
THE EXPERIENCE CURVE'S ROLE IN STRATEGIC PLANNING

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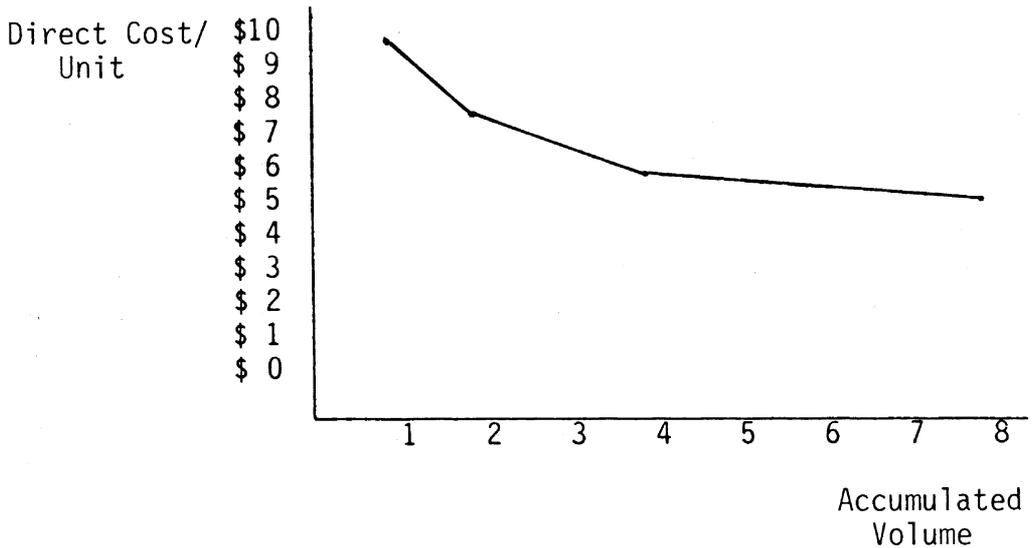
Managers attempting to assess their position in the industry in which they compete, and understand where their firm and industry are headed might benefit from a concept which has been around for a while: the experience curve. The experience curve, or learning curve, was first popularized during World War II, as government contractors searched for ways to predict costs and time requirements for construction of ships and aircraft (15). Later, the Boston College Group (BCG) used it as one of the foundations upon which they built their "BCG Growth-Share Matrix." This paper examines the current status of the experience curve, and its value in the strategic management process. First, the concept of the experience curve is reviewed, along with reasons why costs behave as it suggests. Then the relationship between the experience curve and market share is developed, and implications are outlined. Next, some of the shortcomings of this relationship are discussed. Finally, some guidelines for deciding when and how the experience curve should be used are provided, along with an illustration.

The Experience Curve Revisited

While the applications of the experience curve, and names given it have changed over the years, the basic concept remains the same. Experience curves represent attempts to model the often observed fact that costs in many industries go down as accumulated output increases. While the rate of decline varies from industry to industry, the decline of costs is often highly predictable when constant dollars are used as the unit of measure. It is postulated that every time cumulative output doubles, per unit costs go down by a certain percentage (which is often determined using historical data for the industry). For instance, if an industry is found to have an eighty percent experience curve, and the first unit costs \$10 to produce, then the predicted cost for unit two would be \$8 ($\$10 \times .80$). Unit four's predicted cost would be \$6.40 (or $\$8.00 \times .80$). Unit eight's predicted cost would obviously be \$5.12, eighty percent of unit four's cost, and so on. Exhibit 1

illustrates the relationship between accumulated volume (horizontal axis) and direct cost per unit (vertical axis) (7, p. 109).

Exhibit 1: Accumulated Volume and Cost Per Unit



This cost behavior has been found to exist in a variety of industries, although the cost coefficient varies by industry. The experience curve for margarine production has consistently been found to be about 79%. Italian refrigerator manufacturers report an 82% experience curve. Even service industries such as life insurance have reported significant experience curve effects over the last thirty-five to forty years (1).

Reasons for declining costs

There are three basic reasons why the experience curve effect exists. These include exogenous progress, economies of scale, and basic improvement learned from cumulative output (4).

Exogenous progress. This first source includes such factors as improving technologies, improved production layouts, more efficient maintenance schema and better distribution of the final product. In addition, the introduction of new technology to improve performance becomes feasible as higher volume levels justify such commitments. For example, introducing computer controlled production and automation allows management to focus less on routine administrative and managerial duties and more on product advancement and further cost reduction. However, these improvements require that the company achieve enough volume to justify such costly investments (7, p. 112). As a firm moves down the experience curve, exogenous progress follows something of a compounding effect, allowing the firm to become even more efficient and thus lowering its costs even further.

Economies of scale. Economies of scale, or the decrease in average unit costs as productive capacity is expanded, explains a large portion of decreases in costs. Economies can usually be achieved in nearly every step of the production process. High volume production increases the availability of improved technology. Often resources can only be profitably used when incorporated into fairly large operations. Backward and forward integration of manufacturing processes and business activities, which often permits significant savings, can be justified only by large firms operating in stable environments. Also, increases in scale often result in a decrease in the firm's cost of capital relative to competitors. As the cost of capital decreases, the company gains an obvious strategic advantage over competitors (11).

Basic improvement. The last source of cost reduction is basic labor and management improvement gained from cumulative experience. The repetitive performance of a task allows an individual and an organization to learn more about that task and develop skills to complete the task in more efficient ways. Such learning leads to specialization and standardization, product improvements through design modification, better utilization and substitution of materials, rationalization of the product-mix and improvements in the manufacturing process.

Strategic Implications of the Relationship Between Experience and Market Share

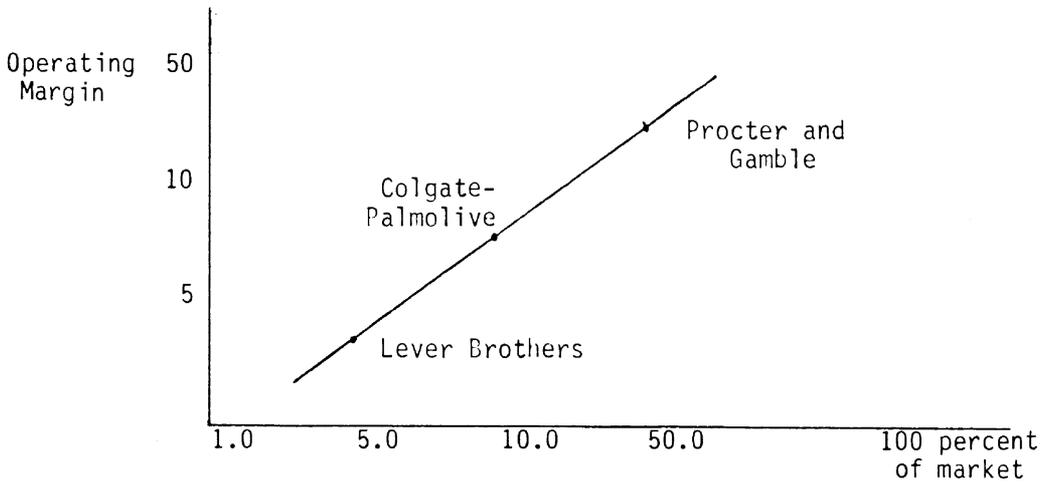
The experience curve is normally used as a guide in forecasting cost behavior and as such has important strategic internal and external implications. Internally, it can provide forecasted cost targets useful in controlling performance. Externally, the experience curve permits competitive comparisons (2). This process of comparison has led to a linkage between the experience curve and relative market share.

Experience Curve-Market Share Relationship

It has been suggested that if firms competing in a given industry face a fairly uniform experience curve, the company with the greatest cumulative output will have the lowest costs in the industry and therefore the highest profitability (2). In most instances, the firm with the greatest market share will be the one with the greatest cumulative output. As a result, the firm with the largest market share is typically furthest out on the experience curve (having the most accumulated experience) and therefore has the lowest cost. This gives the company not only a cost advantage, but positions the firm so that it can lead the industry in technological innovation and exogenous progress, further enhancing its competitive position. This logic seems to have been in part validated by the results of the Profit Impact of Market Strategy Study (PIMS) (9) which identified and measured the major determinants of Return on Investment (ROI). The study found that in various industries each 10 percentage point gain in market share was generally

accompanied by a 5 percentage improvement in pre-tax return on investment (ROI). The linkage between profitability and market share has also been supported by additional studies of various unrelated industries. In the household and personal care products industry for instance, when firms are ranked according to market share (horizontal axis, Exhibit 2) and operating margin (vertical axis, Exhibit 2) the results show that as market share increases so do profits (2).

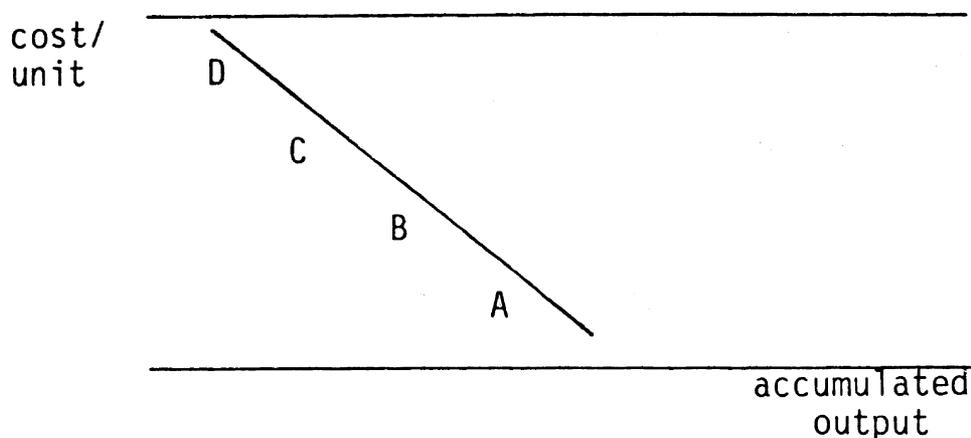
Exhibit 2: Market Share and Operating Margin



Strategic Implications

The relationship between market share and profitability has some important implications for pricing strategies and long-term company survival. Exhibit 3 represents the relationship between accumulated output and direct cost per unit (7, p. 114-115). As can be seen, Firm A has a significant cost advantage over its competitors. Firm D is a marginal firm whose survival will largely be determined by the strategic moves of Firm A, which is capable of waging sustained price wars. In such a situation each firm will need to make some fundamental strategic decisions. Firm A, if aware of its cost advantage, will need to identify and develop options relative to firms B, C and D. Firm D must decide whether to stay in the industry as a marginal competitor, liquidate, or incur the costs necessary to achieve a greater market share. If firm D chooses to remain as a marginal player, it will likely survive only as long as Firm A wishes to avoid direct price competition.

Exhibit 3: Company Survival



Company Survival. Bruce Henderson (1979), building upon the logic just presented, proposes that a stable, competitive industry never has more than three significant competitors, the largest of which has no more than four times the market share of the smallest. This proposition has some important implications.

First, if there are many firms competing, a shake-out will inevitably occur in the absence of outside constraints on the competitors. The market leaders (firms A and B in Exhibit 3) will likely apply pressure on the low market-share firms (firms C and D) until the two largest competitors are the only non-losers.

Second, in order to survive, a firm's volume must grow at a rate faster than the market as a whole or their market share will decrease. When market share decreases, at the very least, large amounts of cash must be used to gain it back which will penalize profits.

Thirdly, the quicker investments in marginal firms, such as firm D in Exhibit 3 are cashed out the better, as such firms are likely to become cash-traps requiring perpetual reinvestments of positive cash flows to compensate for losing years. Investments in firms other than the top one or two are quite risky.

Pricing implications. In terms of new product pricing, a decision must be made whether to charge a price which reflects the eventual experience curve related savings, or price reflecting initial unit costs. A lower price might be used to gain market share, though as shown later, this does not always work. An alternative is to set a high initial price and enjoy high profits as costs decline, before competitors eventually force prices down. Either way, when new competitors start to enter, prices normally decline faster than costs are declining for the average firm. This is true because of the relatively high cost position on the experience curve of the average firm.

Shortcomings of the Experience Curve — Market Share Phenomenon

The experience curve-market share phenomenon and its implications seem straight-forward; leaving the impression that only market share leaders will be profitable and the experience curve will ultimately determine profitability. However, there are limitations to the usefulness of the relationship for strategic planning, and market share is not the only route to profitability.

Some Limitations

The experience curve is not a concept that can be applied to all firms in all industries, and those firms that can use the concept need to recognize three major limitations.

Discontinuation. First, the benefits of learning by doing, at least at the manufacturing level, discontinue after a certain level of output is attained. At some point, the accumulated volume necessary to double output becomes so great and the reduction in costs resulting from a doubling of output so small as to render the experience curve irrelevant (6).

Change of strategy. Secondly, when a firm which has focused exclusively on the market share-volume-cost relationship reaches the limits of that relationship, it may find development of new strategies difficult (14). A company sometimes loses its innovativeness and flexibility because all its energies have been directed toward pursuing the experience curve in one field or product. New strategies can also be very costly if they involve a major change in the technology the company is familiar with and has invested heavily in. The classic example of this is Henry Ford and his Model T. His heavy investments of time and money in the production of the Model T were for a time very profitable, until consumers demanded something else. At that point, Ford Motor lost its innovative edge. Since so much was invested in the specific production of the Model T, product change was very costly. The resulting setback caused Ford to lose market share and leadership of the industry (1). Sometimes the transition can be so difficult and costly that it even forces companies out of business. Such was the case with the shift from manual to electric typewriters, and mechanical adding machines to electronic calculators (1).

Spillover effect. Finally there is a "spill-over effect" associated with the experience curve phenomenon. A company may reduce its costs not only through its own experience to date, but also through industry-wide experience. The spill-over effect accelerates the process of cost reduction for the entire industry and often reduces the incentive for firms to aggressively pursue cost-reducing measures. This is especially true in industries where the learning process is a matter of public record, as has been the case in the nuclear power plant construction industry (12).

Alternative Approaches

The experience curve, as shown earlier, has its limitations and should not be used by all companies. It may be possible to compete effectively without single-mindedly pursuing market share. Innovation appears to be the key to alternative strategies. A study done of the nation's most successful mid-size companies found that 74 percent have an innovative product, service or marketing approach (3). Innovation is a common thread running through Porter's (10) strategic alternatives to pursuing high market share. Product differentiation and targeting are two of his more interesting alternatives.

Differentiation. Studies have shown that market share is less important for infrequently purchased or specialty (differentiated) products. The reason appears to be that such products involve greater consumer risk, and consumers are willing to pay extra for quality assurance (12). For example, Perdue Company differentiated their product by producing a better quality name-brand chicken and was able to command a 10 cent per pound premium (3).

Targeting. Porter's second alternative strategy is to target a particular market segment. This allows the firm to develop a particular strength, charge a higher price and stay profitable. River Laboratories, a leading producer of research animals, detected an unmet market for high quality, genetically defined labor rats. In the same way, Lenox developed a lucrative bridal market for its china (3).

Using the Experience Curve

Although the experience curve has many limitations and market share is not the only way to compete in the market place, there are certain times when the concept is viable and awareness of its implications are crucial to survival.

When to Use the Experience Curve

The industry structure, relative positions of key competitors and the level of government involvement are critical variables which must be analyzed in deciding whether the experience curve is relevant (5).

Industry. Included in an analysis of the industry are such factors as: industry life stage, technology risk and prices.

The experience curve strategies usually gain greatest leverage in the early stages of a product's life cycle. The reason for this is that cumulative output doubles much more frequently in the early stages of a product's life cycle. For instance, optical fibers and vacuum cleaners follow approximately the same experience curve, but it presently takes two years to double optical fiber output and twenty for vacuum cleaners.

Second, when analyzing the industry, technology is important. If a company faces technological uncertainty and decides to produce before uncertainty is resolved (get an experience curve head start), the benefits can be

great, as was the case for Corning glass in the optical fibers market. However the risks and possible losses can also be great, as RCA learned with video disk players.

Finally, experience curve strategies are particularly appropriate in industries where demand is especially price sensitive. A price cut which results in significant volume growth will allow the company to move further down the experience curve and reduce prices further. Texas Instruments (TI) did this in the calculator market. They made the first major cost-cutting advances and were able to cut prices on previously high priced calculators. This allowed TI to capture a large share of the market, allowing further progress down the experience curve.

Competitor analysis. If a firm faces weak competition (usually undercapitalized with high cost structures) the experience curve could be beneficial. If the competition is strong though, an aggressive pricing strategy might backfire on the challenging company. Hewlett-Packard attempted an aggressive pricing strategy in the calculator market but would not compete with TI. Hewlett-Packard then decided to focus on the premium end of the market instead of battling head-to-head with TI.

Government intervention. The government affects the viability of the experience curve through competitive policies and the cost of capital. Government concerns about predatory pricing and attempts to monopolize can sometimes thwart efforts to use experience curve pricing strategies. Government subsidies, tax rates, and depreciation policies can alter the competitive positions of firms within an industry. Additionally, high domestic interest rates, in part a result of government deficits and tax policies, put American firms at a cost disadvantage to foreign firms.

Applying the Experience Curve

Before presenting an application of the experience curve a couple of key points need to be made about its use, these are the importance of shared resources within product groups and the fact that a firm may face multiple experience curves at various stages in the value added chain (or the various stages in the development, production, and delivery of products or services).

Shared Resources. In many industries the experience base may be derived from more than just one product. Often product groups share the same components, production facilities or delivery systems. When such interrelationships exist the combined experience curve position for the product group should be the focus of analysis (4). The British motorcycle industry found out the hard way about the importance of product group management (8). Various classes of motorcycles share many parts and manufacturing processes. The British manufacturers did not realize that in order to maintain a competitive cost position for one product they had to retain the market positions of others, because together they represented accumulated output. Initially, they benefited from dropping smaller motorcycle product

lines through lower R&D spending. But in the long run they suffered from a loss of cost leadership.

The Value-Added Chain. In addition to shared costs, the value-added concept is important in the application of the experience curve. The firm's position on the experience curve at each stage of the value-added chain should be determined. Such analysis should not only include manufacturing, but also research and development, procurement of raw materials, fabrication, assembly, marketing, sales and distribution (Hax and Majluf, 1985). There should be a stage-by-stage comparison of the firm with its leading competitors. The firm's relative strengths should be isolated and exploited. When Phillip-Morris entered the beer industry with the acquisition of Miller Brewing it gained market share by exploiting its experience in market segmentation and product innovation (i.e., the introduction and promotion of Miller Life) (13).

An Illustration

In order to place a firm on an industry production experience curve, along with its major competitors, four steps are required. First, assuming the firm in question uses technology comparable to its competitors, production cost data for the firm must be gathered which will be used to estimate the experience curve behavior for the industry, such as is presented in exhibit 4. Note that in this illustration, only direct labor costs are being examined.

Exhibit 4: Cost Data for Firm Z

Cost Data			
Unit Number	Unit Direct Labor Hours/Unit	Cost Per Hour	Direct Labor Costs
1	100	\$ 12	\$1,200.00
2	85	12	1,020.00
4	72.25	12	867.00
8	61.41	12	736.80
16	52.20	12	626.40
32	44.37	12	532.45
64	37.71	12	452.58
128	32.06	12	384.70
256	27.25	12	327.00
512	23.16	12	278.00

With the above data, the second step can be completed, estimating the rate of decline in costs which occurs with each doubling of production. This step involves calculating some simple percentage cost changes:

$$\frac{\$1,010}{\$1,200} = 85\%; \quad \frac{\$ 867}{\$1,020} = 85\%; \quad \frac{\$736.80}{\$ 864} = 85\%$$

While each of these sample calculations suggest an 85 percent experience curve (or a 15 percent decline in costs with each doubling of output), the percentage may sometimes vary, and an average may have to be taken.

Having estimated the production cost behavior for the industry, the third step requires the analyst to formulate a model which will permit estimation of unit production costs at various levels of accumulated output. To do this the following model is used.

$$C_x = (K) X^{\log n / \log 2}$$

- Where: C_x = Direct unit costs required to produce the unit
 X = unit number
 K = Direct unit costs required to produce the first unit
 n = learning curve coefficient or factor

In the case illustrated here, if the firm is about to produce its 513th unit, the first unit's cost was \$1,200, and the experience curve coefficient has been estimated to be 85 percent, the predicted cost would be:

$$C_{513} = (\$1,200) 513^{\log .85 / \log 2}$$

$$C_{513} = (\$1,200) 513^{-.2344}$$

$$C_{513} = 1200 \frac{1}{513^{.2344}}$$

$$C_{513} = \$277.93$$

Assume the firm whose cost experience was just analyzed (referred to below as firm Z) confronts two major competitors who use similar technology. Further assume one of the competing firms, firm A is thought to have 20 percent more accumulated output than firm Z. The other firm, firm B, is assumed to have 10 percent less accumulated output than firm Z. To complete the fourth step the current cost position of each competitor is estimated as follows:

Firm Z's current accumulated output = 512 units

Firm A's accumulated output $512 \times 1.20 = 614.4$ units

Firm A's unit cost:

$$C_A = (\$1,200) 614.4^{-.2344}$$

$$C_A = \$266.42$$

Firm B's accumulated output = $512 \times .90 = 460.8$

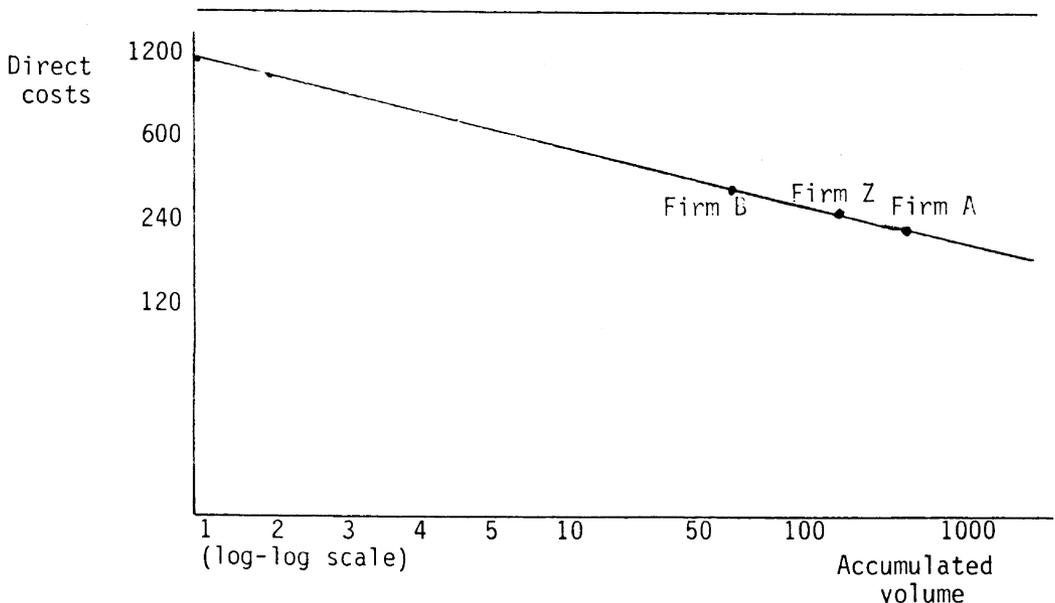
Firm B's unit cost:

$$C_B = (1,200) 460.8^{-.2344}$$

$$C_B = \$285.00$$

Placing the firms on an experience curve on log-log-scales, the relative positions are as shown in exhibit 5:

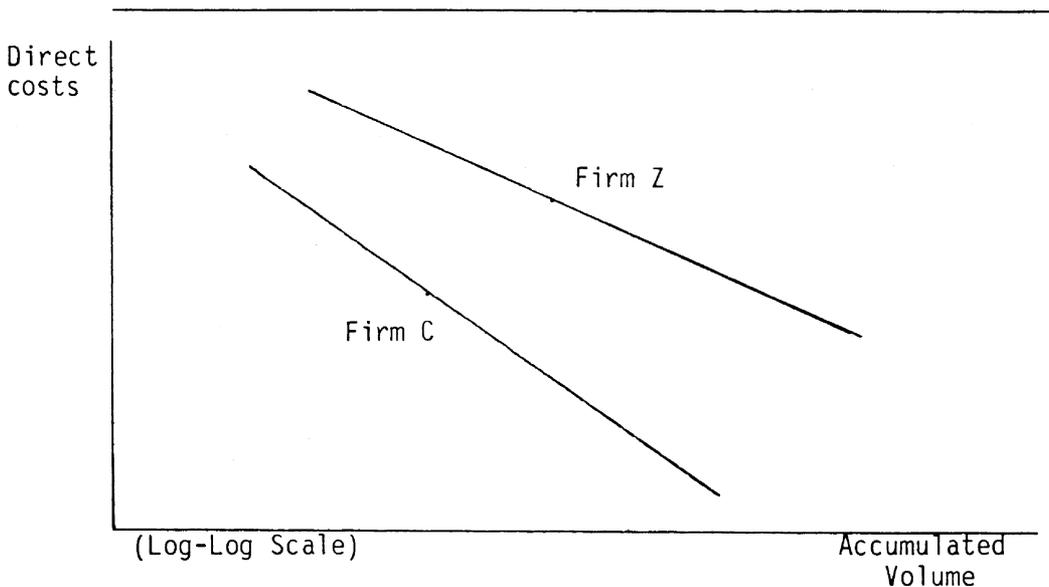
Exhibit 5: Industry Experience Curve



As mentioned earlier, it is assumed that firm Z's cost behavior is representative of the industry. It is also assumed that the management of firm Z has a fairly accurate estimate of the other two firm's accumulated volume.

However, it is possible that a competitor may have more or less sophisticated technology which might place it on a different experience curve. As illustrated in Exhibit 6, firm C, a new entrant to the industry, enters with superior technology, causing its costs to follow a lower experience curve track.

Exhibit 6: Experience Curve Shift Due To New Technology



There is also the possibility that a new entrant or former laggard in the industry, such as firm B in the earlier illustration, may be able to close the gap due to the spillover effect, which was discussed earlier. Finally, it may be quite difficult to get an accurate assessment of the accumulated output of the competition. To correct each of these problems management must make a "best guess" of the situation given the information available. Obviously, the application of the experience curve in strategic analysis is as much art as science.

Summary

Quite simply, experience curve logic suggests that as volume is accumulated costs of production decrease in a predictable, exponential manner. The sources of this cost reduction are exogenous progress, economies of scale, and basic improvements learned from cumulative output. The most important implication of the experience curve is that the firm with the greatest

market share will have the lowest costs and enjoy a number of strategic advantages. In fact the market share-experience curve-profitability relationship implies that only those firms with large market shares can be expected to survive. In many instances the industry leader will determine the destiny of the other firms in the industry. The experience curve concept also has major implications for pricing strategies. While the experience curve model is not without its shortcomings, both antidotal and statistical evidence exists which supports the validity of the concept.

There are a number of shortcomings and caveats associated with the experience curve. The strategic importance of the experience curve effect is probably minimal for mature or declining industries. No competitive advantage may be accrued from accumulated production if there is significant spillover or exchange of experience-based learning among competitors. In fact, if a firm becomes enamored with the experience curve it may lose its ability to recognize and respond to coming changes in the industry. An industry in which non-price competition is prevalent may not be susceptible to experience curve analysis. Finally, government attitudes toward predatory pricing may diminish the usefulness of experience curve analysis.

Concluding, the single-minded pursuit of market share might not always be the answer, and may in fact be dangerous. A firm may be able to compete profitly through continuous innovation and careful targeting of their markets. For further reading on the experience curve concept and its application see:

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