovations, productivity, and organizational and human-resource issues. Many factors can be expressed as combinations of the three fundamental ones. Alternatively, the model could be elaborated to take more phenomena into account.

As it stands, the Volterra-Lotka model provides the baseline—the trend on top of which other, higher-order effects will be superimposed.

It guides strategists through effective manipulations of a competitor's roles in the marketplace. It should be used before any discussions of investments, advertising tactics, or detailed planning take place. The model works equally well for products, corporations, technologies, and whole industries. Only the time frames differ. Strategists now have a quantitative, science-based way to understand the crux of the competitive dynamics and to anticipate the consequences of possible actions.

A typical first question is, “Should we differentiate or counterattack?” You can answer this question with a simulation on a desktop computer using sales data and the Volterra-Lotka equations. Just think—at this very moment there may be a cost-effective way to terminate the state of being prey to the voracious competitor that has been feeding persistently on your achievements.


For further reading

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B I O G R A P H Y

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