SUPPLY OF HEALTH SERVICES AND COSTS OF PRODUCTION

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OUTLINE

- **Productivity Measures**
- **Cost Measures**

ASSESSING THE PRODUCTIVITY OF MEDICAL FIRMS

Economists often describe production of output as a function of labor and capital :

$$q = f(n,k)$$

In the case of health care :

- q = hospital services
- n = nurses
- k = medical equipment, hospital building

ASSESSING THE PRODUCTIVITY OF MEDICAL FIRMS (CONT.)

- Short run : ***k* is fixed, while *n* is variable**

a) At low level of *n*, *k* is abundant. Each ↑ in nurses when combined with capital → greater ↑ in services.
   - potential synergy effect because nurses can work in teams.

b) Further ↑ in nurses → ↑ service, but a decreasing rate - law of diminishing marginal productivity.

c) "Too many " nurses can cause congestion, communication problems, → ↓ hospital services

SUBSTITUTABILITY IN PRODUCTION OF MEDICAL CARE

- There may be more than one way to produce a given level of health care.
  - Enrolled nurses (ENs) vs Registered Nurses (RNs) in hospitals.
    - ENs have less training.
    - Maybe not as productive, but not as costly.
  - Physician assistants vs physicians at ambulatory clinics.
    - But physician assistants can't prescribe meds in most states.

SUBSTITUTABILITY IN PRODUCTION OF MEDICAL CARE (CONT.)

- Potential for substitutability ⟹ If price of 1 input increases, can minimize impact on total costs by substituting away.
- Elasticity of substitution :

$$r = [D(I_1/I_2)/I_1/I_2] : [D(MP_2/MP_1)/MP_2/MP_1]$$

% change in input ratio, divided by % change in ratio of inputs' MPs.

  - r = 0 ⟹ no substitutability.
  - r = ∞ ⟹ perfect substitutability.

PRODUCTION FUNCTION FOR HOSPITAL ADMISSIONS

- Jensen and Morrisey (1986)
  - Sample : 3,450 non-teaching hospitals in 1983.

q = hospital admissions

inputs : physicians, nurses, other staff, hospital beds.

$q = a_0 + a_1 \text{physicians} + a_2 \text{nurses} + \ldots + e$

- Coefficients in regression are MPs.

RESULTS

Annual Marginal Products for Admissions

Input	MP (at the means)
Physicians	6.05
Nurses	20.30
Other Staff	6.97
Beds	3.04

- Each additional physician generated 6.05 more admits per year.
- Nurses by far the most productive

RESULTS (CONT.)

Elasticity of Substitution between Inputs

Input pair	σ
Physicians with nurses	0.547
Physicians with beds	0.175
Nurses with beds	0.124

- Each inputs is a substitute for other in production process.
- If wages of nurses rise, can substitute away by having more hospital beds.

→ Except for when $\sigma = 0$

MEDICAL CARE COST

Accounting Costs

- Explicit costs of doing business.
  - e.g. staff payroll, utility bills, medical supply costs.

- Necessary for :
  - Comparing performance evaluation across providers/depts.
  - Taxes
  - Government reimbursement/rate setting

MEDICAL CARE COST (COST.)

Economic Costs ≠ Accounting Costs

- i.e. opportunity costs.
  - e.g. opportunity cost of a facility being used as an outpatient clinic = rent it could earn otherwise.

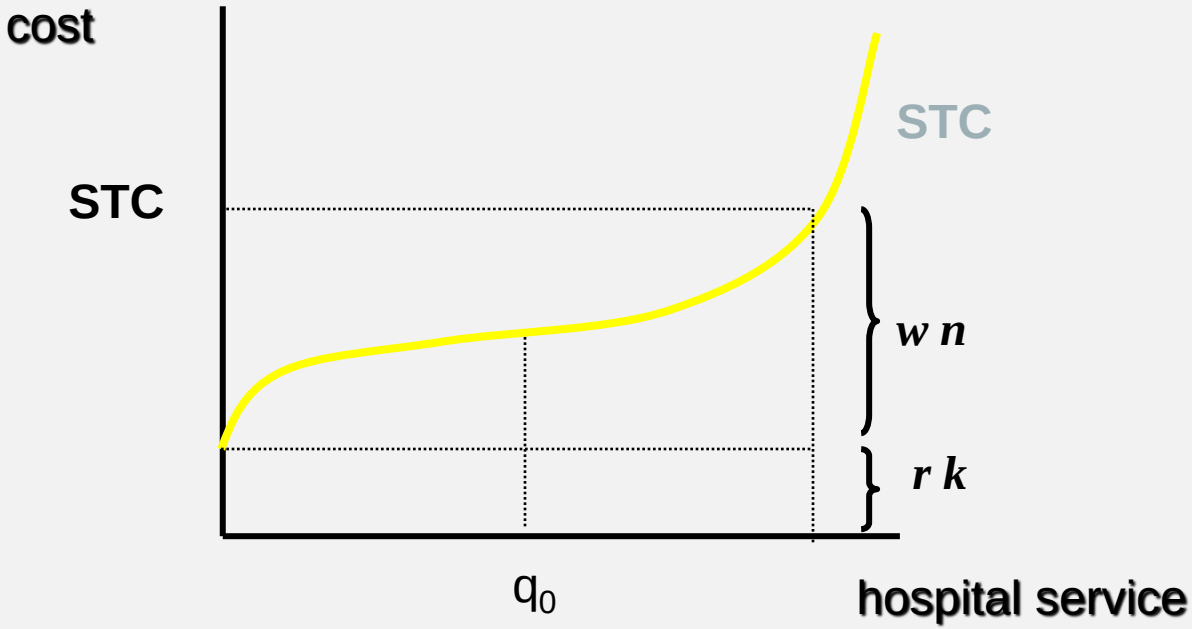
- Necessary for :
  - optimal business planning.
  - allows one to consider highest returns to assets *anywhere*, not just vs. direct competitors, or w/in health care industry.

SHORT-RUN TOTAL COST

STC(*q*) = $w\,n + r\,k^*$

***w* = wage rate for nurses** **short run ⟹ k fixed**

***r* = rental price of capital**
***w n* = variable cost**
***r k* = fixed cost** .



SHORT-RUN TOTAL COST (CONT.)

$$STC(q) = wn + rk^*$$

- In the short run, ***k*** is fixed.
  - ***rk**** is the same, regardless of the amount of hospital services (***q***) produced.
- As ***q*** rises, increases in STC are only due to increases in the number of nurses needed (***n***).

MARGINAL AND AVERAGE COSTS

$$SMC = \frac{\Delta STC}{\Delta q}$$

$$= \Delta(wn + rk^*)/\Delta q$$

$$= w(\Delta n/\Delta q) = w(1/MP_n)$$

$$= w/MP_n$$

The short run marginal cost of nurses depends on their marginal productivity.

MARGINAL AND AVERAGE COSTS (CONT).

$$SAVC = \frac{STVC}{q}$$

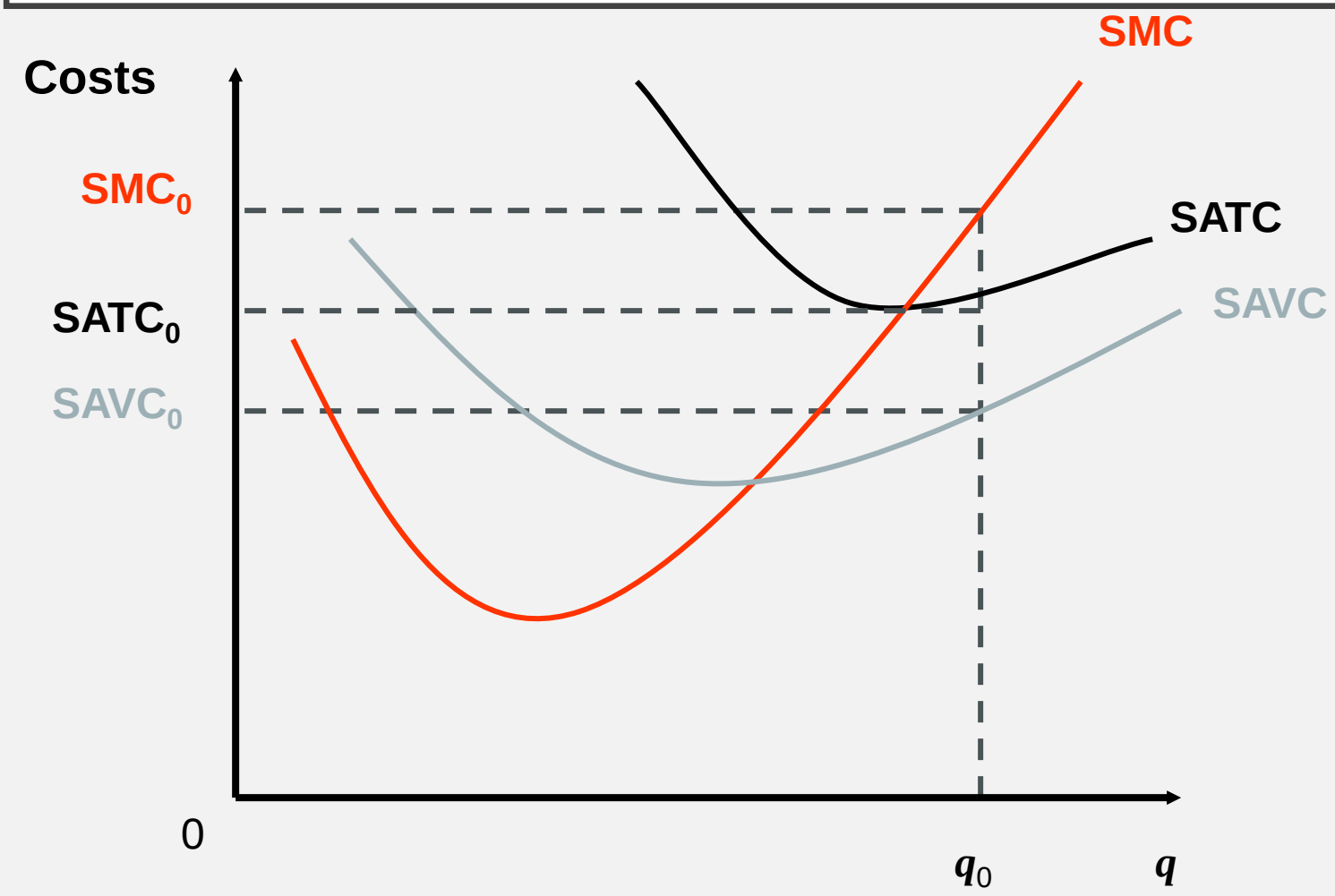
$$= (wn)/q$$

$$= w(1/AP_n)$$

$$= w/AP_n$$

The short run average variable cost of nurses depends on their average productivity.

GRAPHING MARGINAL AND AVERAGE COSTS



GRAPHING MARGINAL AND AVERAGE COSTS

- SATC and SAVC are u-shaped curves.
  - Increasing returns to scale followed by decreasing returns to scale.
- SMC passes through the minimum of both SATC and SAVC.
  - If marginal cost is greater than average cost, then the cost of one additional unit of output must cause the average to rise.

AVERAGE AND MARGINAL COSTS (CONT.)

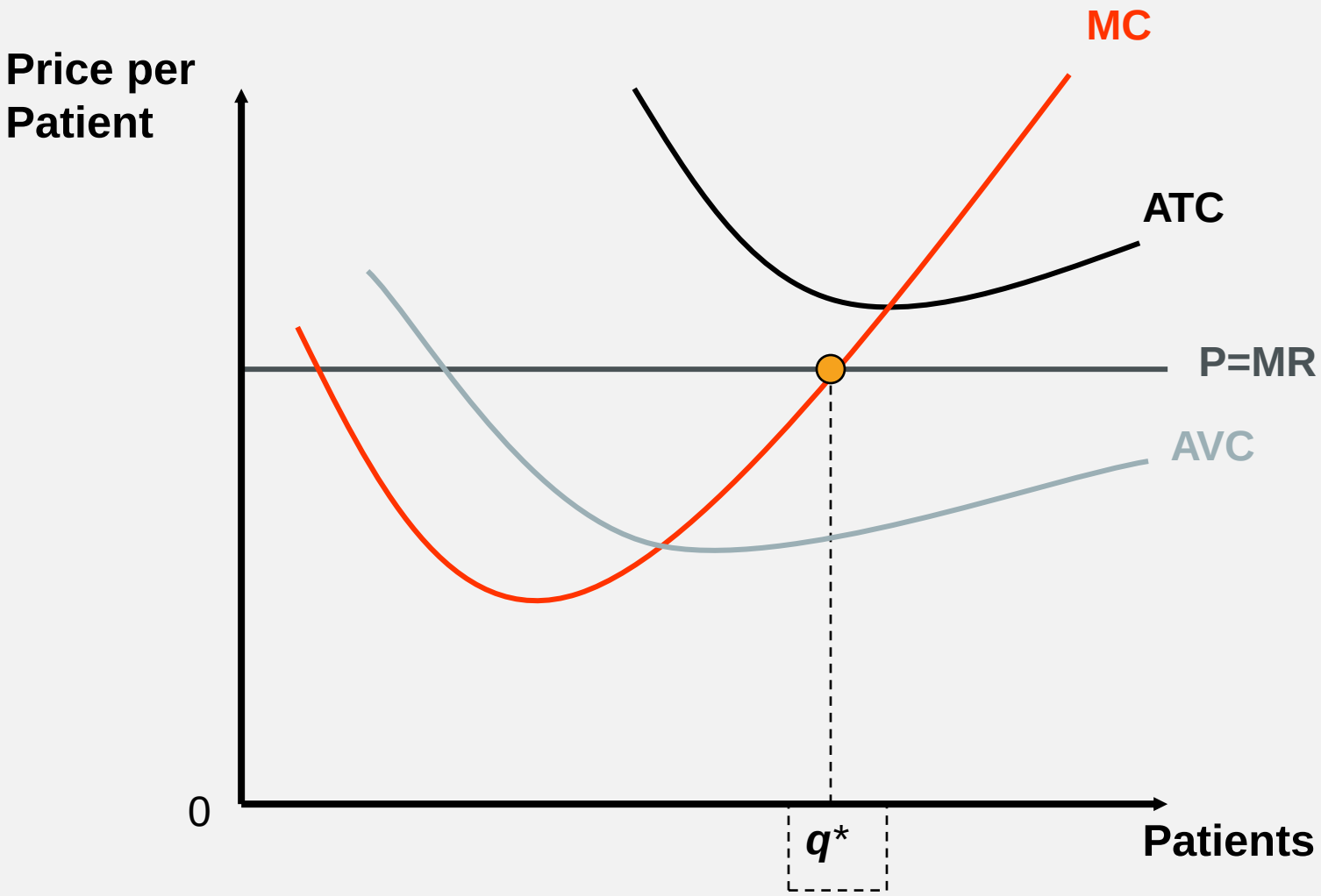
- IRTS (increasing returns to scale) followed by DRTS (decreasing returns to scale) in production leads to U shaped AC curve.
- Hospital doesn't necessarily produce at q* (min. cost).
  - Depends on hospital's objectives.
  - Even so, will attempt to stay on the cost curve (not above it).

AVERAGE AND MARGINAL COSTS (CONT.)

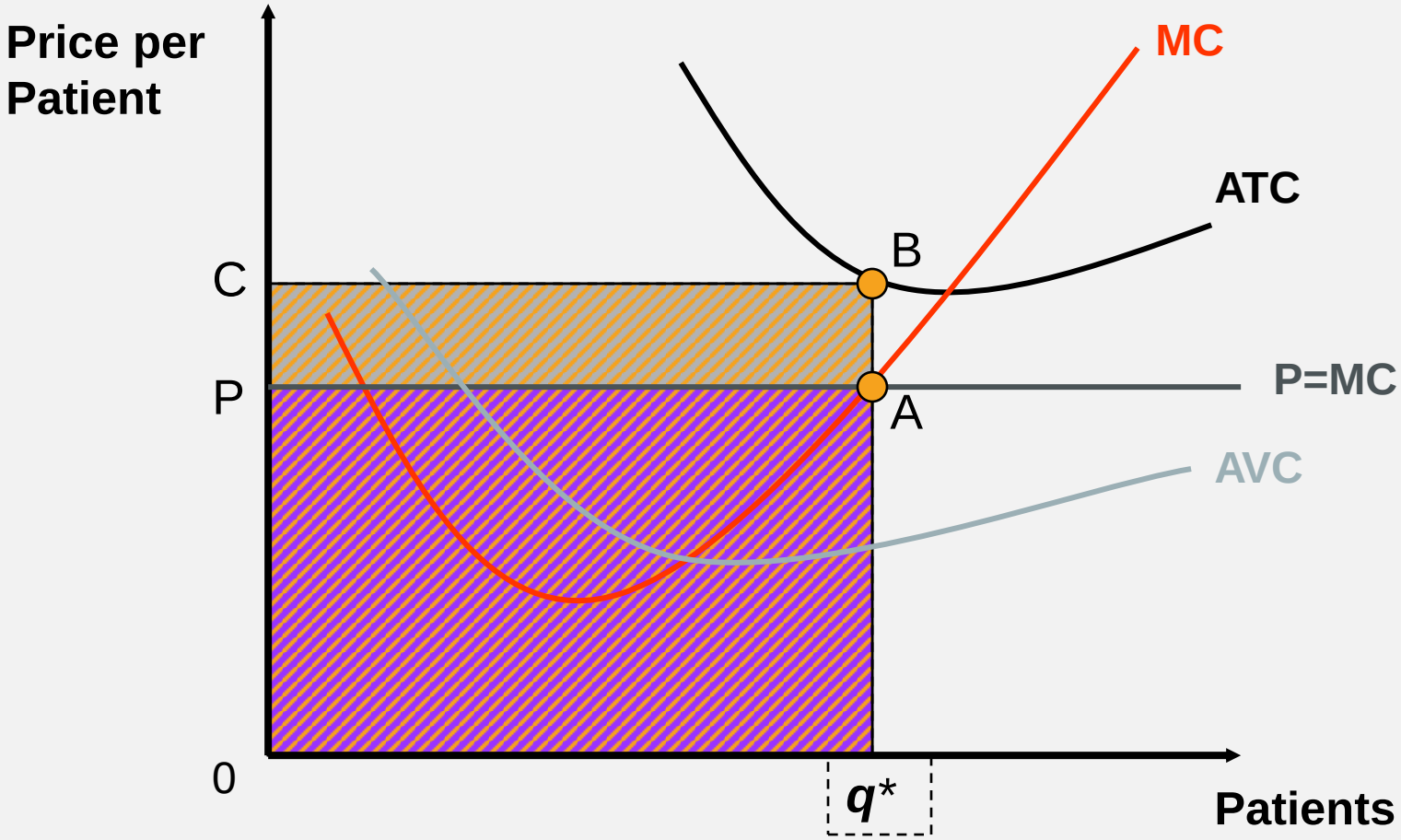
- Why do all of these cost curves matter?

- Many hospitals operate at a loss (profits < 0) in some years.
  - If a hospital seeks to maximize profits, and it knows it's going to lose money in a given year, why should it treat any patients?

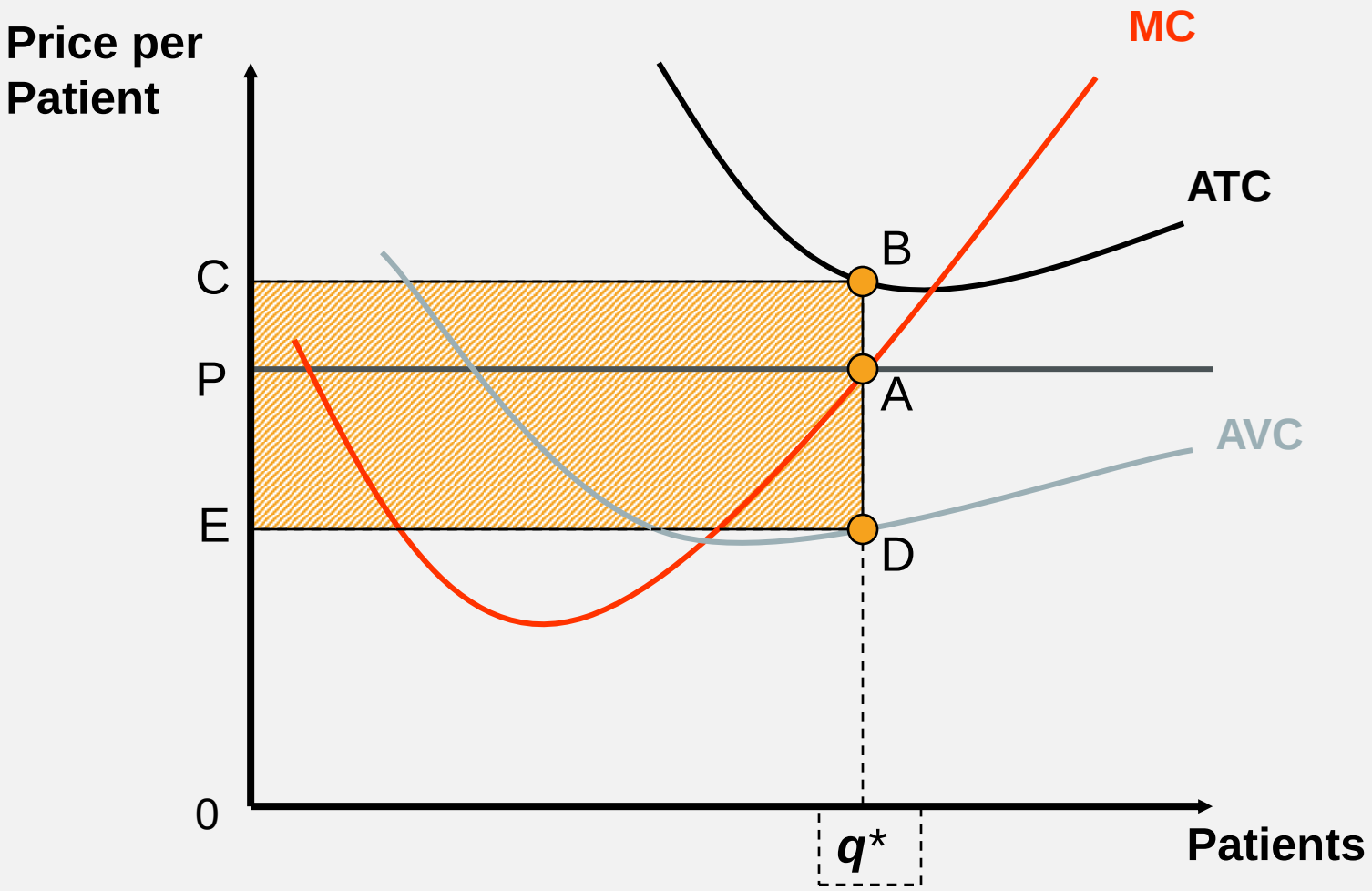
- In the SR (short run), a hospital will still stay open if treating patients will cover its fixed costs and part of its variable costs.



- The hospital will receive a price P from insurers for each patient treated.
  - To max profits, choose q^* where MR=MC.



- At output *q**, the hospital's revenues are PA*q**0.
- The hospital's total costs are CB*q**0.
- The hospital earns negative profits CBAP (Total Revenue –Total Costs).



- The hospital's FC are (ATC-AVC)q^*, or CBDE.
- If the hospital shuts down, it must still pay for FC.
- Since CBDE>CBAP, the hospital will lose less if it remains open.

SHORT RUN COSTS – REAL WORLD EXAMPLE

- In the SR, FC are critical for determining whether a hospital should stay open for business.
- So, in general, how large are FC?
- Study of **Cook County Hospital in Chicago (Roberts, JAMA 1999)**
  - Urban public teaching hospital, 1993

SHORT RUN COSTS – REAL WORLD EXAMPLE

Fixed Costs:

- Capital
- Worker salaries & benefits
- Building maintenance
- Utilities

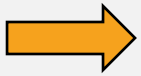
Variable Costs:

- Worker supplies (e.g. gloves)
- Patient care supplies
- Paper
- Food
- Lab supplies
- Medications

SHORT RUN COSTS – REAL WORLD EXAMPLE

- Why are salary & benefits a FC?
  - Workers often have long-term contracts.
  - Many workers won't take jobs w/ frequent layoffs.

- For Cook (1999), the budget was 84% FC, 16% VC.



Often makes sense for Cook to operate at a loss, not reduce patient load.

SHORT RUN COSTS – REAL WORLD EXAMPLE

- **Cutting the # of patients you serve won't save a lot if you can't cut FC simultaneously.**

- If you serve 5% fewer patients, you may still need to:
  - Pay for a CT scanner & technician
  - Pay for upkeep of the ER & OR
  - Pay annual licensing fees to city & state

DETERMINANTS OF SHORT-RUN COSTS (CONT.)

5 different measures of q

- ER care
- medical/surgical care
- pediatric care
- maternity care
- other inpatient care

inputs

nursing labor
auxiliary labor
professional labor
administrative labor
general labor
materials and supplies

Cowing and Holtmann 1983

FINDINGS

- Found short run economies of scale
  - Hospitals operate to left of min. on AVC curve.

    i.e Larger hospitals producing at lower costs than smaller hospitals.

- Best way to reduce aggregate hospital costs?
  - Reduce # of hospital beds by a fixed % in all hospitals.
  - Close the smallest hospitals in each region.

FINDINGS (CONT.)

- Definition : Economies of scope
  - Cost of producing 2 outputs < sum of cost of producing 2 goods separately.
- Found **Diseconomies of scope** with respect to ER and other services.
  - Larger ER's may bring in more complex mix of patients to the hospital. OR
  - Larger ER's generate operating challenges for other services (e.g. communication, staffing scheduling).

SOURCES OF ECONOMIES OF SCOPE

- Economies of scope can arise at any point in the production process.
  - Acquisition and use of raw materials
  - Distribution
  - Marketing

SOURCES OF ECONOMIES OF SCOPE

General vs Specialized Hospitals

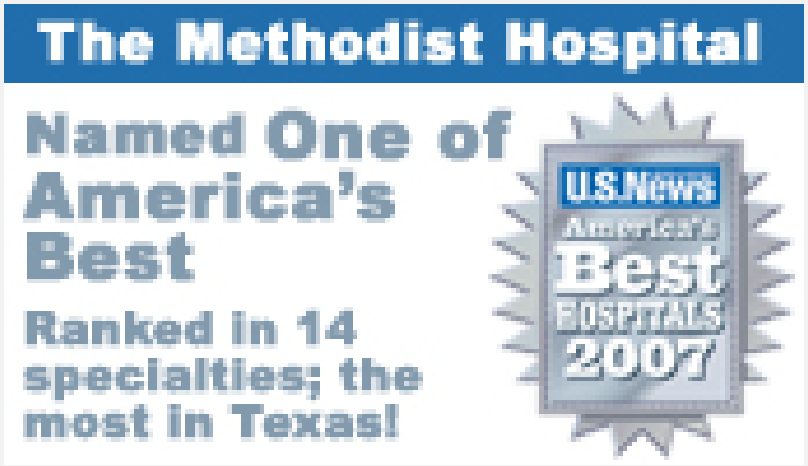
- General hospitals can spread the fixed costs of operating rooms and intensive care units over multiple different operations.
    - Operate at full capacity by treating all types of patients.
- However, specialty hospitals argue that they can lower marginal costs by specializing.

SOURCES OF ECONOMIES OF SCOPE

- Know-how can be spread over products sharing similar technology.
  - Medical device companies frequently produce multiple different products.
  - Ethicon Endo-Surgery.
  - Makes multiple different devices for minimally invasive surgery.
  - Factories often require similar technology, and the marketing strategies are similar too.

SOURCES OF ECONOMIES OF SCOPE

- Spreading advertising costs.
  - Methodist hospital can pay for one ad advertising its top rankings in multiple services.



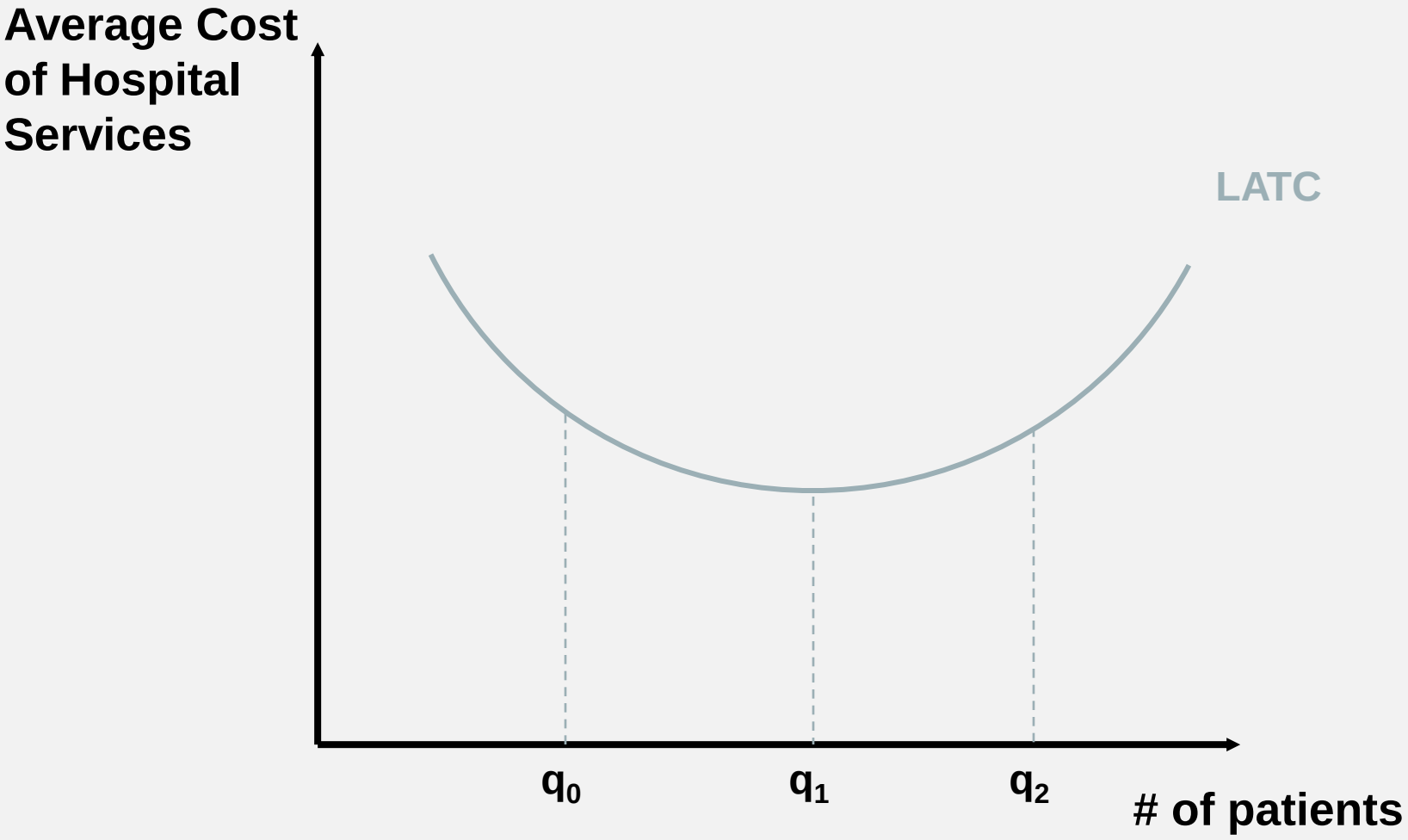
SOURCES OF ECONOMIES OF SCOPE

- Research and development.
  - Pharmaceutical companies can spend hundreds of millions of $'s to develop a drug.
  - Once drug is developed, they sometimes find alternative beneficial applications.
    - Gleevec for leukemia, and gastrointestinal tumors.
  - Costs of production and sales can be spread over many different drugs.

LONG RUN COSTS OF PRODUCTION

- In the long run, all inputs are variable.
  - k is no longer fixed.
  - e.g. A hospital can build a new facility or add extra floors to increase bed size in the long run.
- If all inputs are variable, what does the long run *average* cost curve look like?

THE LONG RUN AVERAGE COST CURVE



LONG RUN COSTS OF PRODUCTION

- Just like the short run cost curve, the long run cost curve for a firm is also u-shaped.
  - However, the short run cost curve is due to IRTS, then DRTS ***relative to a fixed input***.
  - e.g. In the short run, the only way to increase the number of patients treated was to hire more nurses; but the # of beds (k) was fixed.
  - But **in the long run, there are no fixed inputs**.

LONG RUN COSTS OF PRODUCTION

- The u-shaped long run average cost curve is due to **economies of scale and diseconomies of scale.**
- ***Economies of scale***
  - Average cost per unit of output falls as the firm increases output.
  - Due to *specialization* of labor and capital.

LONG RUN COSTS OF PRODUCTION

- Example of specialization and the resulting economies of scale.
  - A large hospital can purchase a sophisticated computer system to manage its inpatient pharmaceutical needs.
  - Although the *total cost* of this system is more than a small hospital could afford, these costs can be spread over a larger number of patients.

The average cost per patient of dispensing drugs can be lower for the larger facility.

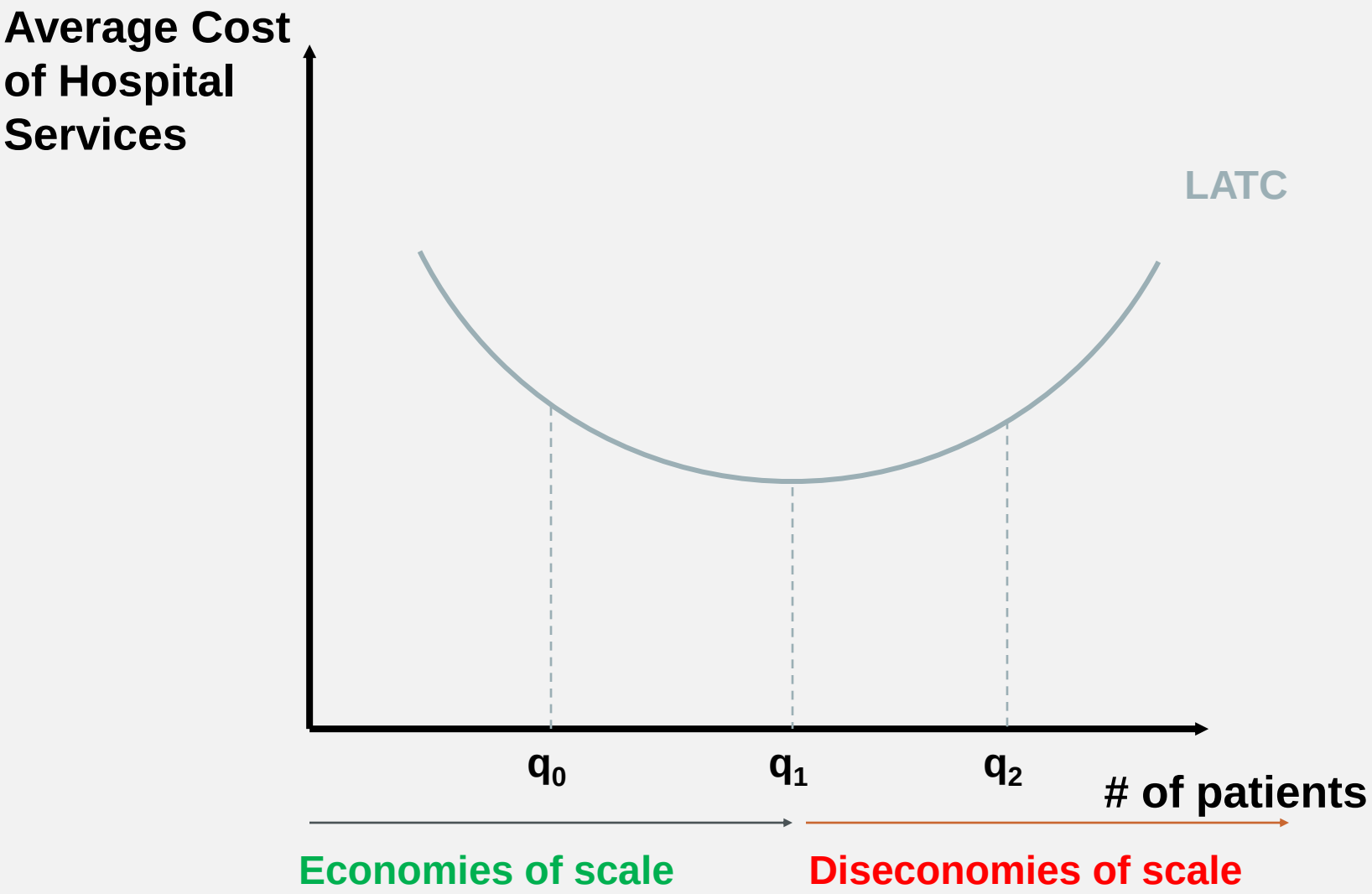
LONG RUN COSTS OF PRODUCTION

- ***Increasing returns to scale***
  - An increase in all inputs results in a more than proportionate increase in output.
  - e.g. If a hospital doubles its number of nurses and beds, it may be able to triple the number of patients it cares for.
- However, most economists believe that **economies of scale are exhausted, and diseconomies of scale set in at some point.**

LONG RUN COSTS OF PRODUCTION

- ***Diseconomies of scale*** arise when a firm becomes too large.
  - e.g. bureaucratic red tape, or breakdown in communication flows.
  - At this point, the average cost per unit of output rises, and the LATC takes on an upward slope.
- Diseconomies of scale (in costs) imply decreasing returns to scale in production.

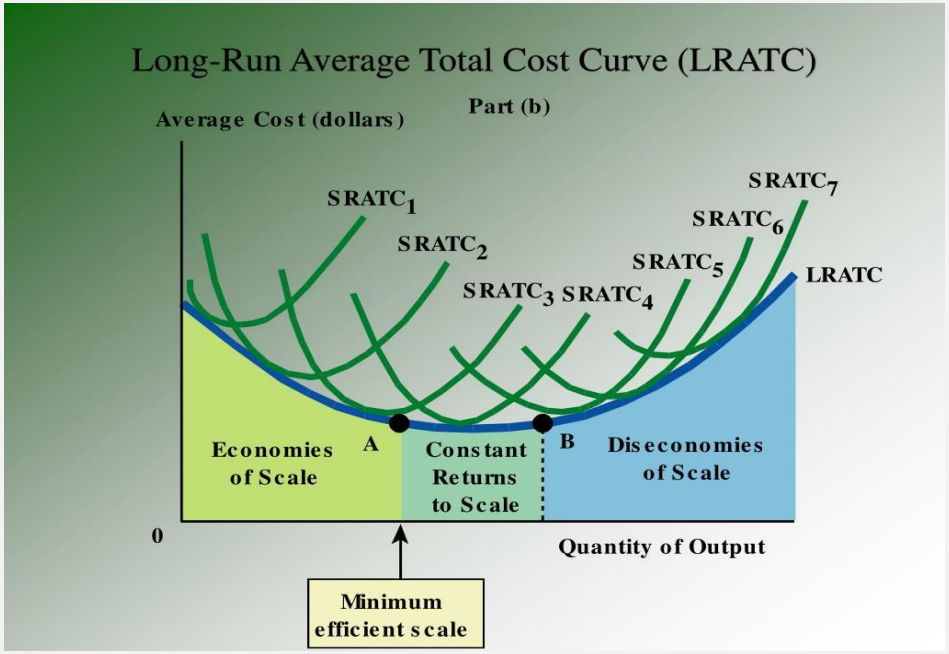
THE LONG RUN AVERAGE COST CURVE

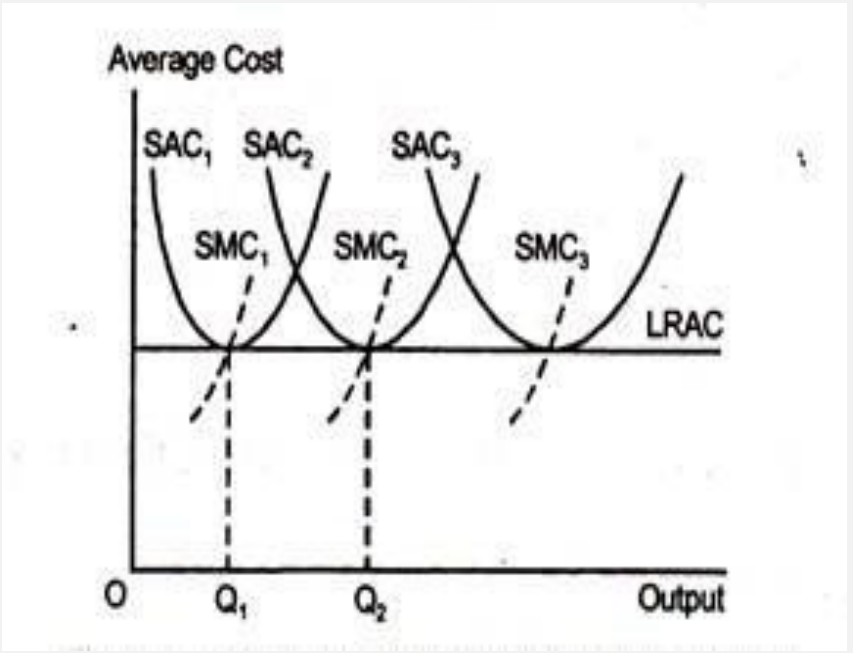


LONG RUN COSTS OF PRODUCTION

- *Decreasing returns to scale*
  - An increase in all inputs results in a less than proportionate increase in output.
  - e.g. Doubling the number of patients cared for in a hospital may require 3 times as many beds and nurses.
- In some cases, the production process exhibits *constant returns to scale*.
  - A doubling of inputs results in a doubling of output.

THE LONG RUN AVERAGE COST CURVE UNDER CONSTANT RETURNS TO SCALE





LONG RUN COSTS OF PRODUCTION

- Like the short run cost curve, a number of factors can cause the long run cost curve to shift up or down.
  - Input prices.
  - Quality.
  - Patient case mix.
- e.g. If the hourly wage of nurses increases, the average cost of caring for each patient will also rise.

  The average cost curve will shift _____

REFERENCES

- Health Economics, Theories, Insights and Industry Studies, 5th Edition by R.E. Santerre and S.P. Neun (S&N), South-Western Cengage Learning, 2010