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Experience curves as a planning tool.¹ Part 2. Pyrrhic victories and practical problems

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Strategies based on the experience curve effect require that predatory price cutting leads to enhanced market share and an increasingly competitive cost structure *vis-à-vis* the competition. The company that rides the experience curve to the bank has cost advantages, pricing discretion and reaps handsome profits. Corporate graveyards are littered with the corpses of companies who have adopted too naive an approach to, and too simplistic an acceptance of, the concepts first pioneered by the Boston Consulting Group. This, the second of two articles on the experience curve, highlights pyrrhic victories in the quest for market share and asks six key questions that need to be answered before adopting an experience-driven strategy. Likewise 12 problem areas in the application of this approach are identified.

S. Afr. J. Bus. Mgmt. 1982, 13: 159 – 168

'n Voorvereiste vir strategieë gebaseer op die ervaringskurwe-effek is dat roofsgtige prys snyery wel lei tot vergroete marktaandeel en 'n toenemend meer mededingende kostestruktuur teenoor dié van die mededingers. Die maatskappy wat volle voordeel uit die ervaringskurwe trek, het kostevoordele, diskresie oor prysvasstelling en maak indrukwekkende winste. Die 'begraafplase' van die sakewêreld het in onlangse jare heelwat grafte bygekry van maatskappye wat ondergegaan het weens 'n te naïewe benadering teenoor, en 'n te simplistiese aanvaarding van die konsepte wat deur die Boston Consulting Group voorgestel is. Hierdie artikel, die tweede van twee artikels oor die ervaringskurwe, vestig die aandag op duurgekoopte skynoorwinnings in die stryd om marktaandeel en stel ses sleutelvrae wat beantwoord moet word voordat 'n maatskappy hul strategie op die ervaringskurwe baseer. Twaalf probleemareas in die toepassing van hierdie benadering word ook geïdentifiseer.

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Second in a series of two articles

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Strategies based on the experience curve effect are immensely appealing to managers. The key to setting strategy is strategic market segmentation followed by predatory price cutting to create barriers to entry, to gain market share and thereby to decrease costs. Lower costs generate enhanced margins and keep competitors at bay. The company that rides the experience curve to the bank dominates the chosen market segment, has cost advantages and pricing discretion and reaps handsome profits, particularly on industry maturity. There is evidence that a simplistic acceptance of the experience curve as a strategic tool without consideration of a number of key questions may be suicidal. This does not negate the use of the experience curve, but rather cautions against the naive acceptance of experience curve strategies. Consider some of the evidence.

Pyrrhic victories in the quest for market share

In 1972 Texas Instruments cut the price of calculators by 42%. They converted the slide rule business into the silicon chip business and gained over 65% of the market by 1978. In 1974 Black and Decker cut their prices by 36% in all domestic markets for the mainstream chain saw business. This gave them a market share jump of 20 points and a commanding lead in the US market.² In 1975 Black and Decker's major competitors cut their prices 28% and began a long hard climb towards losing their shirts against Black and Decker. In 1976 a well-known \$3 billion turnover paper products company cut prices to gain market share. Four years later they were still engaged in a ruinous price war which was terminated by the 1979 – 80 recession and their demise.²

A little self restraint could be an admirable thing. There are times when management should put the ceiling of realism on its ambitions when a thrust for a larger piece of the action could spell disaster.

Although ROI is closely related to market share,³ companies sometimes launch campaigns for building market share without great foresight. Six key questions appear to be critical:

- Does the experience curve apply?
- Does the company have the financial resources?⁴
- Will the company's strategic position remain viable if thwarted?⁴
- Will regulatory authorities permit the company to achieve its objective?⁴

- Do trade and tariff barriers confuse the picture?
- Are the strategic cost implications changing?

The experiences of a number of companies, in separate industries, that fought disastrously to increase their market shares illustrates the point.⁴

Does the experience curve apply?

The experience effect is not a law of nature. It is more akin to a statistical law for any given company in an industry. It exists, if it exists, or can be made to occur. This sounds a note of warning. Slavish belief in the existence of an experience effect can be ill-founded.⁵ Consider the effect of a price cut which is not followed by a gain in market share or, if a gain occurs, no cost benefits are realized by the added volumes. The effect, if demand elasticity is less than one, or if working capital requirements are great, is a drop in margin accompanied by a substantial drop in profitability for no real long-term gain.

The effect can be to drain profits for no long-term strategic benefit. Before embarking on predatory price cutting in quests for market share, it is wise to analyse industry and corporate cost patterns to see if an experience curve effect does in fact apply.

Smaller economies than that of the United States, particularly those of developing nations, often resort to forms of tariff protection to assist the development of fledgling industries. No definitive work appears to have been done on companies within such economies, but it seems prudent not to blithely assume the existence of experience effects unless they can be proved to exist.

This raises a secondary problem for those in charge of public policy for a developing nation. If an experience effect does exist outside of the boundaries afforded by protection, the protection does not offer sufficient support to local companies in the event of the tariff barrier being dropped. The local company cannot compete internationally because:

- costs will not have been aggressively managed downwards due to the protective umbrella, or
- the small size of local ethnic markets may have precluded the ability of the local company to gain by dropping marginal cost due to low cumulative volumes.

Does the company have the financial resources?

During September 1970 General Electric's studies indicated that it required a 15% share of the main frame computer market if the company were to become competitive in the industry.^{2,6} At about the same time, RCA concluded that it needed a 10% share of the main frame computer market and committed itself, publicly, to meeting that goal by the mid 1970s.^{2,7}

Modest as they seemed when related to industry standings (IBM 69% of the market, GE 4%, RCA 3,2%) these targets represented more than a 200% growth in share in a high growth market.² Both companies decided, in the light of potential anti-trust regulations, that expansion would be by means of internal growth rather than that of acquisition.⁸ Fruhan⁴ points out that in this industry operations require large amounts of working capital as computer marketing is by way of leased equipment. In 1969 IBM required \$5,9

billion to support shipments of \$4,95 billion suggesting about \$1,20 of capital for each \$1,00 of shipments. For RCA, this meant that to grow market share from 3,2% to 10% over five years required \$1 334 million in capital with yearly amounts of new capital rising from \$95 million to \$475 million. Similarly GE would have required \$2 076 million rising from \$138 million to \$785 million in the final stages.⁴

With RCA and GE's respective corporate profits being \$151 million and \$357 million in 1969, with dividend payouts of \$68 million and \$235 million, and debt equity ratios of 0,45 and 0,27, the total capital generation potential of each company was only \$120 million and \$135 million after leveraging retained equity up with debt. In addition, in 1969 the computer division revenues accounted for less than 10% of the total corporate revenues in both companies.

The implications were that either the debt equity ratios, already high by IBM standards, would have to be raised sharply, or equity should be obtained by both companies through securities markets at lower price earnings ratios than IBM before either company could come close to achieving their growth objectives. The market share aspirations required capital commitments beyond the corporate capital generating ability of either company.

Both GE and RCA acknowledged in 1970 and 1971 that neither could marshal the resources to achieve a marginal market share in the computer industry at an acceptable cost. They quit the arena.

Before embarking on a market share increasing strategy it is prudent to calculate explicitly the cash flow and capital requirements required to gain and hold market share. A set of pro forma projections for the envisaged time horizon will indicate whether the strategic target is feasible or even desirable. Abell and Hammond^{9,p.116} point out that to grow share from 6% in the face of an industry leader with 24% in an industry growing at 8% per annum requires a compound growth rate of 26% per annum for nine years to catch up to the leader. It implies growth at three times industry levels and a sales and capacity expansion of 640%.

The important questions are:

- What are the requirements for cash flow and capital funding for both fixed and working capital?
- What are the explicit mechanics for gaining market share? The experience model as a frame model¹⁰ advocates gains in market share, but offers little advice on how to operationalize growth effort.

The following questions must be answered:

- At whose expense will share be gained?
- What are the likely strategic competitive reactions?
- Will there be a clear cut advantage associated with market dominance several years down the line?

Will the company's strategic position remain viable if thwarted?

The issue here is if the company is thwarted en route in a quest for market share, the strategic position of the company may become untenable. In Food Retailing the US Federal Trade Commission found a high correlation between the profit contribution of chain stores in a given geographic area and the market share in the same area. This means that the profitability of a chain of grocery retail stores

depends not on the national market share, but rather on the weighted average of its relative market shares in various city market areas in which it participates, as can be seen in Figure 1.

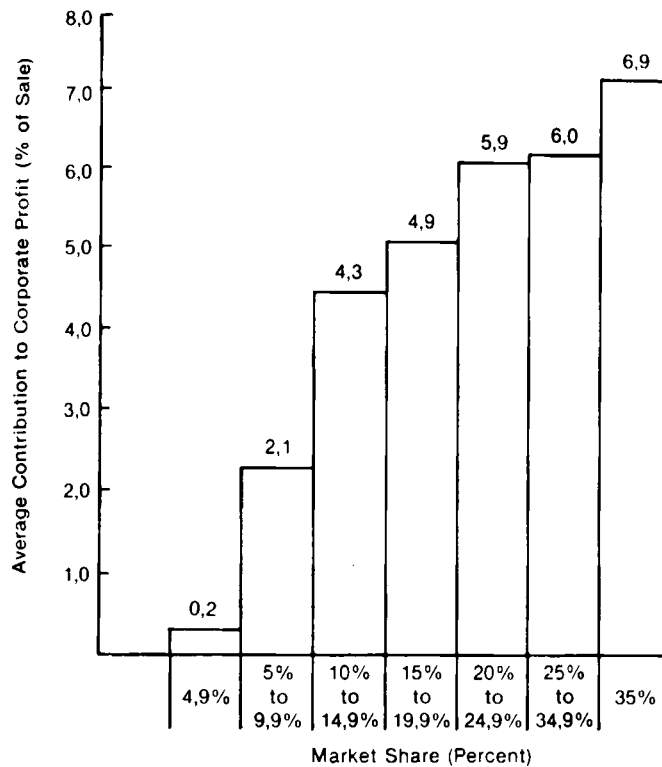


Figure 1 Market share versus store contribution to corporate profit by groups of cities⁴

During 1948 – 58 many US chains moved toward consolidation. The most active acquirer, National Tea, erred by going for national geographic market share rather than for share in specific metropolitan markets. As the last of the independents were being merged into the competitive chains, the Federal Trade Commission was taking decisive action to stop consolidation by blocking future industry mergers.¹¹ As a consequence National Tea could not try for dominance of city geographic segments and has a considerably lower ROI than Winn-Dixie who are dominant in the Southeast USA. This erroneous toehold strategy illustrates both the need to pay careful attention to strategic market segmentation, and the need to ensure that an experience curve really does apply in the particular situation. It also illustrates the danger in getting stopped half-way in a quest for market share.

Will regulatory authorities permit the company to achieve its objective?

Regulatory bodies may abort the quest for market share for various reasons, especially for anti-monopoly reasons or to prevent strategic dependence on a single major supplier.

Fruhan points out that in making travel plans customers initially contact the air carrier which they believe has the most daily flights to their destination.⁴ Thus, analogous to the allocation of shelf space in a supermarket, high flight frequencies imply greater market share and higher load fac-

tors per trip and hence lower costs per passenger mile and higher margins. The minority carriers should operate at a significant loss. The air carrier with sufficient financial resources to purchase extra aircraft and fly higher frequencies on a particular inter city route should achieve the benefits of experience effects.

In practice this does not always occur in the United States as the Civil Aeronautics Board (CAB) tends to influence market shares and relative profitability of US domestic trunk air carriers. This is achieved both by withholding or granting licences for any inter city market, and by regulating the number of carriers competing on the route. Hence the CAB exercised tremendous power over the relative profitability of the various airlines and in fact the big four, American, Eastern, Trans World and United are less profitable than the seven smaller US carriers. This, however, does not seem to have blunted the majors' appetite for waging expensive capacity wars in a no-win environment.

It seems wise, prior to going all out for market share, to check whether any legal, social, ethical or political obstacles may lie ahead. Such obstacles may prevent the gaining of market share, or may force companies to incur such costs that any experience benefits are negated.

Do trade and tariff barriers confuse the picture?

In economies less competitive than the United States, intervention against quests for substantial market share frequently occurs. Mergers or takeovers can be blocked for anti-trust reasons or to prevent strategic national dependence on a major supplier, particularly if the supplier is a subsidiary of a multi-national.

A sage piece of advice, often given by staff of the Strategic Planning Institute to clients with market shares approximating 100%, is to cultivate a small docile and apparently independent competitor to support prices. Frequently the large dominant competitor has to give away experience curve gains so as not to support a price umbrella which invites competitive entry or action by the host government.

Are the strategic cost implications changed?

Although they have achieved fame mainly owing to their work on the experience curve effect and their growth share matrix, discussed later, the Boston Consulting Group has also done excellent work in the area of strategic costing associated with the experience effect. This has not achieved such widespread publicity. The experience effect for any given company operates only on the company's contribution to the product and is applicable to the value-added component of total cost. (Cost of goods sold minus cost of raw materials, including energy, bought in.) If, for reasons of simplicity, experience effects are being analysed using selling prices, the experience curve operates on the value added component in terms of selling price minus cost of raw materials. It includes that value added contribution due to profit, the value added by the market place. If, as advocated by the Boston Consulting Group, marginal pricing is used and no price umbrella is sustained, the price and cost curves follow similar patterns.

This means that for a given product a number of experience effects, often shared with other product lines,

sometimes unrelated, can operate. This can have a profound effect on the optimum strategy of the most innovative and successful number of a complex product chain.

This has occurred in the watch industry. The classic Swiss watch was the handcrafted product of a village industry. After evolving through a number of prototypes, the clockwork timing and mechanical spring mechanism were in recent years replaced by solid state components and electrical storage devices. Initially quite costly, and forming a large part of the cost of a watch, the semiconductor components have sped down an experience curve outstripping the other cost components to such an extent that semiconductor component costs are no longer of major importance in the production and marketing of watches. This has led to Texas Instruments, a hot favourite in the stakes for watch industry dominance because of their competence in semiconductors, exiting the industry in the realization that success will depend more on design and distribution than on experience effects applied to one of the minor, once major, cost components.

Electronic calculators, which in the space of a few years have been transformed from expensive luxuries to every-day items, provide a good example of the strategic impact of changing cost patterns. The events in the calculator market illustrate the need for managers to really understand the dynamics of experience curve cost reduction and its effect on strategy and their ability to remain competitive. Table 1 presents a simplified history of the development of solid state electronic calculators up to 1975.¹²

Table 1 History of solid state electronic calculators up to 1975

	Major cost elements	Dominant competitors
Phase 1	Semiconductors (discrete devices)	Americans, e.g. Wang
Phase 2	Assembly	Japanese Sharp, Casio
Phase 3	Integrated circuits	Americans, e.g. Texas Instruments
Phase 4	Assembly and distribution	Unresolved Tesco, Woolworths, Boots

In the early days the major cost components were the discrete semiconductor devices such as transistors and diodes. Leading competitors were based in the USA close to the source of solid state components and technology. The calculators were expensive and the market was limited to a few applications for which they were cost effective.

Rapid market growth occurred. The market for solid state diodes expanded at more than 50% per annum during the early and mid 1960s. Rapid experience-based cost and price declines occurred. The price of an average germanium diode fell by a factor of 7 in real terms between 1960 and 1965. The main cost component soon became that of the labour required to assemble the calculator, and the competitive advantage passed to the Japanese who assumed virtual control of the market by the end of the decade.

Costs continued to decline and the market became so large and attractive that the American semiconductor manufacturers themselves entered the market. Their strategy was to use large-scale integrated circuits (LSI). The LSI chips made many assembly operations redundant and Texas Instruments set out to dominate the industry.

Calculators were now a consumer item. The consumer calculator market had expanded from only 2 million units in 1972 to 20 million units in 1974. Prices dropped dramatically both as a result of experience-based gains and a shakeout due to competition for market share. The shakeout is not yet complete.

The cost structure is again changing with the integrated circuits and displays becoming a smaller part of the total cost. Labour costs are again becoming important. This implies a return of competitive edge to low labour cost countries, or to highly automated cost-effective mass production in advanced countries. The distribution costs have become a significant cost component now that calculators are so cheap. The leading competitors of the future may very well be those with the best distribution channels and mass merchandising outlets.

With prices declining more rapidly than costs many producers must be squeezed, and Texas Instruments is prepared to tolerate heavy losses to retain the market.

A frequent re-analysis is essential in an experience curve driven industry to see if the cost components upon which early strategies were based are still of strategic significance. There is a particular danger that successful candidates may be lulled into a state of false security.

Practical problems with applying the experience effect

Although the use of experience curves is intuitively appealing as a strategic planning tool, a number of problems in application can arise. Some may be overcome easily, others are not. Twelve basic problem areas appear to exist:

- The market definition problem
- Analysing cost behaviour patterns
- The effect of economic cycles
- Foreign exchange variations
- The time span for analysis
- The choice of unit of analysis
- Separating out cost components
- The effect of shared experience
- Analysing cost components for competitors
- The issue of effectiveness versus efficiency
- Problems in organization
- Problems in motivation.

Many of the issues are interlinked to one another, or are manifestations of underlying problems in the strategic process.

The market definition problem

The problem of accurately defining the market is such an ubiquitous one that a full book can be devoted to the issues involved. It manifests itself in the experience context even though the use of experience curve strategies does not require a definitive measure of market share for a given product.

The experience effect relies on cumulative production volume of a product to drive costs down the experience curve. This depends on accurately defining what is a product and its associated market. For example, piping comes in different materials of different sizes and properties for different uses. In trying to analyse cost behaviour patterns, decisions have to be made as to what constitutes a given product in order to allocate overheads (a problem discussed later), and as to what constitutes a given market for analysis of competitors and oneself in context. Technology transfer between related markets gives rise to shared effects with regard to experience.

Although the market definition problem is not made explicit in setting strategy based on the experience effect, it must be resolved sooner or later to enable the strategist to assess the impact of shared experience, and to decide on the correct allocation of corporate overhead.

Analysing cost behaviour patterns

The analysis of cost behaviour patterns is complicated by four issues:

- the effect of inflation,
- the fact that costs are compared with experience, and not time,
- the difficulty in obtaining accurate information,
- the joint overhead cost allocation problem.

The essence of the experience curve is that costs expressed in real terms corrected for inflation decline in a predictable way as experience is accumulated. The effects of inflation are felt in several ways. Firstly, input costs, because of arithmetic, affect the value added component, particularly if price, not product cost, is being used as a surrogate variable. Costs do not move smoothly and adjustments, when they occur, take the form of step changes, thus distorting the cost picture.

Secondly, because the experience curve depends on real costs, there is the problem of the choice of deflator. Should it be national, and if so which one; or should it be a sectoral deflator? The Boston Consulting Group are quite definitive on the non-use of sectoral deflators which they claim may themselves either have an experience curve effect related to the industry concerned or, if the product is a large input into an industry index, may actually implicitly incorporate the experience effects under analysis. On the choice of which national index, there appears no real guidance other than the use of the consumer price index by default. Since indices are man-made and subject to errors in conceptual design, it may be wise to routinely see if any effects are implicit in the choice of any given deflator.

The experience effect is a relationship between costs and cumulated experience, not time. This means that managers of mature products with large cumulative production may not observe decreases in cost over short time spans even after inflation has been compensated for. If annual volume grows at a constant rate, experience accumulates at a slower and slower rate with respect to time. For example, for a new product growing at 20% per annum, experience doubles in less than two years from start of production (100 units in year 1, 120 in year 2, total 220). In just 5 years 3 months, cumulative production will have gone up by a factor of eight,

but it will take an additional 2 years 7 months to double again. On a 70% experience curve, a cost reduction of 30% is achieved between the end of year one and year two, yet it takes from early in the fifth year to close to the end of the seventh year to achieve an equivalent 30% reduction.

The actual collection of company cost information is often very difficult for a number of reasons. Firstly, costs for a number of product lines may have been collected on an absorption rather than a direct costing basis. One needs to find some means of re-allocating costs related to units produced, rather than with regard to divisional effort, such as marketing or research and development. Secondly, even though a form of direct costing may have been used, allocation of joint overheads is often not made on a basis commensurate with the actual production circumstances, resulting in too large or too small an allocation. As pointed out elsewhere, the joint overhead cost allocation problems is a difficult one which has not even been addressed by many companies, particularly service industry companies. Large general banks, for example, take in retail deposits, lend out money, underwrite leases, and so on, and have no way of allocating costs to strategic market segments.

Abrupt changes in accounting procedures, raw material prices, plant modification, sales tax changes, product modification and other causes can also distort the cost data. Relating the cost data to the unit of production, kilowatt hours of generating capacity or kilos of chicken produced, is another stumbling block as costing systems are usually set up to capture discrete units, such as generators manufactured or chickens sold, rather than cost per experience unit. The careful unravelling of historic cost patterns can be a difficult job.

The effect of economic cycles

Most businesses are cyclical. During a downturn volumes contract, while they expand in the upward phase.

Overheads remain relatively fixed. As a result, allocation of fixed overhead per unit of production varies according to the cycle and distorts the cost data. Changing demand histories and varying loadings and overheads need to be smoothed using a long enough time span to obtain data consistent with the long-run cost behaviour patterns over time.

Foreign exchange variations

This problem is becoming more important with the growth of multinational corporations, the interrelationship between geographically dispersed producers, who may provide inputs to one another, and the reality that it is increasingly strategically naive to consider industries such as automobile manufacture on a geographic basis. The effects of both foreign exchange variations and varying national inflation rates can totally transform different relative experience curves. Thus for a graph such as Figure 2, when costs are measured in a weaker currency like sterling, the slope of the curve could reverse and a real relative cost increase could take place.^{14, p. 113}

There is a mitigating effect in that economies subject to high rates of inflation are also those with poor exchange rate performance and the two effects can cancel one another out to some extent. However, not all currencies are allow-

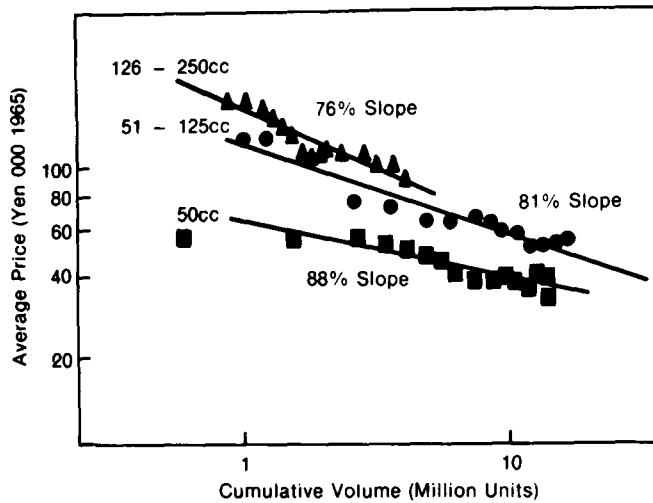


Figure 2 Price experience curve for the Japanese motorcycle industry (1959 - 1974)¹⁴

ed to float freely. They are shored up, slide, glide, move cyclically, and sometimes abruptly devalue, thus changing the experience effect when measured in another currency.

For markets where relative cost positions on an international basis are important both exchange rate fluctuations, suitably smoothed, and inflation need to be taken into account when assessing relative cost advantages.

The time span for analysis

As noted, fluctuating economic cycles affect costs, as do exchange rate variations, plant modification, product modification, wage rate changes and other unlisted variables. As the experience effect is a long-run phenomenon, a sufficiently long time span must be chosen for the analysis and short-run data must be averaged or suitably smoothed to reduce the effects of fluctuations.

The choice of unit of analysis

This is coupled with the market definition problem which has been discussed. The unit of analysis should relate to the strategic market segment which is being studied. For example, if the strategic considerations are focussed on a given defined market segment, errors can be made in choosing a unit which relates to the total market rather than the specific segment. If chosen too broadly, the unit neglects the specialized cost advantages that may accrue to only a segment of a total market due to its unique requirements.

The mirror image problem exists if the unit is chosen too narrowly, particularly if shared experience effects accrue from common production, research and development, marketing, components and so on. Too narrow a choice neglects the impact of peripheral activities which may be shared.

The unit should also be chosen to be meaningful in terms of the benefits to the user associated with an industry. Examples of well-defined units are kilograms of chicken per dollar, not chickens produced; kilowatts of electricity generated per dollar, not generators manufactured; and passenger kilometers per dollar, not airlines seat bookings.

It may be necessary to define the unit in several ways and test the applicability and sensitivity of the experience effect to different units. Similarly it may be necessary in the case

of shared experience effects, discussed below, to use different units of analysis for different product components in order to correctly model the effects. This is especially true when common activities or components are used for a number of products. It may be necessary to analyse costs differently for different functions such as manufacturing and marketing, or even communication costs in the case of a service business such as a travel organization. This detailed analysis reveals the potential for experience cost gains for the various components or functions that constitute the product.

The cost data is not always linear due to mixed experience effects. It may be necessary to disaggregate costs and then, in the light of the analysis, to re-aggregate into larger more meaningful units of analysis.

Different units of analysis may have to be used for different competitors in different markets. Dependent on the market, or factors such as the competitors' level of vertical integration, different units may need to be used for the company and its competitors, particularly in the case of some substitute products. Alternatively it may sometimes be necessary to choose a unit to ensure comparability between two different products that are substitutable for one another, such as steel piping versus plastic piping.

Separating out cost components

The cost of an individual product reduces according to the experience curve effect. Costs reduce because of experience effects acting on the company's value-added component. Costs also reduce because of experience effects operating on the input components. Each component cost, including the company's own, may be driven by different experience curves operating on different starting positions and cumulative production rates. Hence the total cost, being the sum of the individual costs, operates as follows:

Total cost = sum of all individual costs

$$CT_t = \sum_{k=1}^n C_{t,k} \quad (1)$$

where:

CT_t = the total cost at time t

$C_{t,k}$ = the cost for component k at time t

n = the number of component costs being summed.

Substituting for $C_{t,k}$ from equation 1^{1,p.102} in terms of production volumes.

$$CT_t = \sum_{k=1}^n C_{t-i,k} \left(\frac{V_{t,k}}{V_{t-i,k}} \right)^{-\lambda_k} \quad (2)$$

where:

$C_{t-i,k}$ = the cost for component k at time $t-i$

$V_{t,k}$ = the cumulative production volume of component k at time t

$V_{t-i,k}$ = the cumulative production volume of component k at time $t-i$

λ_k = the experience curve exponent for component k .

Each component may have different costs $C_{t-i,k}$ and different cumulative volumes $V_{t,k}$ and $V_{t-i,k}$ associated with it. The volumes can cumulate very differently particularly if component k is used in a number of applications, not just

the product under analysis. Each component may also be moving down different learning curves with different slopes related to different values of λ_k . Total cost can be expressed as

$$\ln(CT_t) = \sum_{k=1}^n \ln(C_{t-i,k}) - \sum_{k=1}^n \lambda_k \ln\left(\frac{V_{t,k}}{V_{t-i,k}}\right) \quad (3)$$

Because of accounting procedures, and arithmetic, the cost components are additive. The successive cost values of $\ln(CT_t)$ will, however, not be a straight line. In general, if a non-linear experience curve is encountered, it may mean the existence of more than one experience curve with the same slope, which is unlikely.

Figures 3 and 4 are graphic examples. In Figure 3 a product uses three components in equal amounts to make one unit of the product. For simplicity, each is assumed to be on different experience curves but to have moved from cumulative experience volumes $V_{t-i,1}$, $V_{t-i,2}$ and $V_{t-i,3}$ with $V_{t-i,1} = V_{t-i,2} = V_{t-i,3}$ to a final cumulative experience $V_{t,1} = V_{t,2} = V_{t,3}$. The total trajectory is plotted and the resulting total cost curve is the simple sum of the three costs. It is not linear as shown by the straight line which has been plotted tangentially to the total cost curve. (The cost is the linear additive value of all three experience curves. It can be seen that initially the curve for component 1 will dominate and finally the curve for component 3 will dominate the cost pattern.)

Similarly Figure 4 represents a product consisting of three components each on different experience curves but each curve has the same slope. If it is assumed that one unit of product uses one unit of component 1, two units of component 2 and four units of component 3, if there is no shared experience from other products, the total cost curve has the same slope as the component curves. The cost curve does, however, have a much more complex configuration when the different components are moving at different and unrelated velocities down separate curves. (Note that in this case all three component costs have been moving with constant velocities down the three curves. Non-constant velocities may generate a non-linear total cost curve.)

Fitting the component cost data will allow predictions to be accurately made as to component costs and, provided suppliers' future production volumes can be estimated, should provide a better tool for forecasting input component costs.

Multiple experience curves can have strategic relevance, as already pointed out. The experience effect apparently slows with regard to production, and especially time, as one of the cost components rapidly diminishes in relative importance as was the example with the solid state semiconductor industry. The relative importance and change in importance between cost components can indicate the need for a revised strategy.

The effect of shared experience

This is similar to the concept, discussed above, of compound experience curves. However, the strategic relevance is that two, or more, products may have common experience either bought in, or as a result of common components, common production lines, common functions such as marketing and

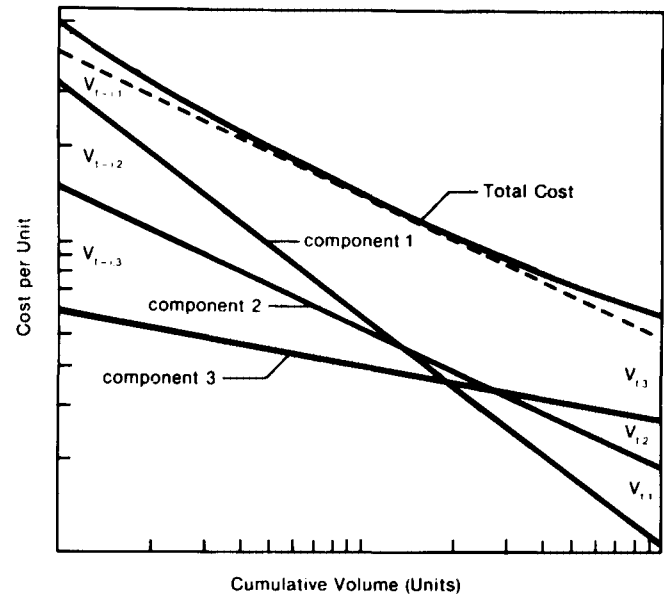


Figure 3 Total cost and individual cost curves for a three component product

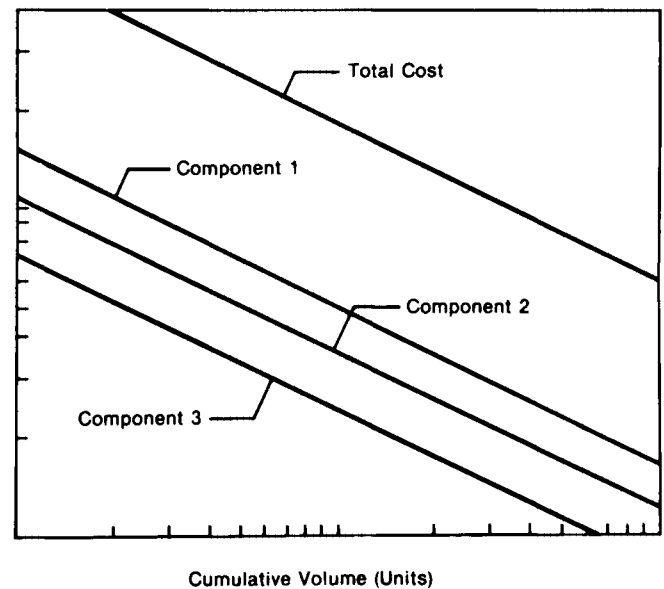


Figure 4 Total cost and individual cost for a three component product

so on. The equations given are valid. However, we are now interested in the various cost performances of several products which utilize common components.

The relationship can be expressed as

$$CT_{t,j} = \sum_{k=1}^n C_{t-i,k,j} \left(\frac{V_{t,k}}{V_{t-i,k}}\right)^{-\lambda_k}$$

where:

- $CT_{t,j}$ = the total cost at time t for product j ,
- $C_{t-i,k,j}$ = the component cost for component k used in product j at time $t-i$,
- $V_{t,k}$ = the cumulative volume of component k product at time t . It includes the volumes for all of component k produced for all the products using the component,

$V_{t-i,k}$ = as above at time $t-i$, and
 λ_k = the experience component for component k 's own experience curve.

The strategic significance is that, although it may be wise to follow a given strategy for one product, the shared experience effects and their impact on other products in the line may result in total corporate suboptimization. It may, for example, pay to cut price on a given product to drive a second product down an experience curve to enhance profits, protect a vulnerable position or harvest a market. Conversely, the removal of a product from a range may have an unexpected impact in the strategic positioning of other related products.

One of the simplest types of shared experience is that of common components, but common functions, markets, technologies all impact the experience. The effective use of shared experience is illustrated by the tremendous international success of the Japanese in the motorcycle industry. Initially Japanese exports were aimed at the low cubic capacity end of the market. Having achieved successful penetration and finally dominance of the low capacity segments, the Japanese successively moved to larger cubic capacity segments, making very effective use of modular component designs and shared experience on many components. The effects on British and German manufacturers was traumatic.¹⁴

Similarly, normalized silicon device price trends¹⁵ can be related to computing costs as shown in Figure 5¹⁶ using a normalized time basis, rather than cumulative production. The conclusion can be reached that the computer industry's spectacular growth has been due mainly to its ability to produce equipment which could compute at ever increasing speeds and reliability levels, and at ever decreasing costs and sizes. All of these attributes have stemmed from advances in silicon technology.¹⁶

Strategically, opportunities for the use of shared experience can be explored, analysed and exploited to gain the benefits of shared experience. Shared experience can be a core strength, its lack a core weakness. The strategic relevance of shared experience must be analysed in decisions to add or eliminate products from the company portfolio.

Analysing cost components for competitors

Analysing competitors' costs is even more difficult than analysing one's own costs, owing to the lack of cost information on, and detailed insight into, the competitors' business. However, the attempt to do so in itself generates more than just cost information. It generates a lot of insight into the competitors' way of running their businesses. In general, cost information is not readily available and estimates may have to be made on the basis of known selling prices, which may, or may not be, adjusted to the expected margins.

Firms can make incorrect assessments of competitors' costs based on an oversimplified idea that a single experience curve exists down which everyone is moving at a rate related to their market share. This oversimplification can be erroneous, and companies may have different curves, starting positions, velocities; or they may even play leap frog

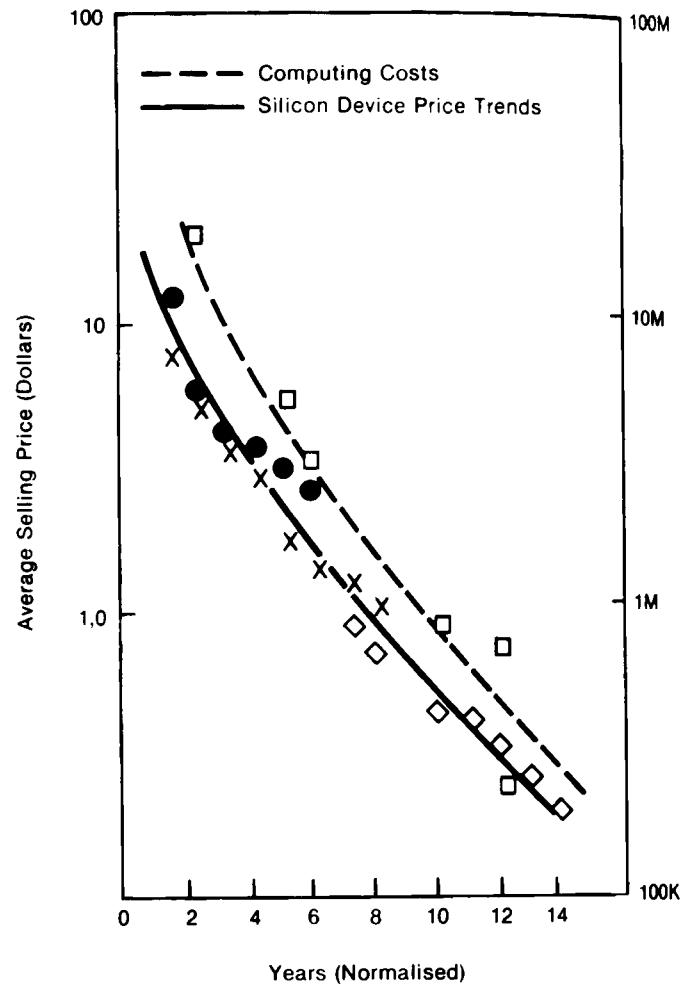


Figure 5 Silicon device price trends related to computing costs

- 1K — bit Dynamic RAM
- × Average IC
- ◇ Diffused silicon transistor
- High performance computer costs

down the curve for various reasons:^{9,17}

- Different companies may have subtly different markets, another manifestation of the market definition problem, or different materials of construction such as plastic versus steel pipes.
- Different international economic cycles and foreign exchange rate variations will cloud the picture.
- Cost components, because of different materials of construction, design differences or production and other functional activities, may vary in behaviour owing to the fact that the competing products may not be identical.
- Common suppliers lead to a sharing of experience with competitors due to the suppliers' experience curve being a driving effect.
- Access to technology from component manufacturers or even production equipment manufacturers and outlet channels reduces the competitive edge of the dominant producer.
- Patent and other protection, and control over raw material sourcing, affect costs.
- Published and other sources of knowledge, including questionable practices such as espionage, narrow the experience gap.

- The purchase or licensing of technology narrows the gap and allows late entrants to catch up, as the Japanese well realize.
- Major technology shifts can allow competitors to leap frog down the experience curve.
- Shared experience can give a competitor the edge, particularly if part of a larger group.
- Transfer pricing practices may distort the picture, or may even be used to enhance the experience effect.
- The level of integration of the competitor, or more cogently the relative amount of the competitor's value added, affects the descent.
- Trade and tariff barriers can exist, or subsidies may be used to negate experience effects.
- Clever management techniques such as the strategic management of working capital, or the use of quality circles by the Japanese.¹⁸
- Clever model line rationalization and design which still serves segments but shares experience, is important. Witness British Leyland's 19 models in 1975 compared with Ford's four, or Chloride's multitude of batteries all specifically designed for minor product variants in the automobile industry, versus the five standard Japanese models of batteries.
- It may be erroneous, even foolhardy, to simply assume that experience curves for competitors are simple and equivalent to your own.

Effectiveness versus efficiency

The efficiency effect is concerned with basing competitive strategy on cost reductions due to experience and scale effects. There are clearly times when market segments, or the market as a whole, will be willing to pay a premium for product and service features as distinct from cost price efficiency. 'Effective' strategies^{19,p.119} based on criteria other than cost-price reduction can be used to defend market share, segment the market or explain the sudden demise of the cost effective leader.

Texas Instruments is the most cost effective company in the production of calculators and aggressively exploits the experience effect on cost reduction.¹⁷ Digital Equipment Corporation do the same in small computers. Hewlett Packard has concentrated on developing products that are differentiated from that of their competitors and find customers who are willing to pay extra for the differences.¹⁹

It could be argued that Hewlett Packard is in fact in a different market segment to either TI or DEC, and does not really compete with either. It could be reasoned that HP in fact dominates its own market segment. Experience with the PIMS programme has ascertained with a high level of statistical confidence that product differentiation, particularly by quality, indicates that, for a given defined market segment, the impact of low market share can be partially offset by differentiation.²⁰ If, in fact, there appears to be insufficient reason for detailed market segmentation on the basis of a number of product characteristics, it may well be that differentiation or 'effectiveness' does offset experience cost price reduction or 'efficiency'.²¹

Ford, following an experience-based strategy, rationalized its product line to the standard model T which only had

one colour option. High levels of capital investment in plant and extensive division of labour, coupled with continuous assembly lines, backward integration and scale economies in the functions, aggressively cut prices, at times in advance of cost reductions.²² Ford gained share of a growing market and had 55,4% of the US automobile market by 1921. In real terms, based on 1958 dollars, the price of a Ford decreased from \$5 000 in 1908 to \$3 000 in 1919 with the introduction of the Model T. Following an 85% experience curve, the price was cut to \$900 in 1926. However, the cost of pursuing a cost minimization strategy led to a reduced ability to make innovative changes to respond to those introduced by competitors. In addition, the rate of capital investment increased from 11c per sales dollar in 1913 to 22c by 1921, to 33c by 1926 (see Figure 6). All expenditure was funded by retained earnings. This increased fixed costs and raised the break-even point.

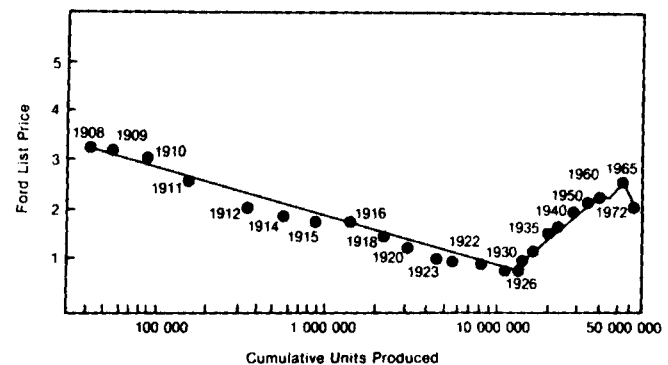


Figure 6 The Ford experience curve (in 1985 dollars)²¹

Consumer preferences began to shift to more comfortable, closed cars with more features, to which General Motors responded. The Model T began to fall from favour and, although Ford added features to the existing design, market share began to erode. In addition, because of frequent design changes, production efficiency declined and experience-based gains decreased. Ford was finally forced to close for a full year to retool for the introduction of the Model A, allowing General Motors to become the dominant market share holder. Ford lost \$200 million, replaced 15 000 machine tools and rebuilt 25 000 more, and laid up 60 000 workers in Detroit alone. Improvements in the product added 25% by weight, thus reversing the experience-gained cost reductions. As volumes dropped, the overhead burden per unit increased and prices, in real terms, increased from 1927 through to 1965.

The specialized production processes lacked the balance for new product innovation. The Model T used wooden parts and the new cars needed more glass and steel. The integrated operations were ill suited to a different car. This does not appear to be a case of market segmentation, but seems to illustrate that, in spite of the attractiveness of large integrated operations with experience-driven cost reductions, the product must continue to satisfy the needs of consumers

In addition, high growth markets must carry the seed of their own destruction because, as the market grows i

becomes more sophisticated, demanding of product differentiation, and amenable to further segmentation. The American motor industry appears to have forgotten the Ford debacle, and under pressure from the Japanese challenge of the 1970s and early 1980s, is once again trying to get back in touch with its consumers.

Problems in organization

Rarely will the formal organization structure conform to the strategic business units. Even rarer is the organization which has a structure which facilitates the allocation of product lines. The service industries, such as banking, are among the worst in this regard. This complicates the determination and allocation of costs.

Secondly, there is a tendency on behalf of management to try to formulate strategy around the organization structure rather than around strategic business units.

Finally, the costing and financial systems of most organizations are geared to accounting procedures aimed at satisfying audit and other requirements, rather than to the provision of strategic cost information for decision purposes.

A new approach to organization design and the installation of costing and management information systems may be needed for the successful use of experience-driven strategies.

Problems in motivation

Economics may well be a dismal science, and the experience effect substantiates this. If a company is third or fourth on an experience curve, it has neither the cost advantages of the leader, nor the cash flow to reinvest and escape the industry. If there is no possibility of strategic segmentation or meaningful product differentiation, then the company is crucified on the cross of its own mediocrity. If the corporate capital investment is large and management or government is unwilling to terminate the company or product line, then a barrier to exit exists.

Those who have worked in successful companies know how much fun it is. The motivational problems in holding staff in, and attracting staff to, an 'also ran' are formidable. To this extent the mediocrity can be a self-fulfilling prophecy as high quality staff may not be easily attracted. It may be that different competitors at different positions on the curve have different organizational behaviours, psychologies and motivations, as yet unresearched.

Conclusions

Strategies based on the experience curve effect require that companies either

- go all out for market share to drive down costs and increase their competitive position and profitability, or
- use strategic market segmentation to occupy a market niche which is both defensible with their resources and unattractive to the industry monoliths.

Blithe acceptance of the prescribed strategy could be suicidal. Six key questions need to be asked to find out whether an experience curve exists in the industry and whether the company can fund an experience-driven

strategy.

If strategic nirvana cannot be attained due to regulatory authorities, it is essential to enquire whether the company position will remain viable. Trade and tariff barriers may confuse the picture. Success at a given point in time does not guarantee immortality, as the strategic impact of costs are always changing.

Problems in application exist ranging from the perennial problem of exactly what constitutes a market, through the impact of economic variables such as inflation and exchange rate variations, to the thorny problem of how to analyse and allocate costs. Problems also exist in motivation, and the bald facts do not really consider the people aspects at all.

A judicious evaluation of all the pros and cons is advocated prior to embarking on the high seas of predatory pricing in the quest of market share, a competitive cost position and unassailable market dominance.

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