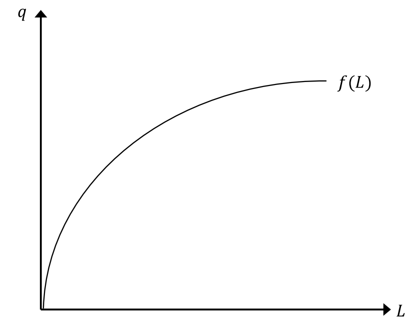
PRODUCTION & COSTS

A firm, using available technology converts inputs (economic resources) into output which is then sold on the marketplace – a firm will typically require more than one input to produce its final output
Short-Run: Period of time during which at least one of the factors of production if fixed (i.e. size of factory)
Fixed Input: Resources used in production process which cannot be changed regardless of output produced
Long-Run: When all factors of production are variable
The short & long-run are defined in relation to how long it takes for all of a firm's inputs to become variable

PRODUCTION

In order to produce its final output a firm requires inputs of factors of production
Production Function: Demonstrates relationship between the quantity of inputs used & the (maximum) quantity of output produced (given state of technology)
Productive function is often represented through an equation

⇒ E.g. q=f(L) – where *q* is the level of output which depends on *L* the amount of labour



Curve demonstrates that output increases as inputs increase but at a decreasing rate (due to MP)

MARGNIAL PRODUCT

Marginal Product (MP): Refers to how output responds to a change in input (*slope of production function)*
If are given the production function as an equation differentiation can be used to find the MP of an input

⇒ If production function takes form q=f(L), $MP = \frac{\Delta q}{\Delta L} = \frac{dq}{dL}$

Diminishing Marginal Product: If MP becomes progressively smaller
Increasing Marginal Product: If MP becomes progressively larger
Diminishing MP is very common as in the short-run there is a fixed input of some kind which creates a capacity constraint

⇒ This means that each additional input will contribute to output less & less than those utilised previously

N.B. Diminishing MP is a short-run phenomenon because it relies on the idea that at least one input is fixed
The MP can also be differentiated with respect to L:

$$MP' = \frac{\Delta MP}{\Delta L} = \frac{dMP}{dL}$$

If MP' is positive then MP is increasing (& conversely)

N.B. If the marginal product of labour (MPL) is greater than the average product of labour (APL) then each additional unit of labour is more productive than the average of the previous units

⇒ Hence by adding last unit, overall average increase (if MPL is greater than APL then APL is increasing)
⇒ If MPL is lower than the APL then the last unit reduces the average
⇒ APL is a maximum when MPL=APL

RETURNS TO SCALE

(In the long-run, all inputs into the production process are variable)
Returns to Scale: Refers to how the quantity of output changes when there is a proportional change in the quantity of all inputs

- <u>Constant Returns to Scale:</u> Output increases by the same proportional change
- <u>Increasing Returns to Scale:</u> Output increases by more than the proportional increases in all inputs
- <u>Decreasing Returns to Scale:</u> Output increases by less than the proportional increase in all inputs

N.B. Returns to scale is a long-run concept
It is possible for a firm to have diminishing MP in the short run but have increasing returns to scale in the long-run

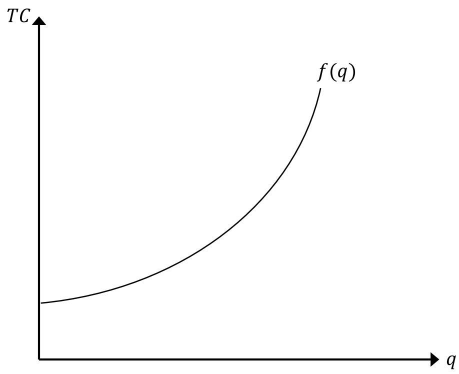
PRODUCTION COSTS

SHORT-RUN COSTS

In order to use inputs of production to produce output a firm will incur some cost (e.g. wages)

Cost Function: Equation that links the quantity of output with its associated production cost

⇒ E.g. TC = f(q) where TC represents total cost & q represents quantity of output



This is a typical cost function (or cost curve) with output on the x-axis & total cost on the y-axis

⇒ When output is zero, TC is positive due to fixed factors of production apparent in the short-run

⇒ TC curve rises as output increases – represents the increase in cost as greater quantities of variables are used

⇒ Curve rises at an increasing rate – reflects diminishing MP as a greater quantity of inputs are needed to increase output by the same amount

FIXED/VARIABLE COSTS

In the short-run a firm will have a combination of fixed & variable costs

Fixed Costs (FC): Costs which do not vary with output (when output is zero all costs are fixed)

FC = TC when q=0

Variable Costs (VC): Costs that vary with output (all other non-fixed)

VC = TC -FC

TC = VC + FC

MARGINAL COSTS

Marginal Cost (MC): Increase in total cost that arises from an extra unit of output

$$MC = \frac{\Delta \text{TC}}{\Delta \text{q}} = \frac{\Delta \text{VC}}{\Delta \text{q}}$$

When total cost is expressed as a continuous function the MC can be calculated by taking the first derivative of the total cost function with respect to q:

$$MC = \frac{dTC}{dq} = \frac{dVC}{dq}$$

A typical MC curve will eventually increase with output due to diminishing MP (has a positive slope)

⇒ i.e. Diminishing MP implies increasing MC since the extra cost of producing another unit of output must increase

AVERAGE COSTS

Average Fixed Cost (AFC): Fixed cost per unit of output,

$$AFC = \frac{FC}{q}$$

AFC curve is always downwards sloping – numerator is fixed but denominator increases with output

Average Variable Cost (AVC): Variable cost per unit of output

$$AVC = \frac{VC}{q}$$

AVC curve will eventually be upward sloping because of diminishing MP

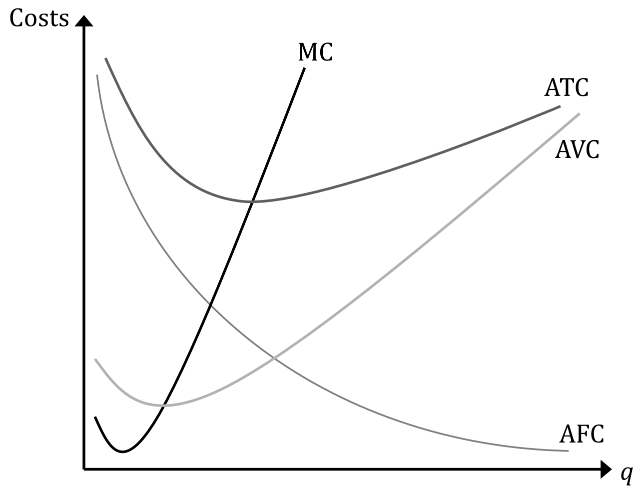
Average Total Cost (ATC): Total cost per unit of output

$$ATC = \frac{TC}{q}$$

$$ATC = AVC + AFC$$

Since both AFC & AVC combine to produce ATC, the shape of the ATC curve is determined by both

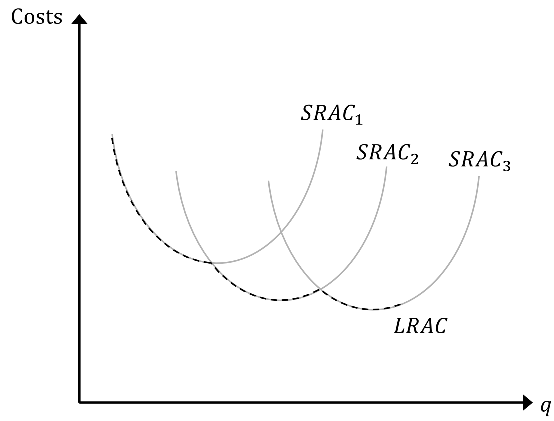
⇒ Has a u-shape (i.e. initially decreasing due to AFC but eventually increasing with output due to AVC)



N.B. MC passes through the minimum point of ATC & AVC
⇒ If MC of a unit of output is higher then TC will increase the AC (& conversely)
⇒ Hence, if MC curve lies below ATC curve it will drag the curve downwards & if MC is above ATC it will pull the curve upwards
⇒ Therefore, as ATC is decreasing when MC is below it & increasing when MC is above it, ATC must be at its minimum when it is intersected
⇒ Similarly, MC intersects AVC at its minimum

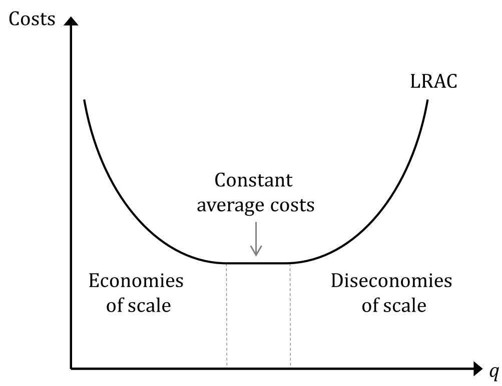
LONG-RUN COSTS
Since all costs are variable, <u>all costs are zero if a firm does not produce</u>
A firm producing positive output has more flexibility to adjust all of its inputs – hence long-run costs should not be higher than short-run (for a given level of output)

MARGINAL COST
Long-Run Marginal Cost (LR MC): Marginal cost of increasing output by one unit (all inputs can be varied to achieve this increase)
Hence, for the same level of output, LR MC will be ≤ SR MC



AVERAGE COST
Long run AC cannot be greater than short-run AC given firm's extra flexibility
N.B. In the long-run there is only one average cost (as there are no fixed costs)
Since a firm can anticipate output requirement, it can minimise input quantity etc. that gives it the lowest AC for that level of output
⇒ Consequently LR average cost curve will be the *lower envelope* of all the SR cost curves as demonstrated to the right

ECONOMIES OF SCALE
Economies of Scale: Cost advantages that a firm obtains from increasing its output – when LRAC decreases with output
Diseconomies of Scale: When LRAC increase with output
Constant Returns to Scale: When LRAC are constant as output expands (also referred to as *constant average costs*)
N.B. Whilst inputs have been considered as variable in the long-run, it has also been implicitly assumed that input prices are fixed & there have not been changes in the state of technology (ceteris paribus)



TOTAL REVENUE/COST & ECONOMIC PROFIT
Total Revenue (TR): Amount a firm receives for the sale of its output

$$TR = PxQ$$

Total Costs (TC): Economic costs a firm incurs for producing output
Economic Profit: Revenue minus total opportunity cost
N.B. Firms aims to maximise economic profits rather than just accounting profits (revenue minus all explicit costs)

Profit (π) = TR - TC

Zero Economic Profit: Revenues just covers opportunity costs (firm could earn same net benefit from undertaking next best opportunity) – although may have received accounting profit

EXAMPLE QUESTION

Tony owns a restaurant, his cost function is $TC = 100 + 10Q + Q^2$, where Q is the number of 3 course meals prepared in an hour:

a) What are Tony's fixed & variable costs?

<u>Solution:</u> FC = TC when q = 0 (when output is zero all costs are fixed)

$$\therefore FC = 100 + 10(0) + (0)^2$$
$$= 100$$
$$VC = TC - FC$$
$$= 100 + 10Q + Q^2 - 100$$
$$= 10Q + Q^2$$

b) Calculate Tony's average cost curves: ATC, AFC & AVC

<u>Solution:</u> $AFC = FC/Q$

$$= 100/Q$$
$$AVC = VC/Q$$
$$= (10Q + Q^2)/Q$$
$$= Q(10 + Q)/Q$$
$$= 10 + Q$$
$$ATC = TC/Q$$
$$= (100 + 10Q + Q^2)/Q$$
$$= 100/Q + 10 + Q$$

c) Calculate Tony's marginal cost curve:

<u>Solution:</u> MC = dTC/dQ (derivative of total cost function with respect to quantity)

$$= 10 + 2Q$$

d) If Tony was minimising his average cost per meal/ how many meals would he be producing each hour?

<u>Solution:</u> ATC is minimised when MC = ATC (MC passes through minimum point of ATC & AVC)

$$10 + 2Q = 100/Q + 10 + Q$$
$$Q = 10$$

Alternatively, $ATC = 1000^{-1} + 10 + Q$ = can find derivative of ATC & set this to equal zero (i.e. $dATC/dQ = 0$) to find minimum