Managerial Economics and Production Functions - Theoretical Review and Practical Applications

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Abstract: **The objective of this paper is to review the important economic concept of production functions with regard to how they influence business decisions both in the short and long run, and also shows how practically they determine how firms compete to make profit. This paper is a short review of an important economic concept so the approach adopted as methodology was that of a qualitative approach based on relying on secondary data. It is hoped that the paper will stimulate further reading and research by researchers and students alike.**

Keywords: **production function, short run, long run, economies of scale, economies of scope, diminishing returns, fixed costs, variable costs, profit maximization, relevant costs, irrelevant costs**

I. INTRODUCTION

Relevant and Irrelevant Costs

According to Study.com (n.d.), an online source, Relevant Cost is cost which is influenced positively or negatively by a management decision, and such costs change in the future. For example, if there are five copy-typists for an organisation, who operate from a typing pool, and management decides that going forward, all managers should learn computer skills and do all their documents themselves, then in the near future, the services of the copy-typists would be dispensed with leading to savings in salaries. This is an example of relevant cost.

On the other hand, Irrelevant Cost is cost which remains the same such as contractual overheads or sunk costs such as interest on loans, rentals, among others. Irrelevant costs are therefore Fixed Costs.

II. LITERATURE REVIEW

Firm Short run Production Function and Short run Cost (MP&MC)

According to Keat *et al.* (2013) the firm's short run production function is with assumptions of fixed technology and capital, and it is the maximum output which results from a combination of factor inputs with at least one factor fixed in the short run. Here, raw materials and labour can be variable input while capital and land can be the fixed inputs whose acquisition takes time to organise or negotiate for.

According to Lipsey & Chrystal (2010: 109) the long run and short run are derived from the same production function with the short run Cobb-Douglas production function being $Q = A L^b K_0$ while the long run model is of the form $Q = A K^a L^b$, showing that in the short run, capital is held constant while in the long run, both labour and capital are allowed to vary.

The three varying production functions are first, increasing returns to scale (where b>1 or a + b >1), second, constant returns to scale (where b = 1 or a + b = 1), and third, decreasing returns to scale (where b<1 or a + b < 1) (Keat *et al.,* 2013). Each of these functions assumes exogenous market prices and an endogenous technology (Lipsey &Chrystal, 2010: 109; Begg *et al.* 2011: 162)

The production functions are related to the Cobb-Douglas production function of the 1920s where output Q = f (A, L, K) where Q is output, A is Technology, L is labour input, and K is capital. Some production functions show increasing returns to scale and are exponential while others show constant returns to scale and are linear. A third type shows decreasing returns to scale (Keat *et al.,* 2013). An exponential type is $Q = a L^b$ which can be linearized by taking logarithm of both sides of the equation as log Q = log a + blog L. In the short run, the firm cannot vary some fixed factors such as plant, machinery, and some skilled personnel.

The short run cost curve is U-shaped showing the combined effects of Average Fixed Cost (AFC) and Average Variable Cost (AVC) and also the law of diminishing returns and economies and diseconomies of scale. As output expands, fixed factors are better utilised till the optimum output point on the Average Total Cost Curve (ATC). AFC is TFC/Q and AVC is TVC/Q while ATC is TC/Q. Therefore ATC = TFC+TVC/Q or AFC +AVC.

According to Begg *et al.* (2011:144) the production function shows efficient methods of combining factor inputs to produce outputs. The production function indicates the set of all technically efficient ways of production represented by iso-product curves and tangential to iso-costs in production space. According to Begg *et al.* (2013: 157) if a firm faces an upward shift of its demand curve or Average Revenue (AR) curve, then it will expand the scale of output by operating on a higher iso-product curve in production space, which is constrained by its highest isoquant and iso-cost lines (Beardshaw *et al.*, 2001: 348-350).

According to Witztum (2005: 102-153), the long run average cost curve (LRAC) describes the three stages of production encompassing increasing returns to scale, constant returns to scale (best and most rational output position for the firm to be) and going further, the last or third stage, of decreasing returns

to scale where variable cost starts rising sharply as output outstrips capability and capacity to manage. Witztum (2005) also observes that the expansion paths of the production function for the short and long run meet at one point where capital is initially fixed.

Sloman & Garratt (2010:85) state further that the supply side decision to maximize profit leads producers to weigh costs and revenues in the short run during which period at least one factor of production is held constant with others being made variable, and that the fixed factor can only be varied in the long run.

Sloman & Garratt (2010) also observe that it takes three years for a shipping Company to add another ship to its fleet because ship-builders take that long to build a ship that meets buyer's specifications. Mankiw (2008:272) observes that a series of short run cost curves trace out the envelope of the long run cost curve which is an envelope of the planning horizon. Both short run and long run cost curves are U-shaped with the long run cost curve being much flatter than the short run cost curve (Begg *et al.* 2013:166-188; Begg *et al.* 2011: 160)

Marginal Product (MP) is net addition to Total Product as a result of employing an additional factor of production such as labour. MP is subject to the law of diminishing returns, being high in Stage 1 of production, reaching its peak in Stage 2, and cutting the AP curve at its peak from above, thereafter falling twice as fast as the AP (Average Product) curve which becomes the effective supply curve of the firm.

The MP multiplied by price shows the productivity of labour (MPP_L), and hence where to maximize profit and stop employing more factors. The MPP_L becomes the effective demand curve for labour, and equilibrium in the labour market is where this curve meets the market wage line or supply curve. After this point, any addition of labour will be costly and wasteful or loss making because MPP_L will be lower or less than the horizontal wage supply line. However, improvement in productivity of labour resulting from training, education and labour reorganisation will shift MPP_L upwards and then more labour will be demanded.

In a multi-factor environment, the entrepreneur will employ factors up to where $MP_L/w = MP_K/i$ or where MPP_L =MR=MC or where MR is Marginal Revenue and MC is Marginal Cost, that is where the factor costs and MP ratios are equal.

Law of Diminishing Returns (AVC/AFC)

The Law of Diminishing Returns operates everywhere in nature and was first written about by Adam Smith in 1776 in his famous tome, *The Wealth of Nations,* in which he talked about Division of Labour and Specialization.

According to Beardshaw *et al.* (2001)

If one factor of production is fixed in supply and successive units of a variable factor are added to it, the extra output derived from the variable factor must after some time decline.

(Beardshaw *et al.* 2001: 37)

Table 1 below illustrates the law of diminishing marginal returns. Underlying the table is assumed an underlying endogenous technology which is combined with labour. From the table, it can be seen that the peak of MP at 10 is reached before the peak of AP which occurs at 6.4 and when TP reaches its peak at 40, MP goes to zero, showing that MP is obtained mathematically by taking the derivative of TP with respect to L, labour, holding capital constant. MP_L = d TP/dL.

Table 1 Law of Diminishing Returns

Labour	Total Product (TP)	Average Product(AP)	Marginal Product(MP)
0	0	0	-
1	2	1	2
2	6	3	4
3	14	4.6	8
4	24	6	10
5	32	6.4	8
6	37	6.1	5
7	40	5.7	3
8	40	5	0
9	38	4.2	-2

(Source: Adapted from Begg *et al*., 2013:145)

III. METHODOLOGY

The objective of this paper is to discuss the theoretical underpinnings of the concept of production functions in Economics and show their applications in business. The author therefore decided to use a qualitative approach as there was no need to collect primary. Also secondary sources were relied upon for this review paper. It is hoped that researchers and students alike will find the discussion in this paper useful and interesting.

IV. DISCUSSION

Distinction between Short run and Long run in Economic Analysis

In Economics, the short run is taken as any period of time within which one factor of production is fixed while the long run is a period long enough to vary all factor inputs. Both terms vary from firm to firm and within the manufacturing and service industries their usage differ (Begg *et al.* 2013:188). In fast-changing industries such as ICT and fashion, speed of production and first to market are cardinal as products have short life cycles, and production runs are also of short duration. This means that specialised machinery soon become obsolete and difficult to sell or dispose of as they are asset-specific or industry-specific.

Thus more capital should be set aside for Research and Development as well as for Innovation in such volatile environments.

Economies of Scale and Returns to Scale-Determinants

Economies of scale are the returns to output as variable factor inputs are added. Here, there is distinction between organic or internal economies and external economies. Internal economies of scale are benefits to output arising from internal expansion and changes such as acquiring a bigger plant or rationalisation which reduces waste, costs and bring about efficiencies from the 5S Japanese system of removing Muda/waste through lean production, synergies, tight integration, restructuring, delayering, team working, creating internal customers, and internalization of external costs (Keat *et al.*, 2013)

Economies of scale include reduction of production costs as the firm operates at the optimum of AC curve or the Second Stage of production where AFC falls considerably as there is adequate uptake or absorption of fixed factors or overheads (Keat *et al*. 2013; Grant, 2008:363).

Internal economies of scale, according to Grant (2008: 363-364) comprises marketing economies, plant size technical indivisibilities, managerial economies, risk-bearing economies, financial economies, R&D economies, principles of multiples or critical mass, synergy, economies of linked processes, stock economies or bulk-purchasing or pool-buying economies, by-product economies, and increased dimensions economies.

Through mergers, acquisitions, joint ventures, strategic alliances, collaborations and networking innovations, firms derive considerable cost -saving benefits. The Japanese 5S state that Systemize, Sanitize, Structurize, Sensitize, among others in order to reduce internal costs, waste, and turnaround time.

This is done through forward, backward, lateral, horizontal, and vertical integrations as well as Conglomerate integration through the Holding Company structure or the Parent Company and foreign subsidiary structure (SBUs) as found with Multinational Corporations (MNCs) (Grant, 2008:372-373). All these can confer increasing returns to scale as competition is reduced.

Diseconomies of Scale

Both the short run and long run cost curves are U-shaped as a result of the influence of AFC and AVC. As output expands beyond the lowest point or optimum point on the AC curve, management becomes inefficient and machine breakdowns become rampant. The local market may also become saturated.

All these combine to raise costs considerably, leading to diseconomies of scale. This is the stage the firm may consider buying a larger and more efficient plant size or pulling out of the market if competition is very stiff. Diseconomies of scale crop up when the firm exceeds its installed capacity. At that point, it may strategize to have mergers, acquisitions, alliances, and other forms of collaborations which will lead to cost-sharing and effective utilisation of their joint facilities.

Economies of Scale and Scope

Economies of scope are those external economies of scale derived from various forms of integration in the supply chain. For example, when a wheat farmer takes over a warehouse or silo as well as a distribution channel, it has done forward vertical integration to reduce external costs which arise from information asymmetry, incomplete contracts, negotiation costs, transport costs, and other marketing costs (see Williamson's model).

V. CONCLUSION

In production, firms explore the best factor combination to maximize profit. Factor combinations are determined by cost and technological constraints. Firms face both variable and fixed costs. Relevant costs are costs arising from management decisions while Irrelevant costs are neutral of management decisions. All firms seek efficient size of plant size to operate both in the short and long run. This is because they are profit maximizing.

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