The Production, Cost and Technology of Health Care (Part 1)

EE 474 Health Economics

Semester 1/2012

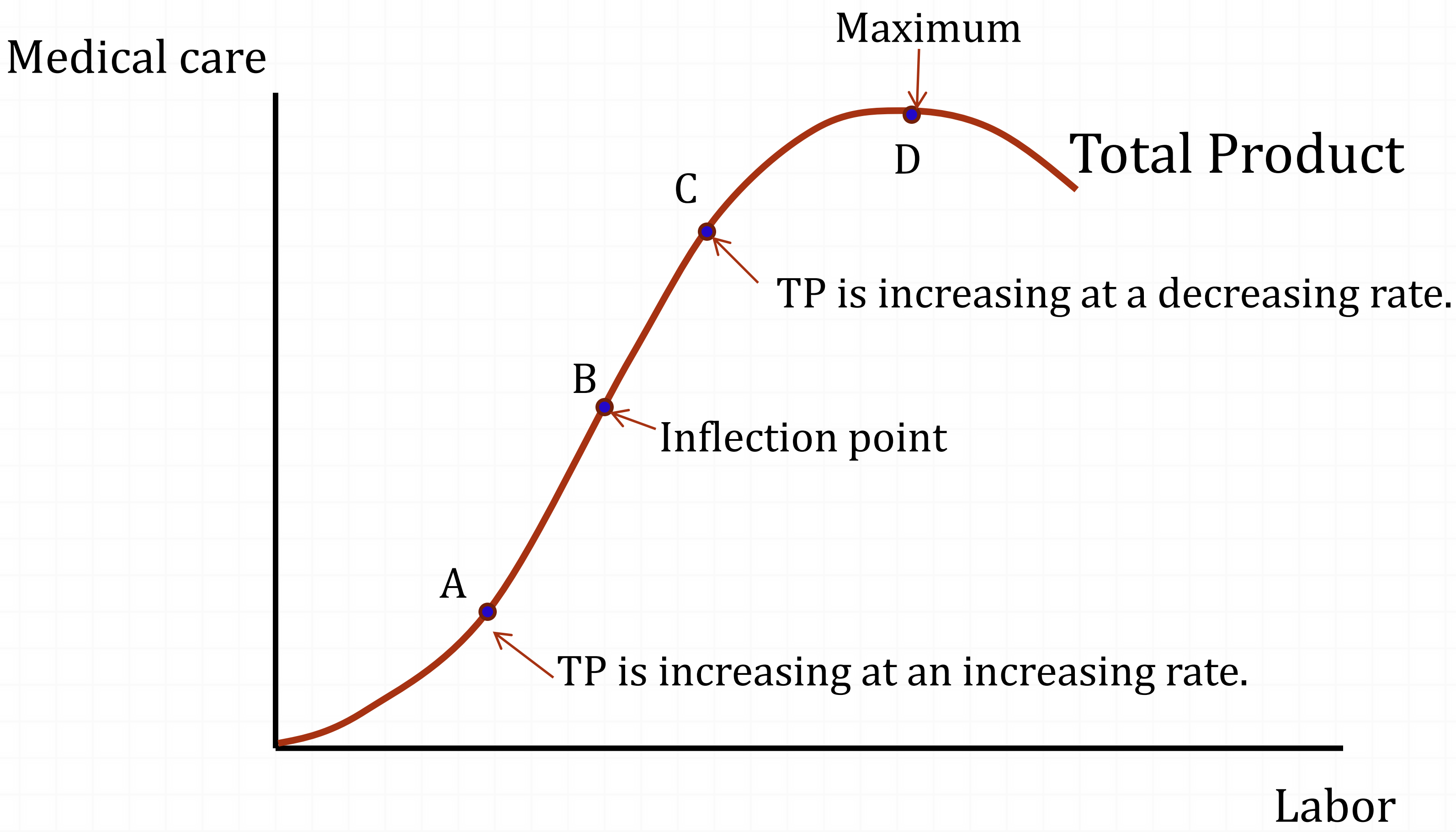
Topics

- Production and the Possibilities for Substitution
  - Short-Run Production Curves
  - Input Substitution
- Costs in Theory and Practice
  - Derivation of the Cost Function
  - Cost Minimization
  - Economies of Scale and Scope
  - Long-Run Cost Curve
- Technical and Allocative Inefficiency

Production

- Short-run production
  - A production in which *at least* one input cannot be modified within a given period of time.
  - Fixed inputs – fixed at all levels of output, e.g. capital, salary
  - Variable inputs – vary by the amount of output, e.g. labor
- Long-run production
  - A production in which *all inputs* can be changed over time

Recall: Short-run Production

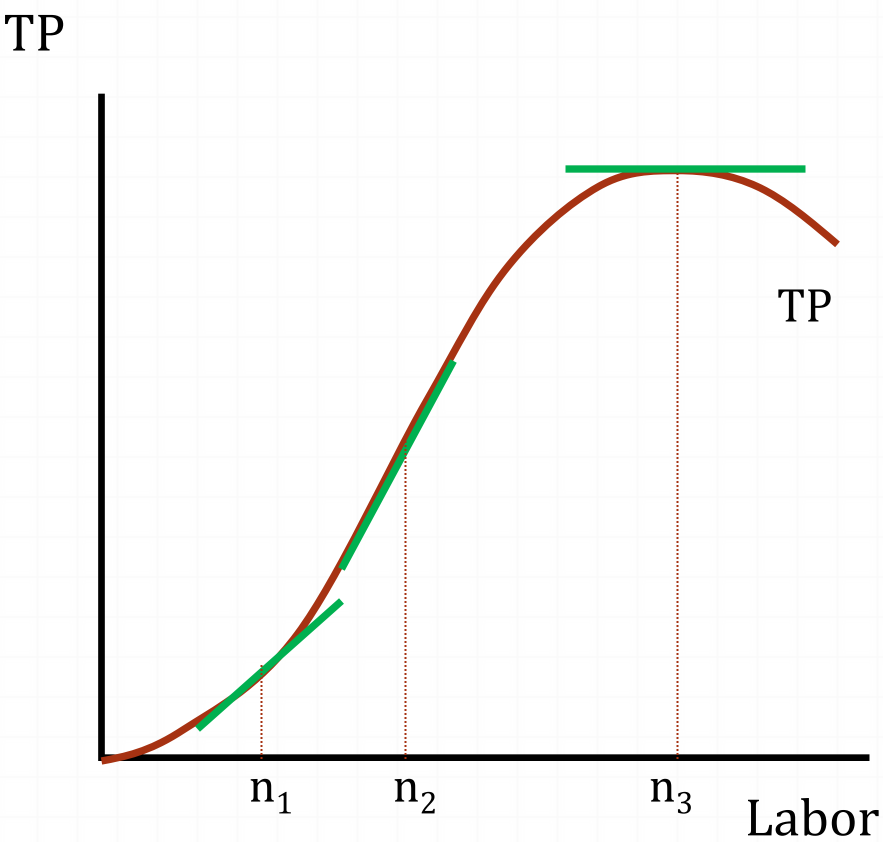


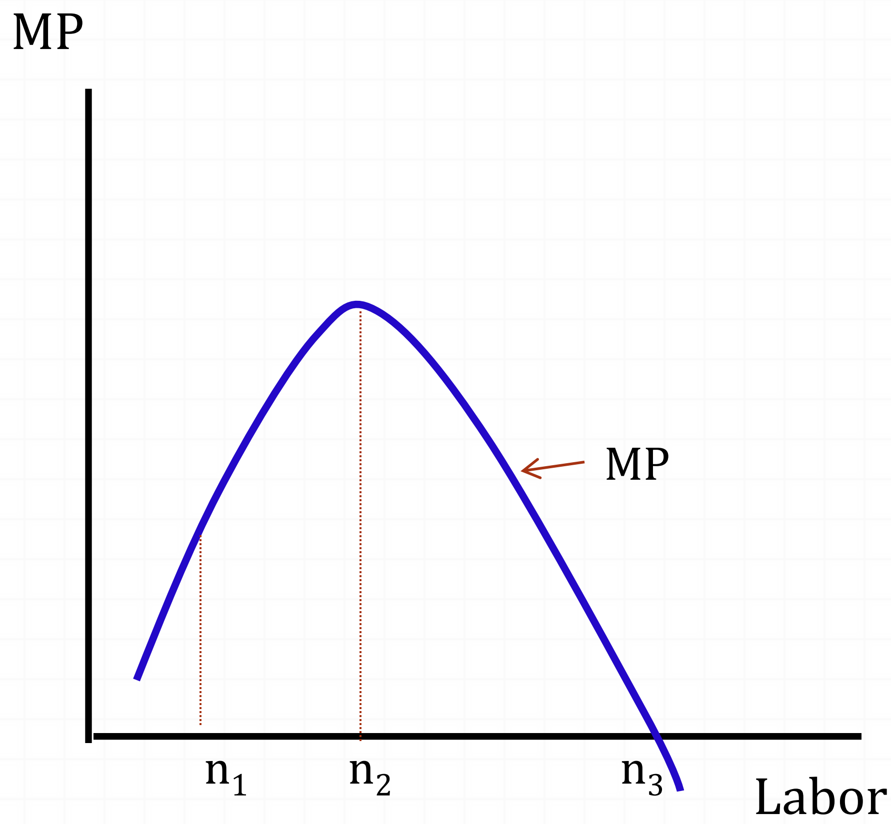
Marginal Product

- Economists are concerned about efficiency and optimization.
  - How much output is generated by each additional unit of an input
  - Want to know *how much input to buy*
- Marginal product measures the amount of output (q) increased from using an additional unit of input (L).
  - MP is the slope of the production function.

$$MP_L = \frac{\Delta \text{Output}}{\Delta \text{Labor Input}} = \frac{\Delta q}{\Delta L}$$

Marginal Product Curve



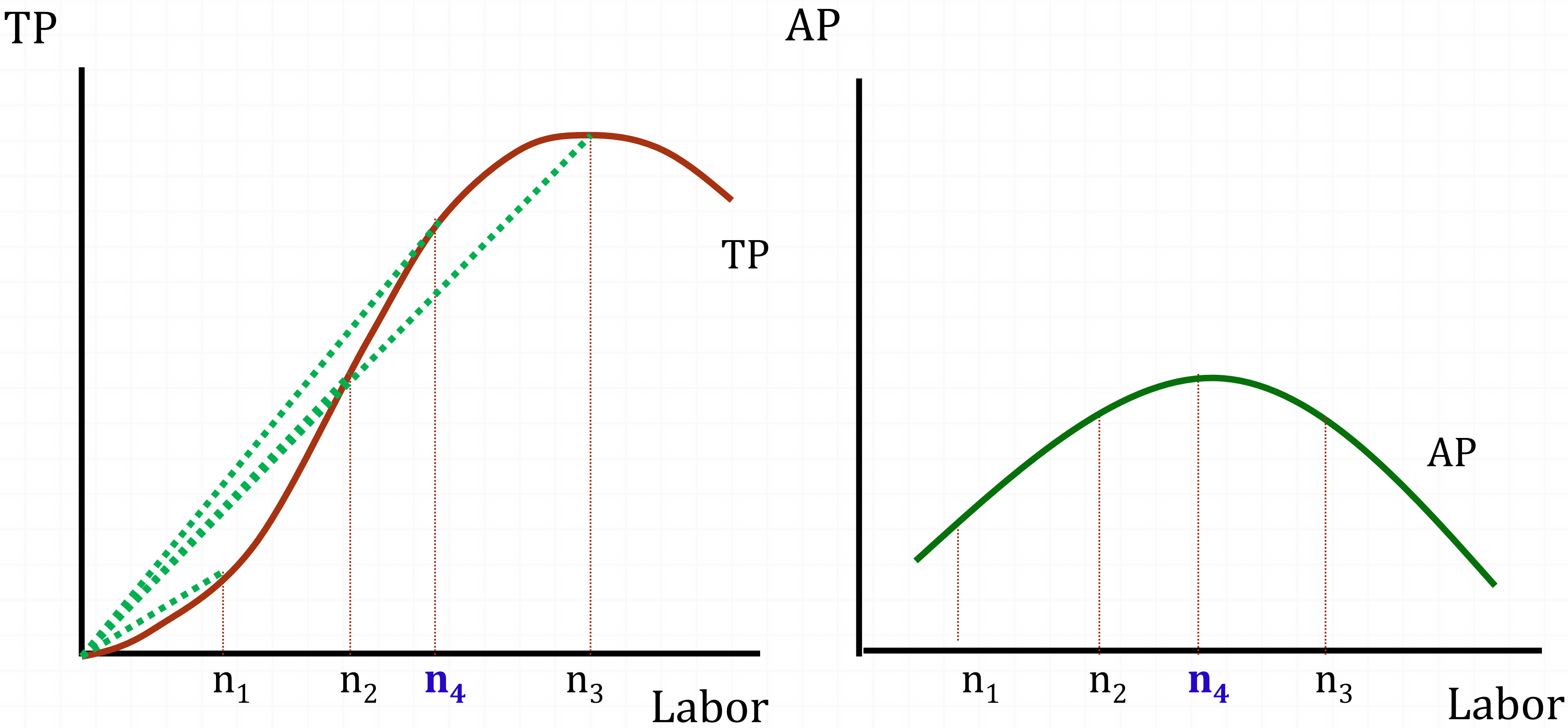


Average Product

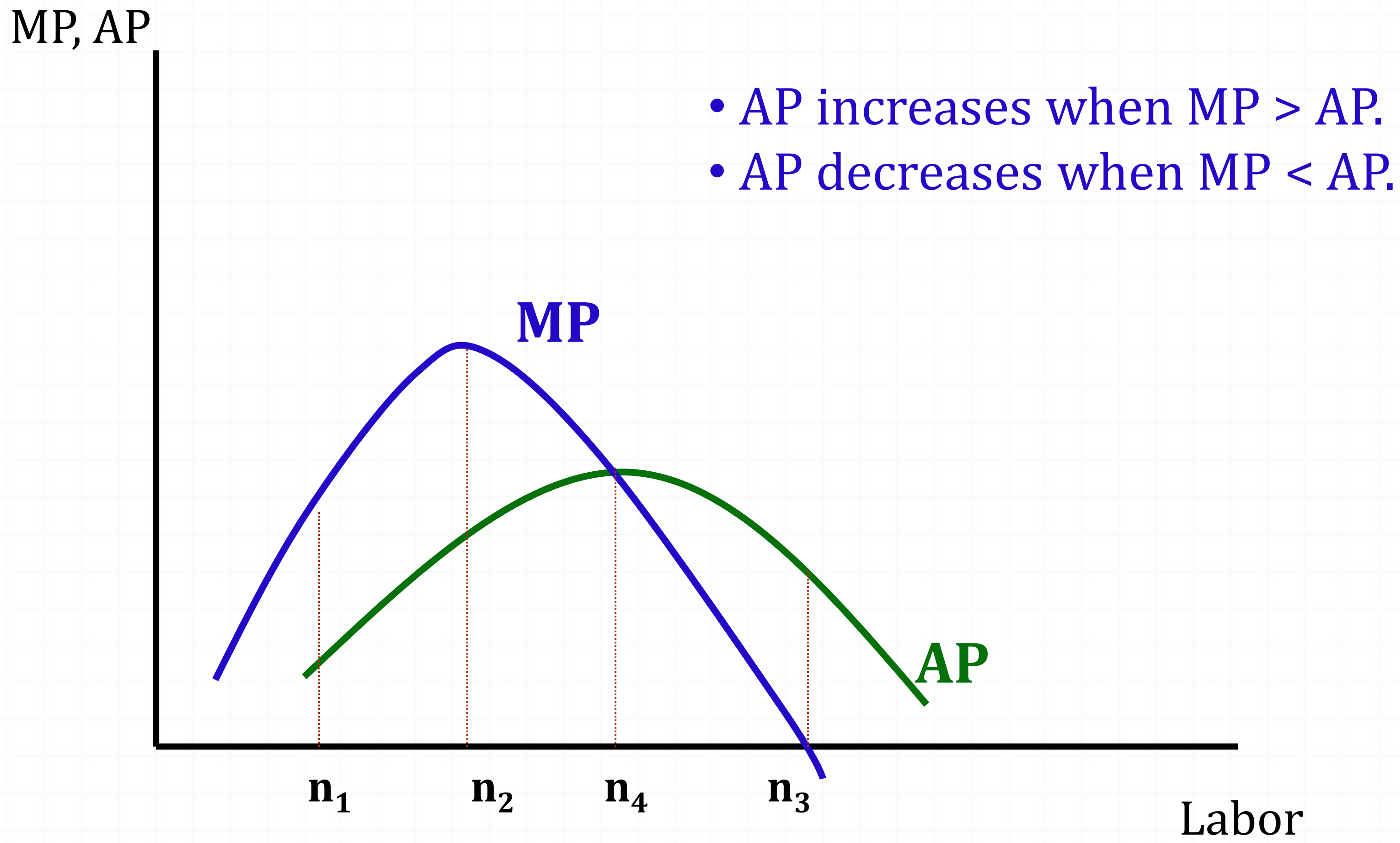
- The average product (AP) is the amount of output that is produced on average per unit of input.
  - AP varies with the level of input.
  - AP is the slope of a ray from the origin to a point on the production function.

$$AP_L = \frac{\text{Output}}{\text{Labor Input}} = \frac{q}{L}$$

Average Product Curve



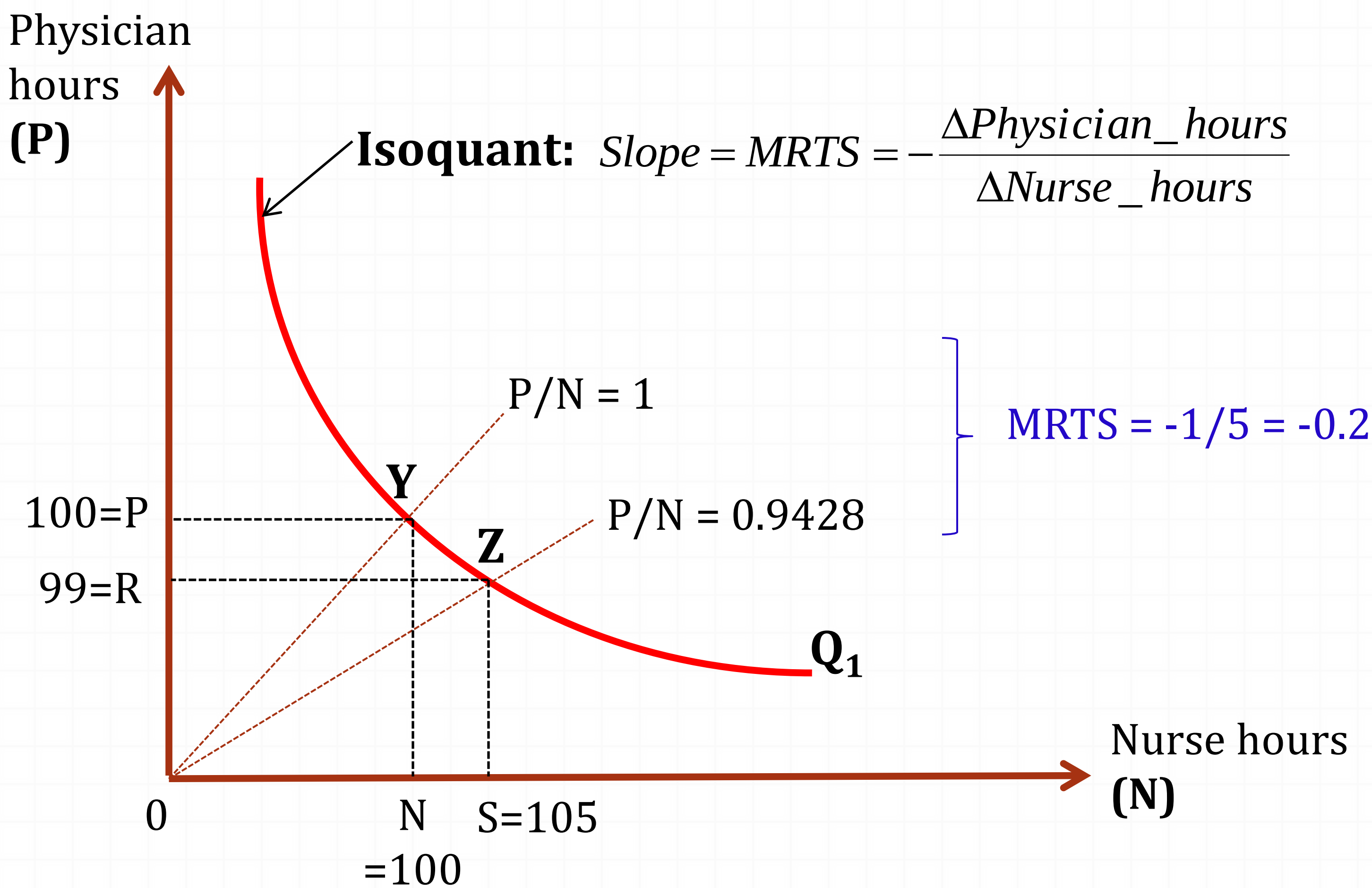
MP and AP Curves



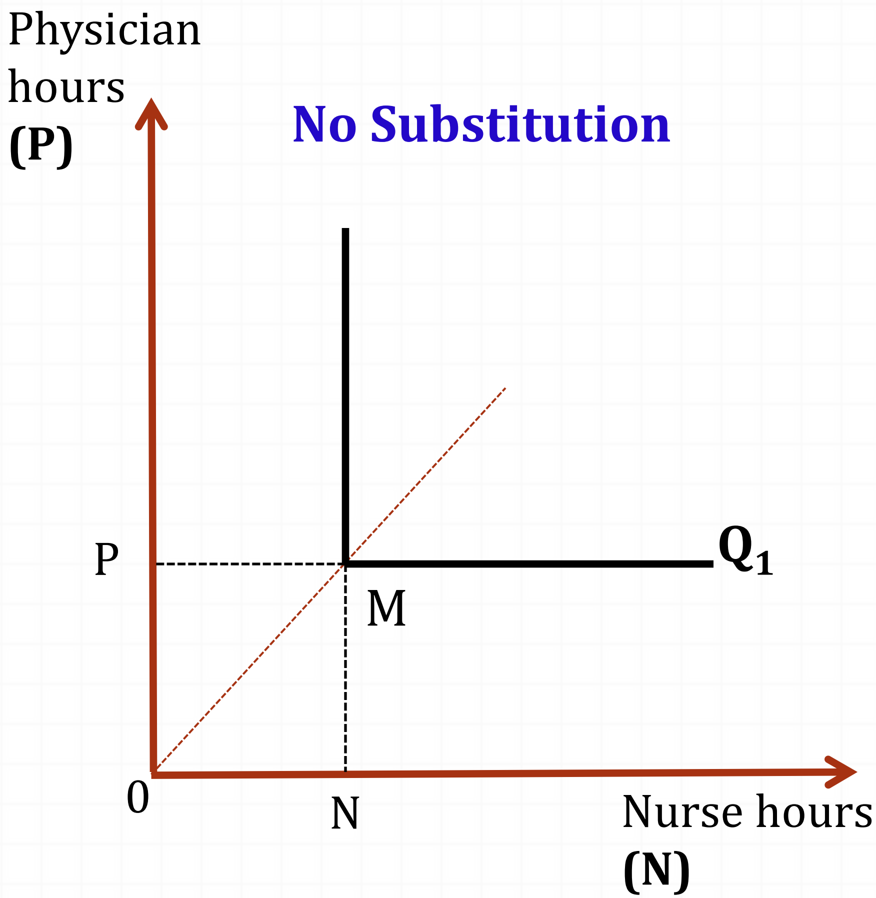
Possibilities for Substitution

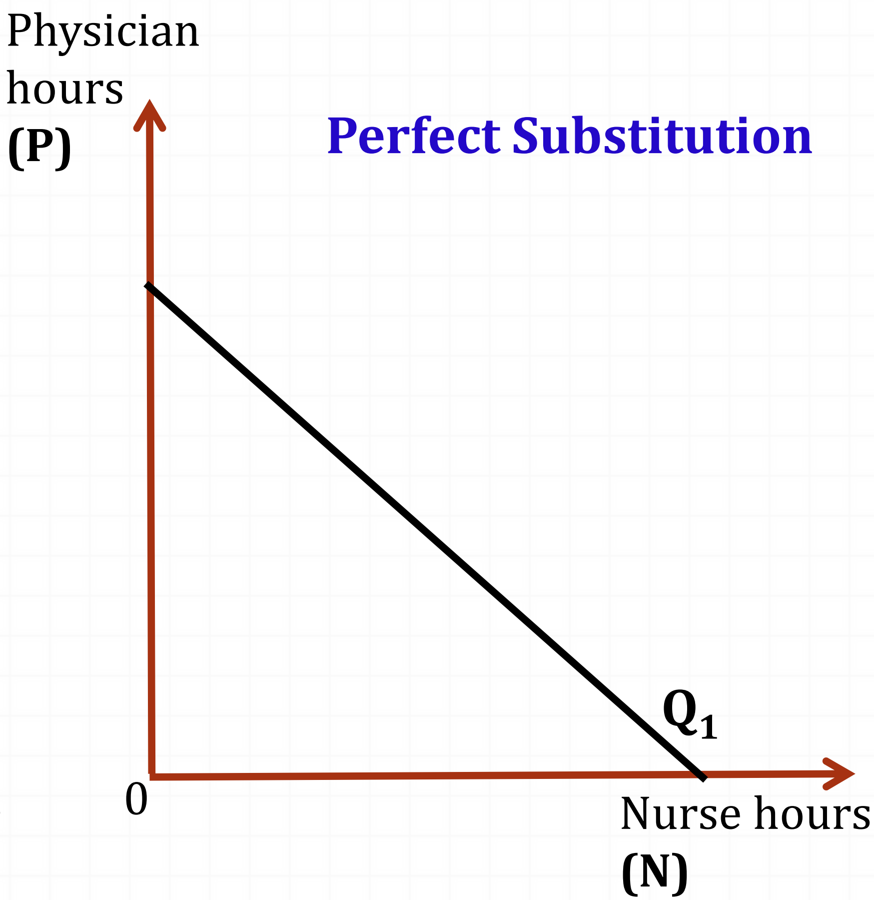
- Now, consider the production with *more than two variable inputs* (e.g. physicians and nurses) in the short run.
- We are interested in the ability to substitute one input (e.g. physicians) for another input (e.g. nurses) while maintaining the level of output.
- The degree to which one input can be replaced by another input, while output remains constant, is measured by the *slope of the isoquant*, which is equal to the marginal rate of technical substitution (MRTS).

Substitution between Physicians and Nurses



Substitution: Extreme Cases





Question: Would these two cases be possible in the real world?

Elasticities of Input Substitution

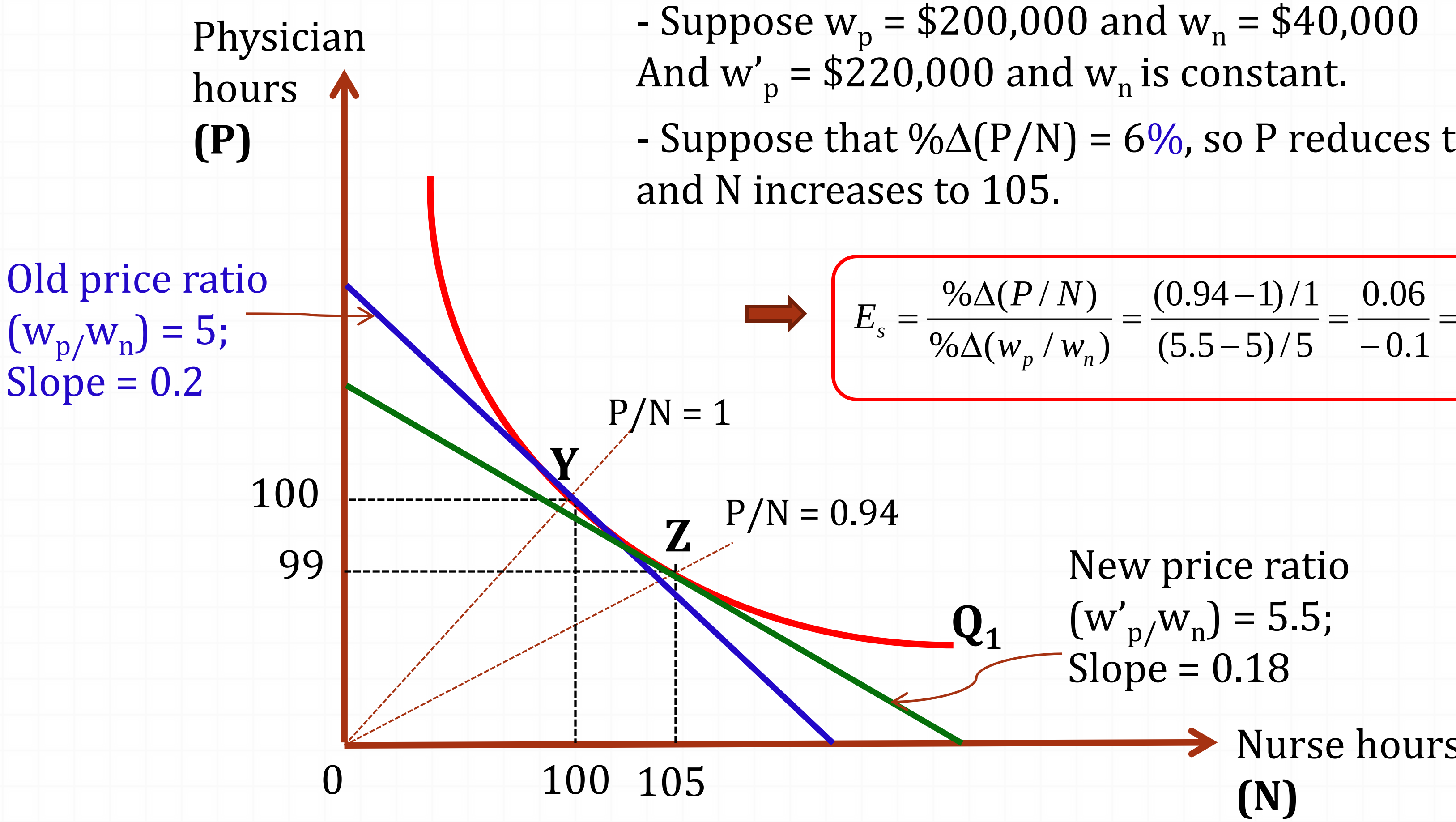
- If an input price changes, a cost-minimizing firm would respond by shifting away from the *costlier* input to the *cheaper* input.
- The new input combination is determined by the elasticity of substitution of inputs.
- The elasticity of substitution (E_S) measures the responsiveness of a cost-minimizing firm to changes in relative input prices:

$$E_s = \frac{\text{Percentage change in factor input ratio}}{\text{Percentage change in factor price ratio}}$$

Substitution between Physicians and Nurses

- Suppose w_p = \$200,000 and w_n = \$40,000
And w'_p = \$220,000 and w_n is constant.
- Suppose that $\%\Delta(P/N)$ = 6%, so P reduces to 99 and N increases to 105.

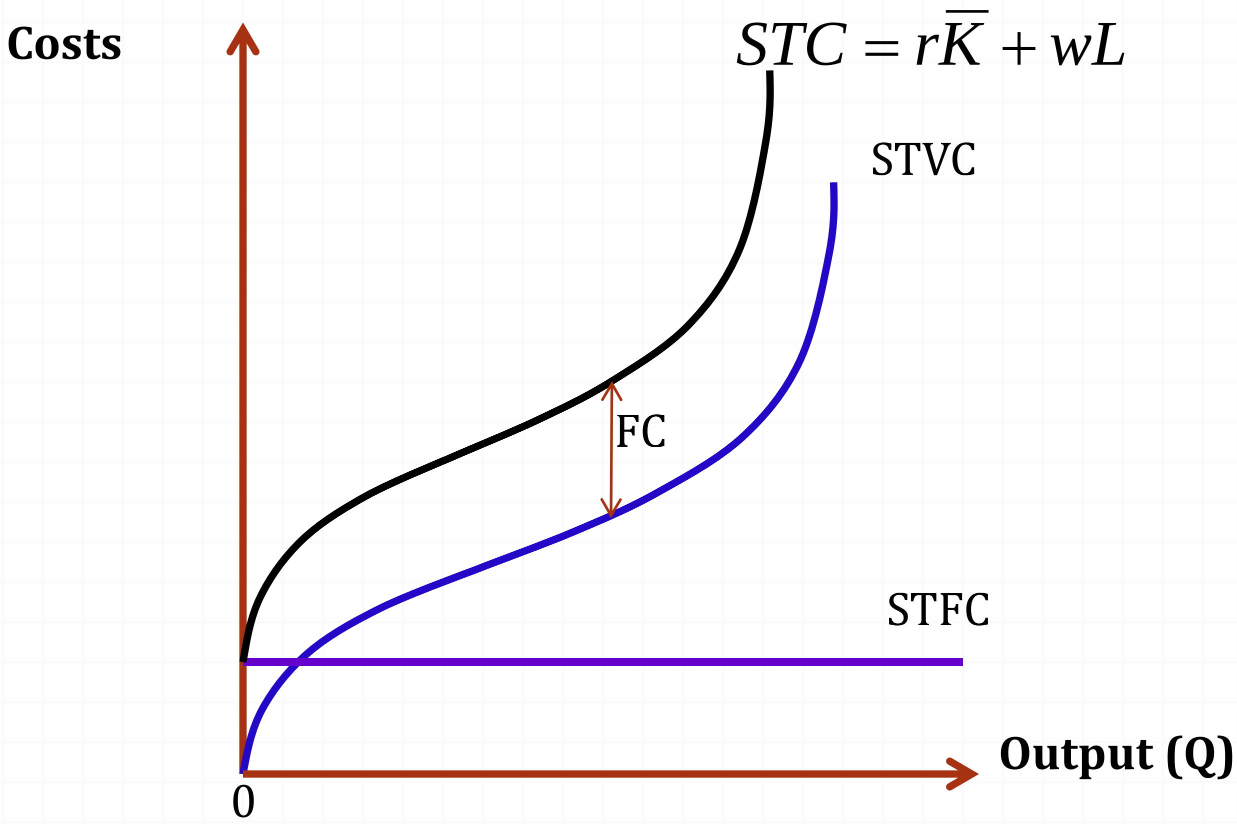
$$E_s = \frac{\%\Delta(P/N)}{\%\Delta(w_p/w_n)} = \frac{(0.94-1)/1}{(5.5-5)/5} = \frac{0.06}{-0.1} = -0.6$$



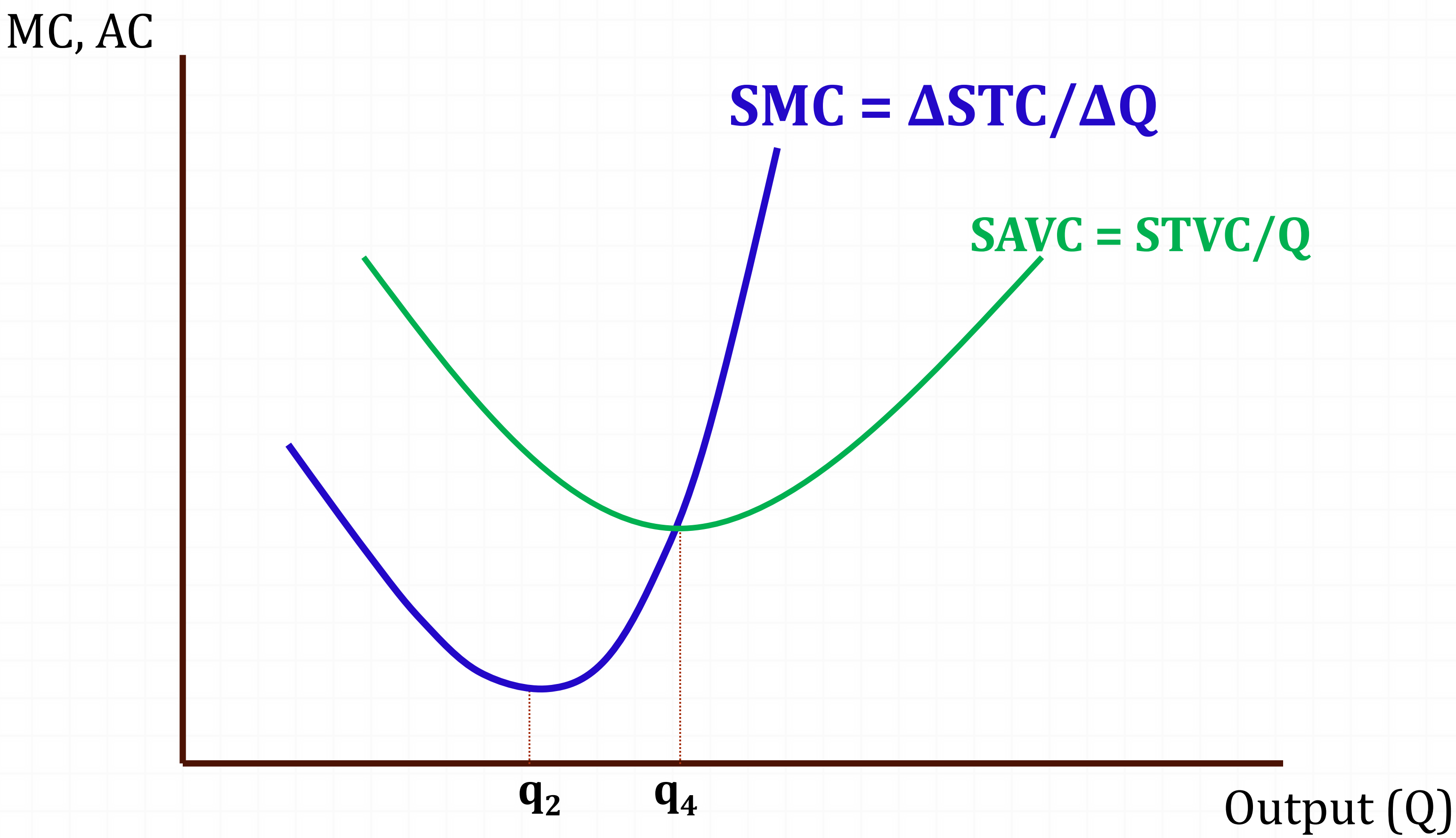
Input Substitution: Application

- The absolute values of E_s range between 0 and ∞.
  - $E_s = 0$ ➔ No substitutability
  - Larger E_s ➔ Greater potential for substitutability
- The concept of input substitution can be applied particularly to the *long-run production*, where all inputs are flexible.
- Other examples of input substitution:
  - Substitution between health workers and new technology
  - Substitution between local physicians and foreign physicians (Think about AEC integration in 2015!)

Short-Run Cost Curve

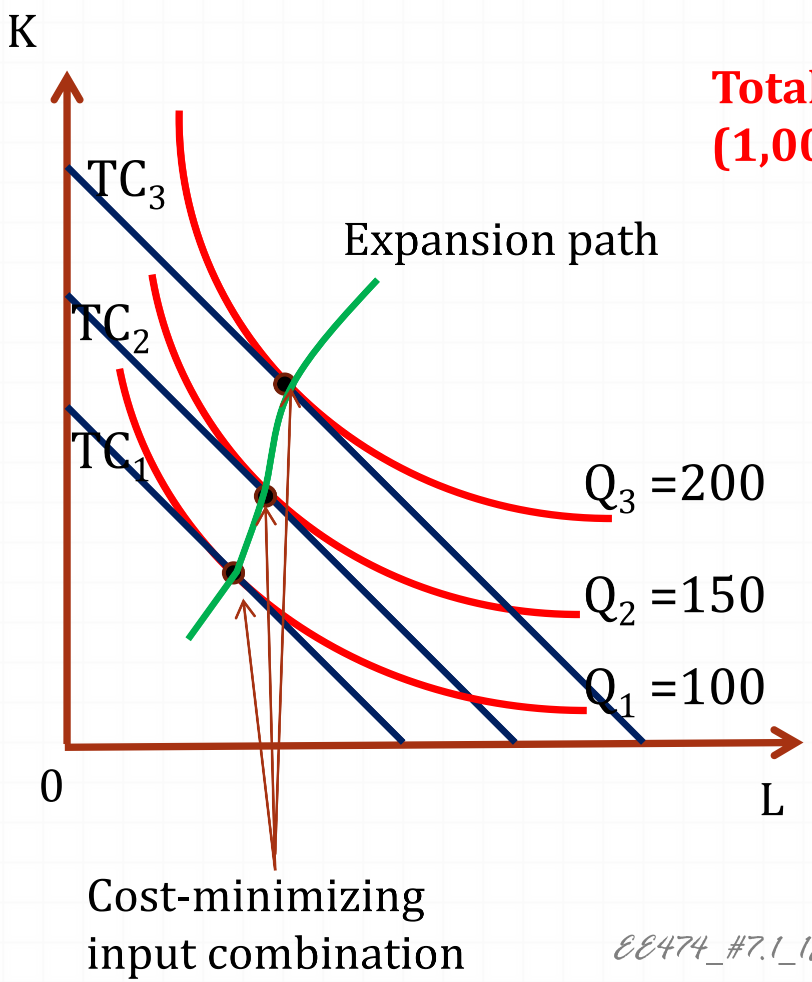


Marginal Cost and Average Cost

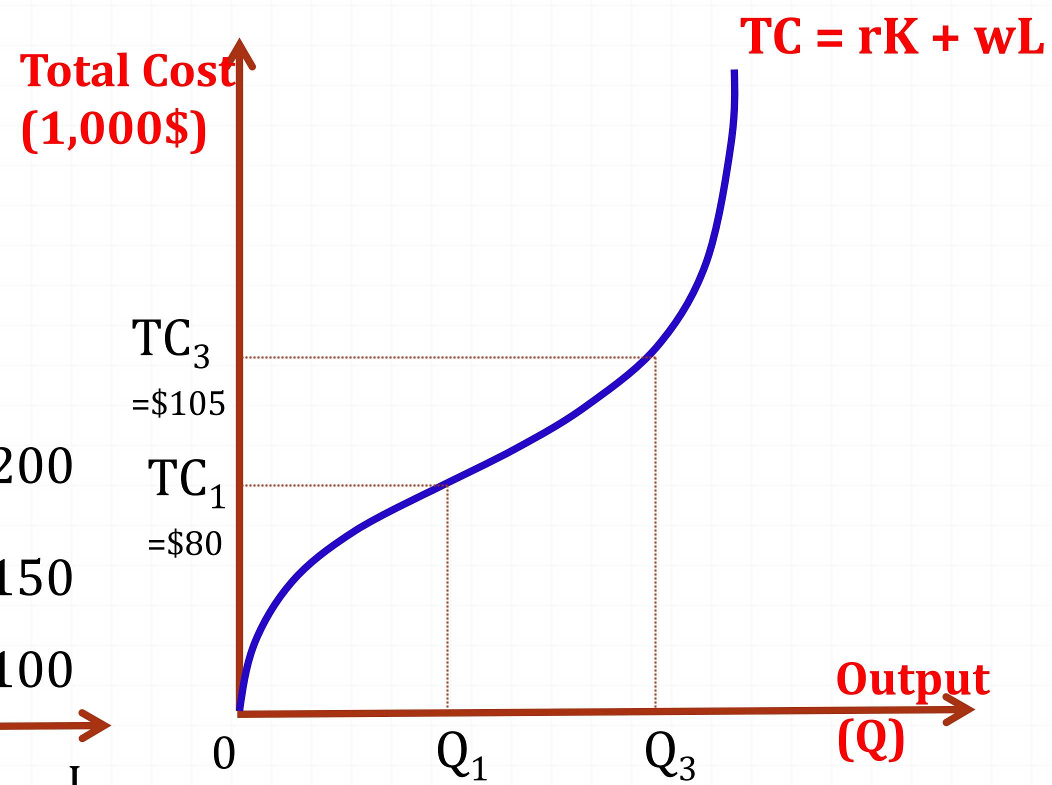


Long-Run Cost Function

Production Isoquants



Total Cost Function



Cost Minimization

- Hospital's objective:

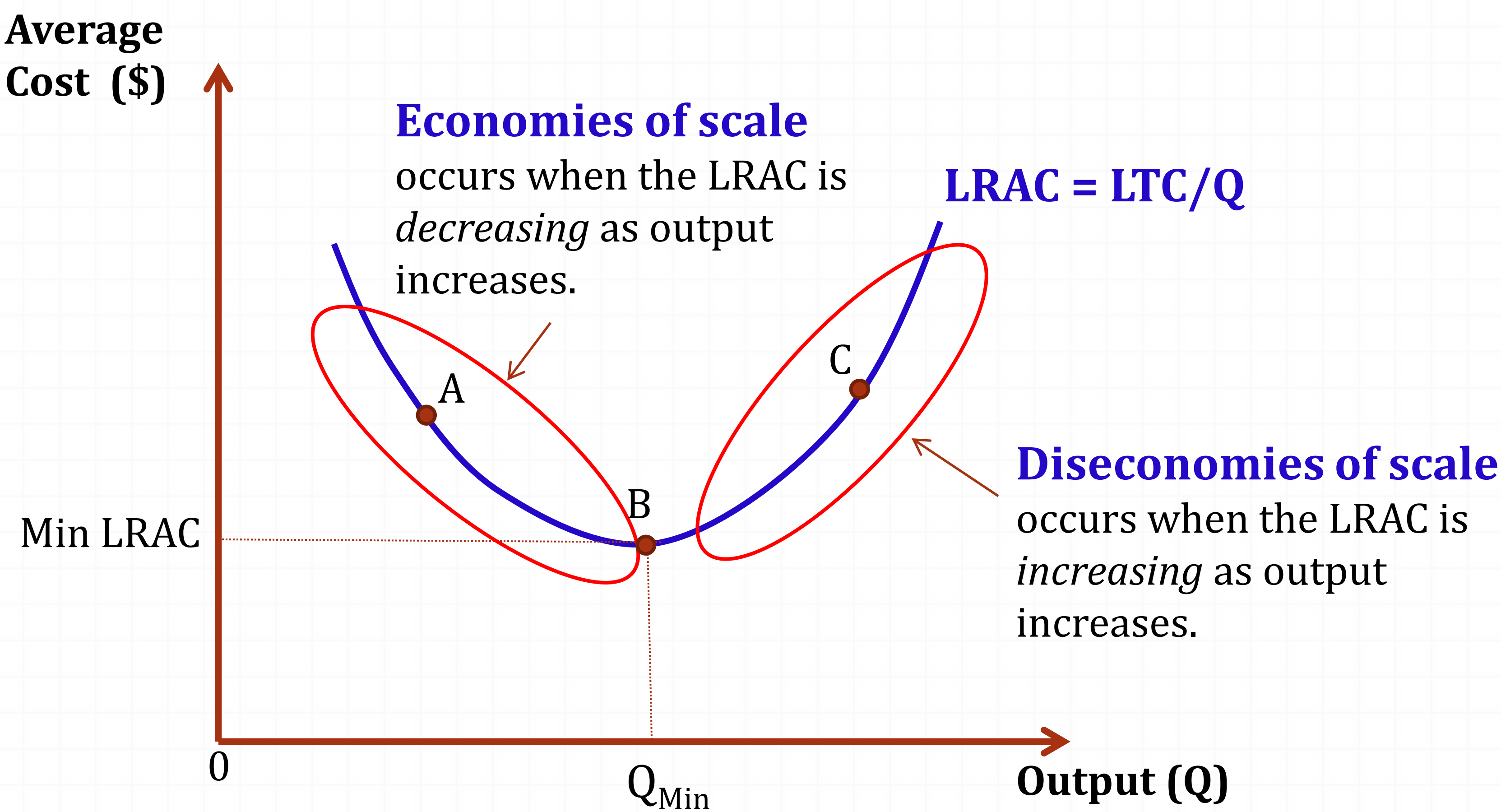
  Min $TC = rK + wL$

  Subject to $Q^* = Q(K,L)$

  ➔ (K^*,L^*) is the input combination that gives the least cost at a given output level.

- The set of all possible points of tangency between the isocost curves and the isoquants is called the expansion path.
  - Tells the relationship between a given output level and its minimum cost.

Economies of Scale



Economies of Scope

- Definition:

  For a multiproduct firm, economies of scope occur whenever it is possible to produce two or more goods jointly more cheaply than they can be produced separately.

- Mathematically, suppose a firm has 2 outputs Q_1 and Q_2. Economies of scope exists if:

$$\mathbf{TC(Q_1,Q_2) > TC(Q_1,0) + TC(0,Q_2)}$$

where $TC\ (Q_1,Q_2)$ = the joint cost of producing both outputs together

$TC\ (Q_1,0)$ = the cost of producing output 1 only

$TC\ (0,Q_2)$ = the cost of producing output 2 only

Significance of Economies of Scale and Scope

- Both concepts can provide implications to public policy and to managerial policy.
- Economies of scale:
  - Profit-maximizing firm
    - Prefers to produce where AC is still decreasing
  - Society's perspective
    - Prefers lowest average costs (not necessary where it max π)
- Economies of scope:
  - Provision of different departments in the same hospital
  - Subsidization in teaching hospitals

Empirical Cost-Function Studies

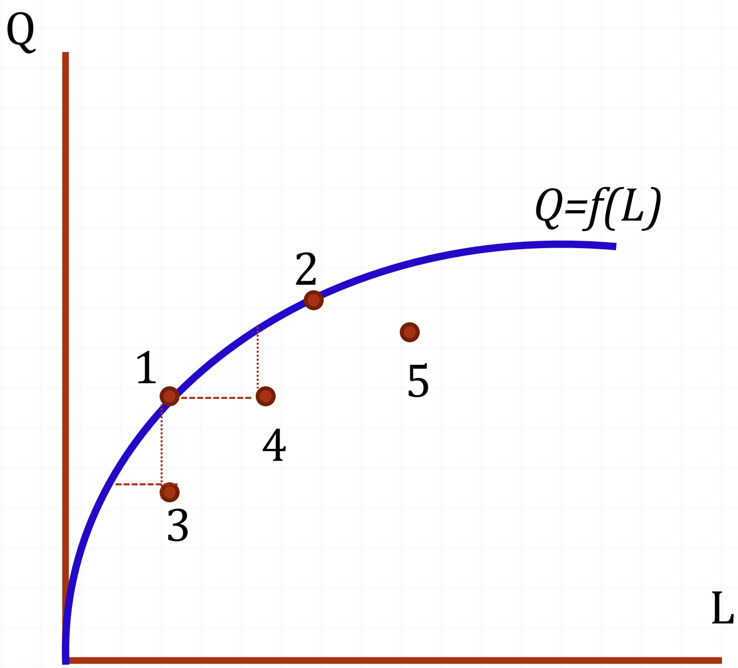
- "Structural" vs. "Behavioral" cost functions
  - Structural cost functions
    - Use production isoquants and isocost to estimate cost functions
  - Behavioral cost functions
    - Use other variables, e.g. teaching hospitals, to describe cost difference across different hospitals
- Challenges in conducting hospital cost studies
  - Case-mix problem
  - Treatment of quality
  - Lack reliable measures of hospital input prices
  - Problems with physicians' input prices

Efficiency

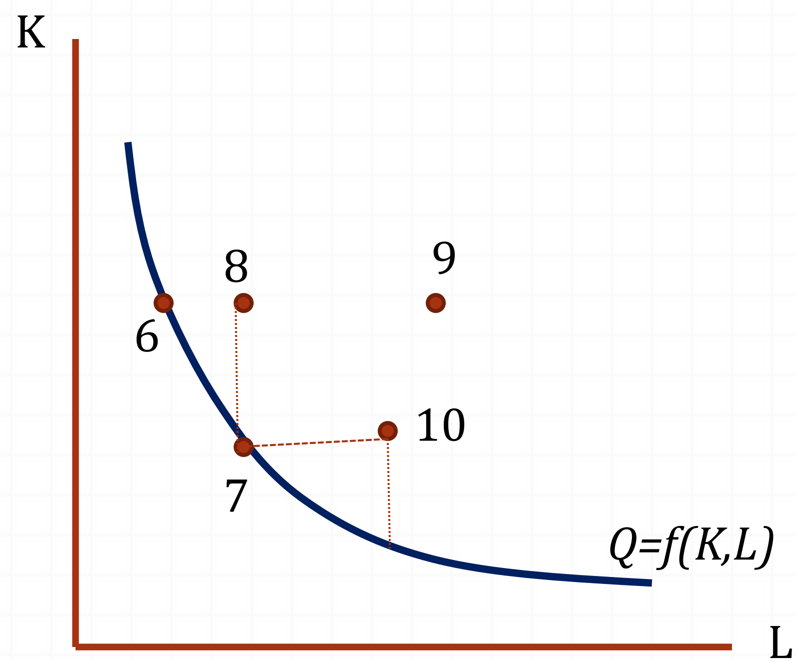
- Technical efficiency
  - Applies to production within a given firm
  - Technical efficiency is achieved when a maximum output is being produced from a given input combination.
- Allocative efficiency
  - Requires the efficient allocation of inputs between firms and between outputs.
  - Allocative efficiency is achieved when inputs are put into their best uses so that no further gains in output are possible.

Technical Efficiency

- 1 Input



- 2 Inputs



Technical inefficiency results when a firm uses more resources than necessary to produce a given level of output.

Technical and Economic Efficiencies

Technology	K	L
A	3	4
B	4	2
C	3	3

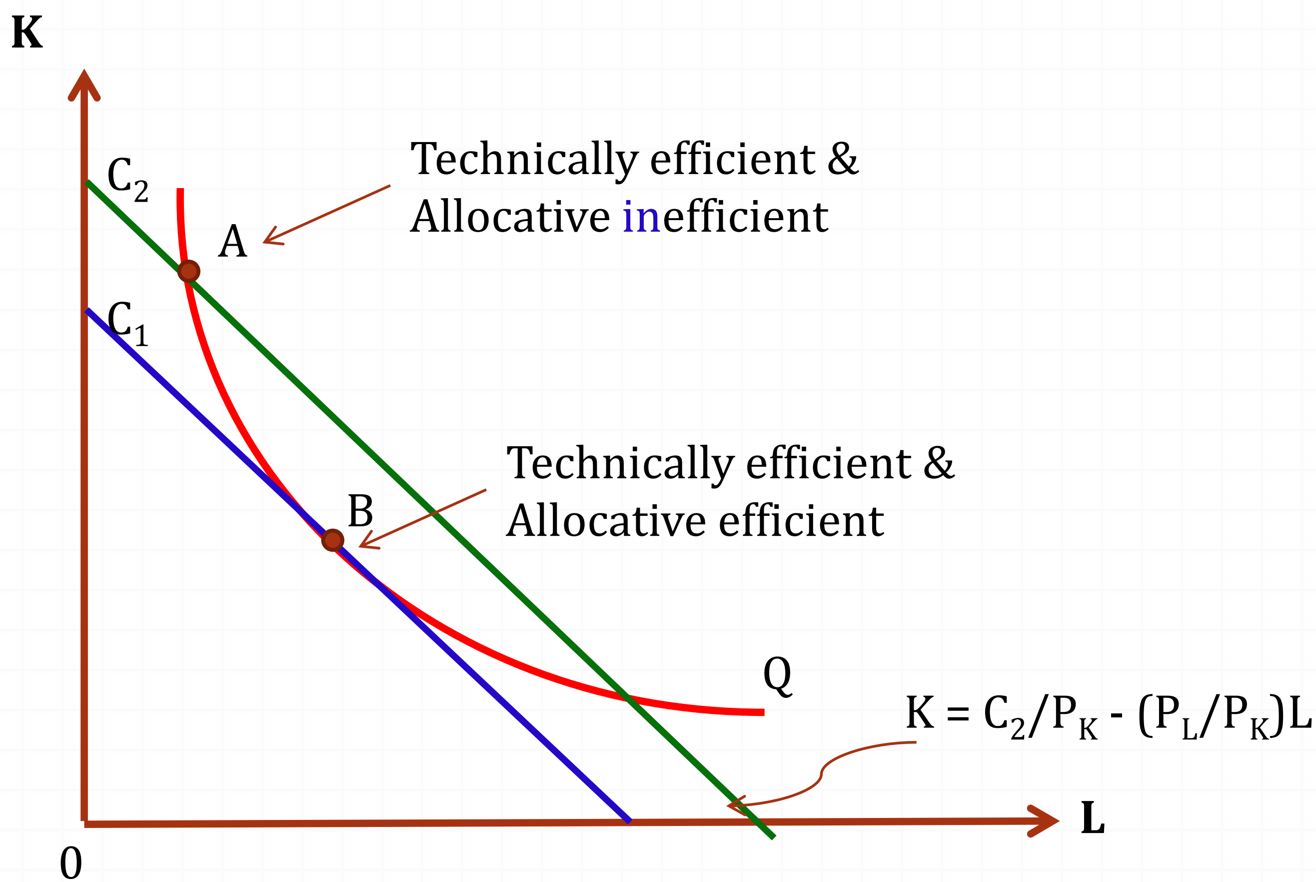
- Which technology is technically inefficient?
  - Technology A.
- Which technology is allocative inefficient?
  - We can't tell whether B or C costs less until we have prices.

Technical and Economic Efficiencies

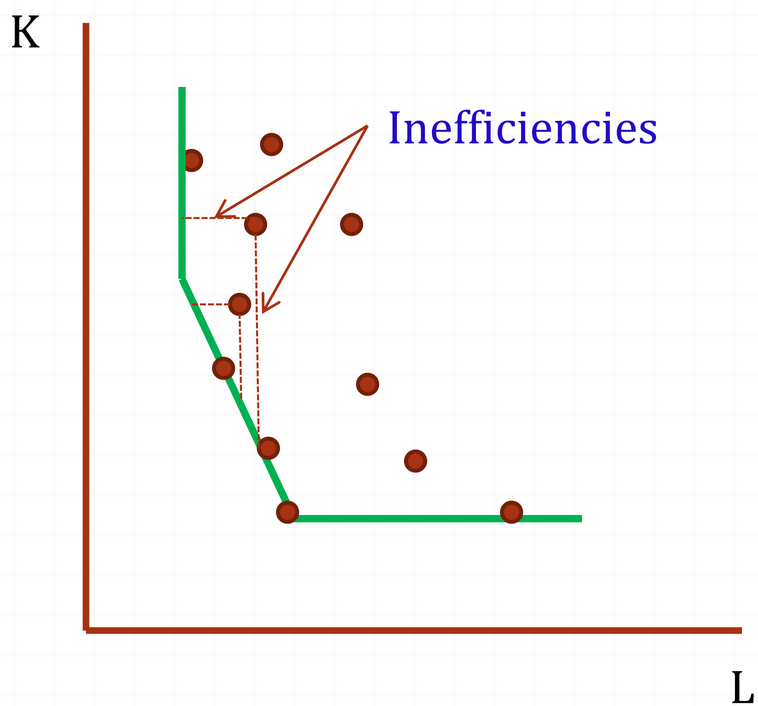
Technology	K	L	Cost (if P_K=10, P_L=5)
A	3	4	$50
B	4	2	$50
C	3	3	$45

- Suppose P_K = 10 and P_L = 5, which technology is allocatively efficient?

Allocative Efficiency

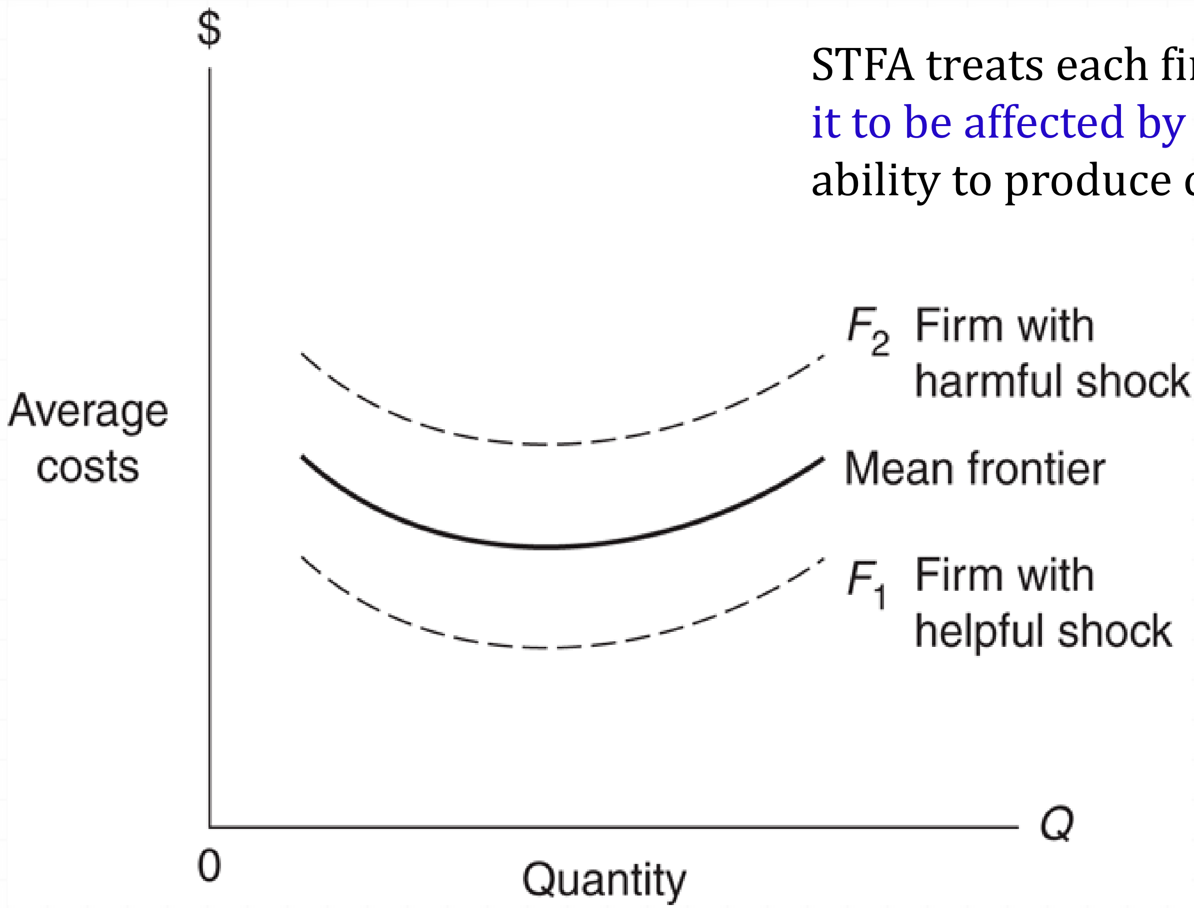


Frontier Analysis: Data Envelope Analysis



The Data Envelope Analysis (DEA) identifies the efficient outer shell enveloping the data.

Frontier Analysis: Stochastic Frontier Analysis (STFA)



STFA treats each firm uniquely by assuming it to be affected by a potential shock to its ability to produce care.

Case Study: Efficiency of Public Hospitals in Thailand (Patamasiriwat, 2011)

- Examined cost efficiency of 3 different types of public hospitals in Thailand
- 2 Methods: DEA and STFA
- Finding:
  - An average efficiency score for the regional hospitals were found to be 94%, compared with 64% for provincial hospitals, and 81% for community hospitals
  - There were signs of resource underutilization.