CHAPTER

5

Cost Technology

"Feel the force, Luke: let go of your conscious self and act on instinct."

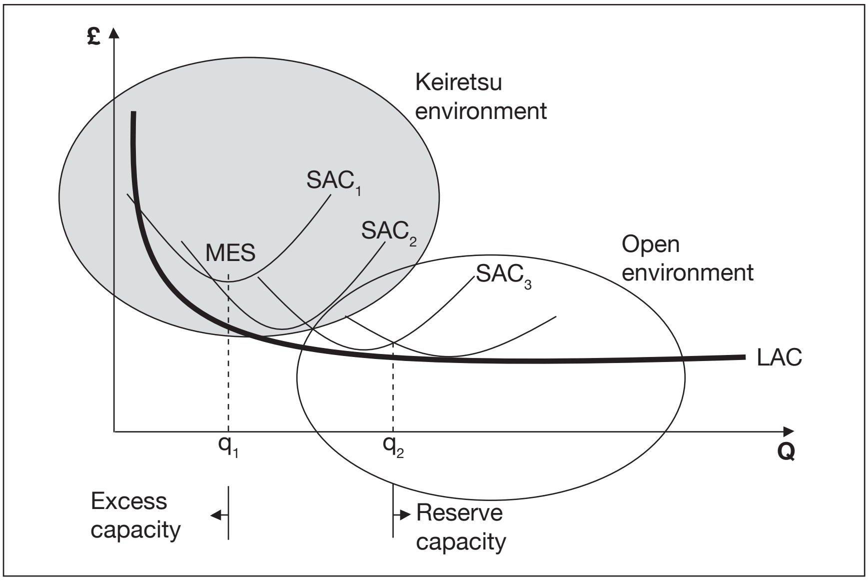
Star Wars

Competition has changed: there was once a reliance on price and quantity, the two classic firm-specific variables; now it is quality and innovation, which are quintessentially firm non-specific, yet the consumer benefits directly from them. One key parameter is the level of consumer demand for the product. In a zero-sum world, for example, one firm could be challenged to meet extra demand due to falling sales of the rival. Whatever the reason for the extra demand, management strives to set the production rate equal to the rate of consumer demand. This just-in-time approach can result in waste elimination and lead time reduction. Historically, batch production has been considered optimal due to long machine changeover times and the requirement for immediate satisfaction of customer demand. This can involve high stock holding costs for the firm. Production smoothing is the process of adapting the production rate to variations in customer demand. From management's perspective, a high-quality product is still delivered to market on time, with significantly reduced costs.

The production technology within a company has been presented in neoclassical models as the constraint imposed on achieving optimal firm size. In the management models there is no optimal size, but rather the growth of the company depends on the abilities and capabilities of management. If the management are not performing, the company fails in its objectives. Bounded rationality is one reason advanced to explain management underperformance. In this chapter, we advance the idea that management are faced with a capacity constraint that they do not fully understand. The reason for this is failure to further understand the cost technology embedded in the production.

There is a greater need to improve the lines of communication between the production, procurement and sales divisions within a company, whether it be manufacturing or service oriented, otherwise management will be faced with a production–demand dilemma. One way to overcome this dilemma and obtain a sustainable cost advantage as a cost leader (CL) is to understand the cost technology. The cost technology has been broken down into five constituent steps in this chapter, so that management can decide at time period t which step applies to their company. The steps can be followed in sequence and may take up to seven years to complete. In the case of Canon, illustrated by Figure 5.1, the process took ten years over a period that saw the emergence of Canon as a formidable CL-type player in the market for copiers, scanners, printers and cameras with a sustainable cost advantage in its market.

Figure 5.1
Canon and Cost Leadership Type



Production–Demand Dilemma

For management, understanding capacity is key to ensuring cost efficiency throughout the production process. Framework Tn=3 focuses on the link between the cost and product curves and also distinguishes between excess capacity and reserve capacity. In obtaining cost efficiencies, management must be prepared to allow production to determine demand. Why? If demand determines production in a product market with innovation and increasing product differentiation, there is a risk that sales will lag as consumers opt to purchase the latest innovative product. A company with lagging sales will carry inventory and risk carrying obsolete products in a market with ever-changing consumer preferences. Therefore, in the 21st century, many companies risk carrying excess capacity as they are unable to sell what they have produced, simply because consumers no longer prefer their products. This becomes more acute in those markets where innovation, technology and product differentiation are key drivers of demand. One way to escape this dilemma is to engineer the production process so that production determines demand.

Against that background, we introduce the cost leadership model with the five strategic steps that act as a filter, helping to identify the cost leadership (CL) type of player. In achieving this status in its industry, management would have to ensure that a number of steps are followed within the company. We adopt the premise that the companies are not single-plant, single-product manufacturers serving only a national market. This may be the case for a small engineering plant, but in the aggregate, cost leadership is obtained in multi-plant, multi-product companies that transcend national or indeed regional market boundaries.

Collectively the five steps define the production relationship within a firm. Step 1 is to distinguish between economies of scale and economies of size. Size should be interpreted as a global economy of scale that can be achieved only once management neutralise the zero-sum constraint. Step 2 focuses on maximising the average productivity of labour, realising that the measure of average productivity is the inverse of the average variable cost of production. Step 3 requires the introduction of a normalised wage system within the company, offering incentives to the workforce so that a reduction in the number of employees is carefully matched with an increase in productivity.

Step 4 is key; it is about controlling costs: once costs are controlled or fixed during the production cycle, management can focus on decreasing the average fixed cost. This can be achieved by hedging raw materials required during the production cycle, offering workers a fixed term or fixed term-fixed wage contract or by outsourcing or by rebalancing costs back to the suppliers in the supply chain. Finally, step 5 requires management to identify the capacity constraints within the company and to clearly demarcate excess capacity from reserve capacity at each plant within the production technology. Reserve capacity requires the building of additional capacity in the plant in the expectation of demand; excess capacity is to be avoided — it can arise if the company is unable to differentiate its products fast enough in an ever-changing consumer market. The ideal outcome is one of zero excess capacity, with a reserve capacity in production.

Wage Normalisation

From the geometry of the product and cost curves, we can observe an inverse relationship as follows:

$$AVC = w/AP_L$$

From this equation, we note that the average variable cost (AVC) is inversely related to a measure of average productivity (AP_L), depending on the wage level, w. It is a simple observation but one that can be easily overlooked by management. The management at TooBig plc have decided that 7,000 employees is too big a number to sustain as they search for cost efficiencies. So they decide to downsize to 4,000 employees, with a plan to lay off 3,000 employees. This is achieved usually with generous redundancy payments.

In many cases, the most productive take the package on offer; after a period of time, management at Smaller plc with 4,000 employees realise that they are not achieving their cost reduction objectives. In fact, costs have increased in real terms at Smaller plc. One reason is that the 4,000 employees remaining are not as productive on average as the 7,000 were. The 7,000 employees included the 3,000 most productive workers who took the redundancy package and ended up being re-employed by Smaller plc on a fixed-fee contract. In other words, costs are increasing at Smaller plc because productivity has fallen. This is not the only explanation for increasing costs, but it is often a contributor.

It would have been more judicious for TooBig plc to focus on the productivity issue, encourage the most productive staff by way of incentives, and encourage the least productive to leave the plant. It is important to note that average productivity can increase if existing workers are more productive so that $q^* > q$ for a given number of workers, L, hence $q^*/L > q/L$, and productivity has increased because output has increased to q^*. This is contrary to a more conventional approach that reduces the number of workers from L to L^* believing that $q/L^* > q/L$: sadly, this result may not occur. Productivity falls as the level of output, q, does not increase, and q will not increase if the most productive workers exit. Management should remember that the total product of L produced on a fixed amount of K is the same as the average product of K when L is fixed. If we assume that when K is fixed, its value is 1, and when L is fixed, its value is also 1, then the following relationship holds:

$$AP_L = TP_K, \text{ when } K = 1$$

With a normalised wage structure there is a greater focus on productivity, as the wage structure offers incentives to the most productive workers to stay and the least productive to exit. There could be share options, for example, and a range of productivity incentive contracts present in the plant. A normalised wage sets $w = 1$, and we have

$$AVC = 1/AP_L$$

So, notwithstanding how costs are reduced, sustainable cost advantage can be obtained only if there is an increase in productivity as a consequence of the cost-reduction measures.

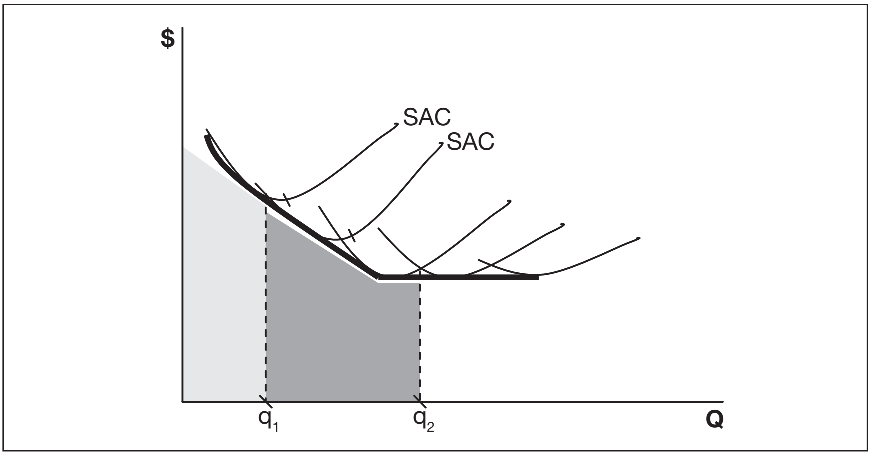
Excess versus Reserve Capacity

During the production phase it is important for management to understand the capacity constraints facing a modern production facility. We distinguish between excess capacity and reserve capacity. For each plant size there is a minimum efficient scale of operation (MES). At this point average costs are at a minimum, and production beyond this point will give rise to diseconomies of scale and rising costs. However, production is often at a production level to the left of the MES plant size. Traditionally, this is the point of excess capacity, and the older arguments were developed in economics accusing the monopolist of producing with excess capacity. Why bother to produce more (towards the MES output) when there was no other rival supplier in monopolist's market?

However, modern firms today, and not in a monopoly position, can be producing with excess capacity simply because they are faced with an ever-increasing demand for their product at a time when they are unable to product-differentiate fast enough to meet the demand. Technically, they have spare capacity in the plant, which translates into excess capacity with a slack demand for the firm's product. Unless the firm is able to differentiate its product in the market, it will be producing at a point to the left of its MES, with excess capacity. This is equivalent to **capacite excedentaire**. This is not a preferred position — for management to be located to the left of the MES — because it is simply not cost-efficient.

Conversely, reserve capacity arises when production is at a point of LMC = 0. It is best to think of reserve capacity as **installed capacity** used by management when it is required. In other words, different levels of production can be reached at zero marginal cost. This is because the company has built in additional capacity into the production process early on in the production cycle. This situation could exist in a product market where **production determines demand**: this is very relevant

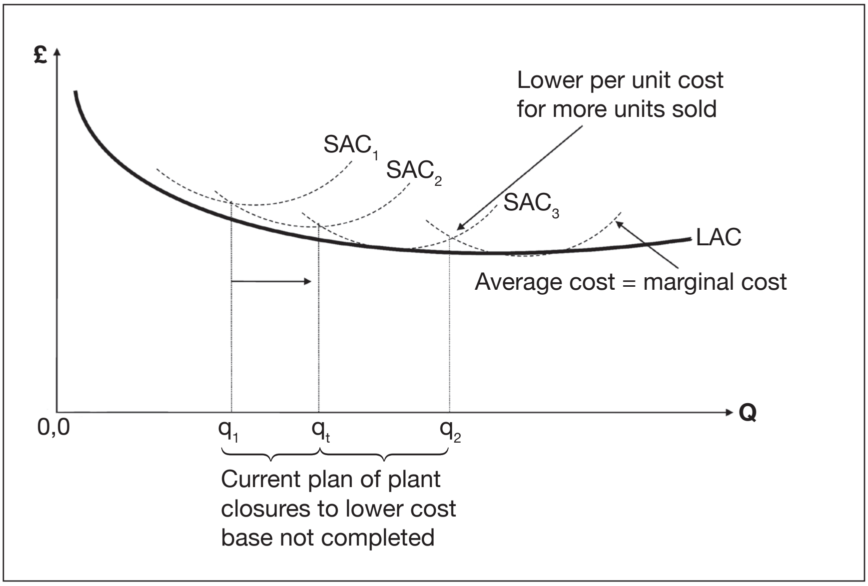
Figure 5.2
Theoretical Short-run Cost Curve



for the management of innovative products such as mobile phones, printers and video game consoles.

Reserve capacity is illustrated with an L-shaped cost structure for the LAC. In economics we refer to this as level of production, as production where constant returns to scale prevail. However, more interesting is the case where L-shape neither increases upward (looking like an elongated U-shape) nor trends downward (representing a declining LAC). In this case, the cost structure implies that output is not large enough to observe whether or not average costs will rise. Management may prefer to be cautious and not push production too far in case costs increase.

Figure 5.3
Declining LAC



CL: Cost Leader Type

The demand (for a product) may be so demanding — what we call **reserve capacity on demand**, or CoD — that it is better for the manufacturer to allow production to control demand. This is contrary to the conventional wisdom that it is demand that drives production. Arguably, it may be more cost-efficient to engineer a plant with reserve capacity so that production determines demand.

Functionalities are precisely what the consumers are demanding. For example, a printer is a printer + copier + scanner + fax machine. Or a mobile phone is a telephone + MP3 player + mega-pixel camera + email communications device. The combination of different functionalities (q_1, q_2, … q_n) generates **economies of scope** at step 1, such that

$$C(q_1, q_2) < C(q_1) + C(q_2)$$

It is more cost-efficient for management to have one large plant that produces a printer and a copier and a printer + copier than to have three separate plants.

Once the plant has reached its size, then economies of scope can be engineered into the cost technology. But it may take time. If so, the time component should be signalled to the market. If there are any production delays, then they should be signalled as shipment delays, not as a failure to meet demand. The signal is necessary in order to calm investors while allowing management to plan for additional capacity at the production plant(s). Consequently, management are in a stronger position to control costs. What one observes is a flat-bottomed cost curve; and with seasonality in demand or a new innovative product on demand, the company with reserve capacity in production will be better placed to meet that demand at cost-efficient levels of production. The firm is more likely to emerge as a CL type in its market.

A key assumption here is that management can change the plant size. This can occur due to economies of scale from the larger-size plant when to the left of the minimum point on the LAC curve. The minimum point on the LAC is the **optimum scale of plant**, the MES. SAC represents the cost structure of the smaller-scale plant, and the corresponding minimum point on the SAC is the **optimum rate of output**. The challenge for management is to move from optimum rate of output to optimum scale of plant. Division and specialisation of

Checklist: Five-Step Analysis

STEP 1: Distinguish between Economies of **Scale**, Economies of **Size** and Economies of **Scope** within the production process.

$$\textit{Scale}: \Delta K = \Delta L = 2\% \text{ and } \Delta q > 2\%$$

Size: Achievable in competitive market $\Delta q = 4\%$ in phase 1; decide ex-post in phase 2 of the production process the most optimal, ΔK or ΔL; and implement in phase 3.

Scope: Across production so that $C(q_1,q_2) < C(q_1) + C(q_2)$

STEP 2: Focus on increasing average productivity of labour AP_L. How?

Note that $AP_L = w/AVC$, where w = wage proxy and AVC = average variable costs.

STEP 3: Normalise the wage structure: let $w = 1$. In other words, offer the workers incentives or bonus payments as productivity increases, revisit the organisational structure and consider the production process as a nexus of contracts.

STEP 4: Control more of the production costs to allow more costs to come under control during the production process. Hedge positions on material inputs, minimise exchange rate risks, and have workers on fixed-wage, fixed-term contracts with incentives per flexible manufacturing.

STEP 5: Demarcate between excess capacity (idle capacity) and reserve capacity (installed capacity), bearing in mind that excess capacity can occur if the product is not sufficiently differentiated fast enough in the market to capture market sales. At the point of production in phase 1, ensure sufficient installed capacity to meet demand in later phases of production.

labour can bring about the economies of scale; likewise, the adoption of advanced technology, for example, robotics and computer technology, can trigger economies of scale.

Management today seek to obtain economies of scale in the supply chain by outsourcing to a lower-wage economy, as with the move from the European Union to the economies of Brazil, Russia, India and China in equipment manufacture, textiles and back-office financial administration. However, with outsourcing, management must ensure that productivity does not decrease at the outsourced plants: simply offering lower wages does reduce the variable costs, but average costs will decline only if productivity is increased. As output increases, management are faced with a second challenge in understanding the capacity constraints that may emerge during the production process. Arguably, management intent on cost leadership will not produce at the minimum point on an SAC curve because if they did, they would lose in the sense that they could produce at a still lower average cost, with a slightly larger but underutilised plant if it were to the left of the minimum point of the LAC, and with a slightly smaller but over-utilised plant if it were to the right of the low point of the LAC curve. This is McNutt's dilemma: do management build a larger plant that may be underutilised or retain existing plant that may be over-utilised? The dilemma cannot be solved unless management introduce a normalised wage structure and demarcate the point at which present production levels are in terms of capacity. The economic argument is simply that the cost curve derives its shape because of five CL-type steps.

De Nihilo Nihil Fit

Rational management know the old adage that 'nothing comes from nothing' so a decision has to be taken. For example, Brand Inc in time period t could signal the launch of a new product in time period t+1 and allow a 'word of mouth' moon-shot to exist in the market. So consumers who want to purchase the product in time period t find that it is not available. Demand is not determining the production. It is by signalling that Brand Inc is able to create a **ghost demand** in time period t so that the production cycle in t+1 can be engineered to meet that level of demand. However, it is the production at time period t+1 that determines the demand at t+1.

This back-scatter approach to production would be characteristic of a CL type at step 5. The risk in delaying production is the loss of a first mover advantage (FMA) in a product with a growing demand for its functionalities. However, the gain in observing another player succumbing to demand, as a product underperforms due to lagging consumer expectations, is the second mover advantage (SMA). In the production game, there are two conjoint decisions:

1. FMA loss < SMA gain
2. FMA gain > SMA loss

CL type is not about an obsession with cost cutting per se, ensuring that every purchase no matter how small is logged into a central accounting system. CL type is about mistake-proofing against these two decisions. Mistake-proofing can be assisted by a regret matrix (Chapter 10), which computes the opportunity cost or loss of deviating from an optimal decision.