

The Production, Cost and Technology of Health Care

Chapter 6

Chapter Outline

- Production and the Possibilities for Substitution
- Costs in Theory and Practice
- Technical and Allocative Inefficiency
- Conclusions

Background

- Health is the ultimate output in the healthcare sector
- Policy interest is often directed at the production and costs of intermediate output, healthcare, which is (or can be) used to produce health
- Firms in healthcare are generally hospitals, but can also refer to individual physicians

Policy Relevance

- From a policy perspective a few issues are of relevance
 - To what degree can healthcare inputs be substituted?
 - Do physicians do everything or can nurses be more involved?
 - What is the efficient size of the healthcare firm?
 - Technical and allocative efficiency of healthcare firms

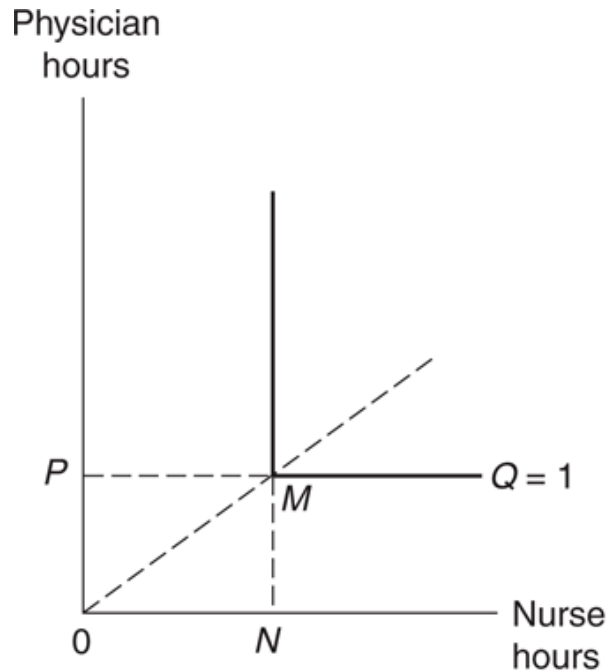
PRODUCTION AND THE POSSIBILITIES FOR SUBSTITUTION

What is Meant by Substitution?

- Flexibility in production means that there are some opportunities to substitute one input, say capital, for another, say labor, while maintaining the level and quality of output.
- Substitution does not mean that two inputs are equivalent, but that an output can be produced with different techniques or recipes.

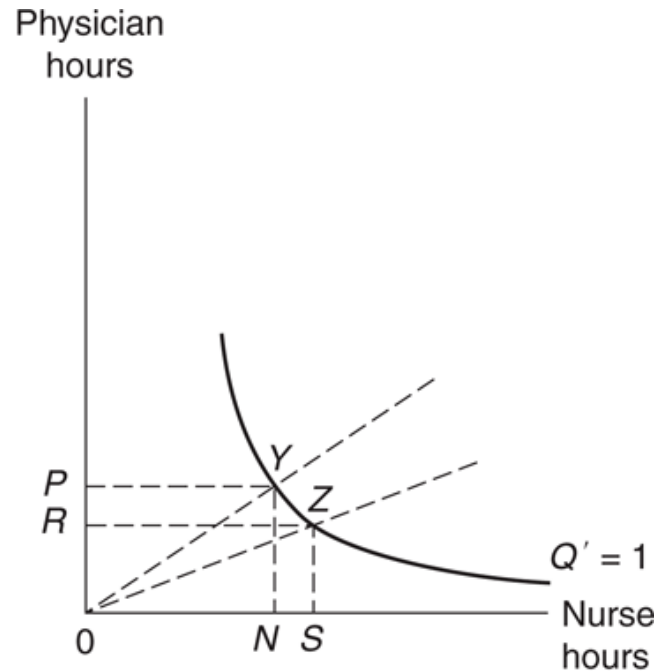
The Theory

Figure 6-1 Degree of Substitution Between Physicians and Nurses



A. No Substitution

No substitution possible between physician and nurses hours. (Leontief technology)



B. Considerable Substitution

Substitution possible between physician and nurses hours. (Cobb Douglas technology)

- The slope of the isoquant is the Marginal Rate of Technical Substitution (MRTS) and represents the rate at which nurse and physician hours can be exchanged while still maintaining output.
 - The rate of substitution varies along the isoquant; at Y to replace 1 unit of physician input requires some number of nurse inputs; at Z to replace 1 unit of physician input requires more nurse inputs

- This implies that physician inputs are more scarce relative to nurse inputs, so physicians are becoming harder to replace
 - This could reflect that nurses are not properly trained to do everything a physician can do, so you need some physicians to do some things (e.g., surgery)
 - If the isoquant becomes flat at a certain point, then there is a minimum input of physicians that you need, so here substitution possibilities go to zero.

What Does the Research Suggest?

- The work done by economists suggests that substitution possibilities could be substantial. Depending on the number of physician hours employed, one physician extender could substitute for 25 percent to more than 50 percent of a physician's services
- For example, physician extenders/assistants, in 2009, 70,000 in the U.S., 140 in Canada; The University of Toronto, graduated its first class of physician assistants in 2013.

Recent Developments: More Technology

- Robots to assist with some types of surgery; can improve quality of surgery (less invasive, fewer complications, e.g. infections from wounds)
- Telehealth/ehealth/cloud based health care, physicians can provide some services (consultations) via video conferencing or via phone.
- AI image recognition; Generative AI/LLM; customized chatbots to discuss health and medical problems

Elasticity of Substitution

- The elasticity of substitution (E_S), which measures the responsiveness of a cost-minimizing firm to changes in relative input prices.

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

What does the elasticity of substitution mean?

- If a firm, like a hospital, were a cost minimizer, then it would be responsive to changes in input prices, and it would tend to respond by shifting away from the now costlier input to the now relatively cheaper input. For example, if physician salaries increased relative to nurses salaries, then we would observe hospitals substituting nurses for physicians.

Empirical Evidence for Input Substitution in Hospitals

Table 6-1 Substitution Elasticities for Teaching and Nonteaching Hospitals Evaluated at the Mean

Input Pair	Nonteaching Case-Mix Adjusted Admissions	Teaching Case-Mix Adjusted Admissions
1. Medical Staff with Nurses	0.547	0.159
2. Medical Staff with Beds	0.175	0.155
3. Nurses with Beds	0.124	0.211
4. Nurses with Residents	—	2.127
5. Medical Staff with Residents	—	0.292

Source: Gail A. Jensen and Michael A. Morrisey, "The Role of Physicians in Hospital Production," *The Review of Economics and Statistics* 68:3 (August 1986), pp. 432-442. Copyright © 1986 by the President and Fellows of Harvard College and the Massachusetts Institute of Technology, with permission.

Teaching versus non-Teaching Hospitals

- In the hospital sector there is a distinction between teaching and non-teaching hospitals
- Medical training has a very practical component to it, so doctors need to get some practical experience
- This practical experience is obtained in teaching hospitals where medical students (residents) work with doctors who train them

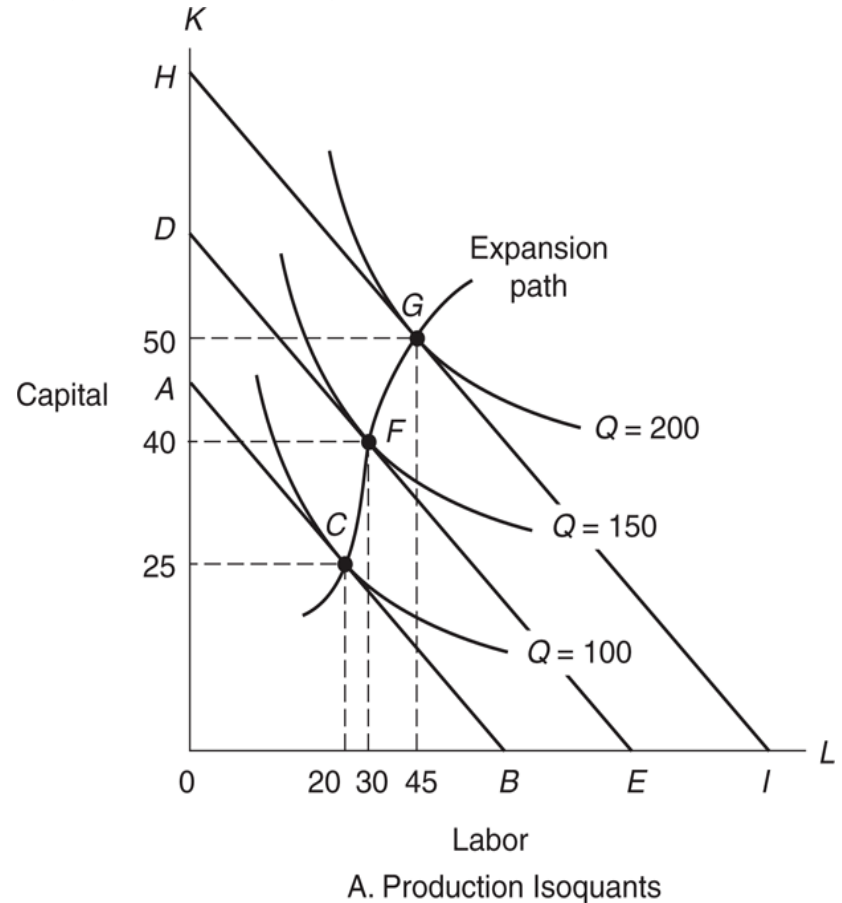
- When a medical student is relatively new, there are not very productive; however, the more advanced residents are fully trained and can pretty much do everything a licensed physician can do.
- The new residents are being trained can be viewed as unproductive inputs, but because they need to be trained you can't substitute away from them to more productive inputs.

COSTS IN THEORY AND PRACTICE

Deriving the Cost Function

Figure 6-2 Production Function for a Hypothetical Physician Practice

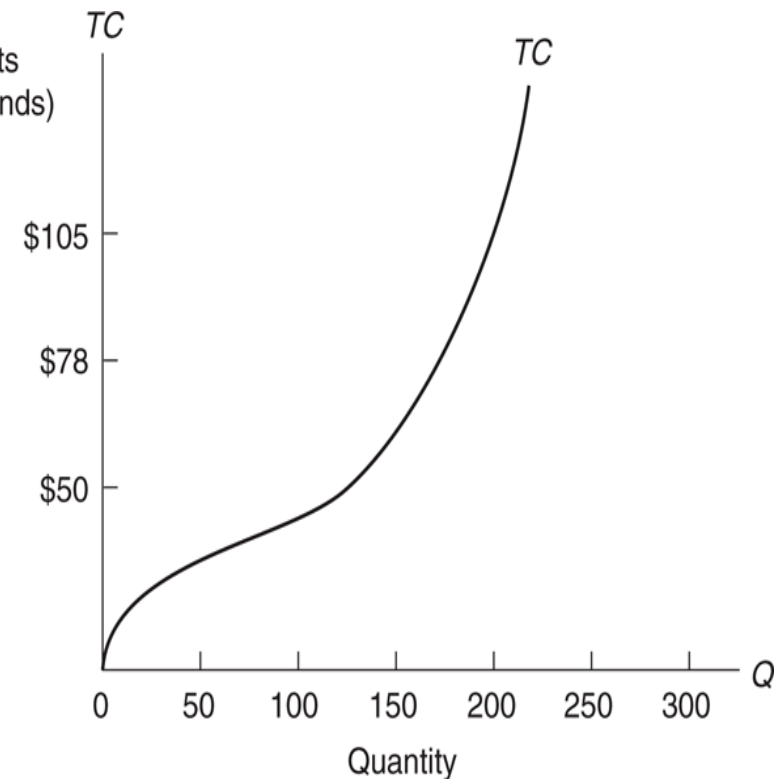
- The expansion path CFG shows the cost-minimizing combinations of capital and labor that can be used to produce 100, 150 and 200 physician office visits, respectively.



Deriving the Cost Function – continued

Figure 6-2 Production Function for a Hypothetical

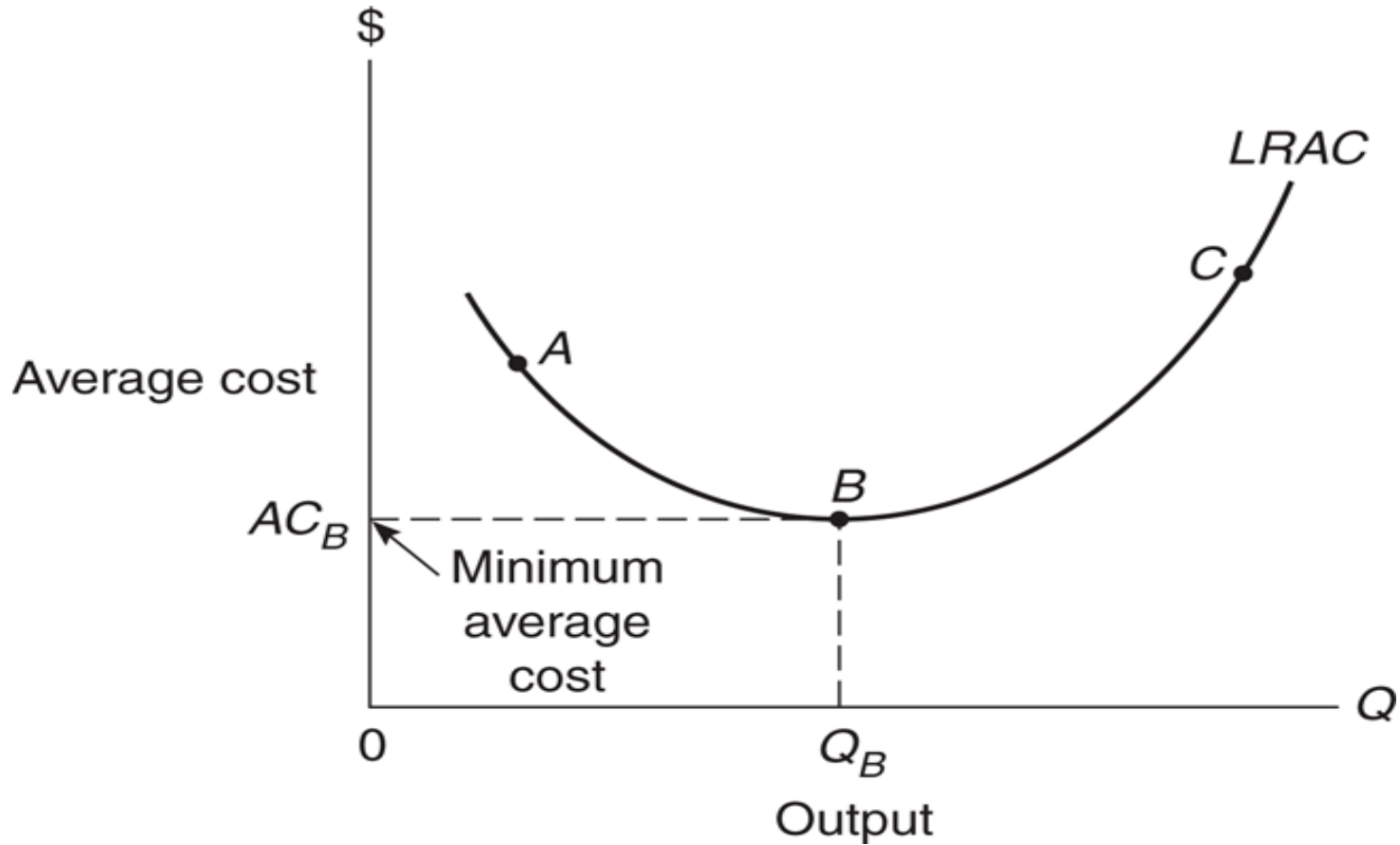
- With prices, given input prices, $r = \$1,200$ and $w = \$1,000$, it can be determined that the cost of producing 100 and 150 physician visits would be \$50,000 and \$78,000, respectively.



B. Derived Total Cost Function

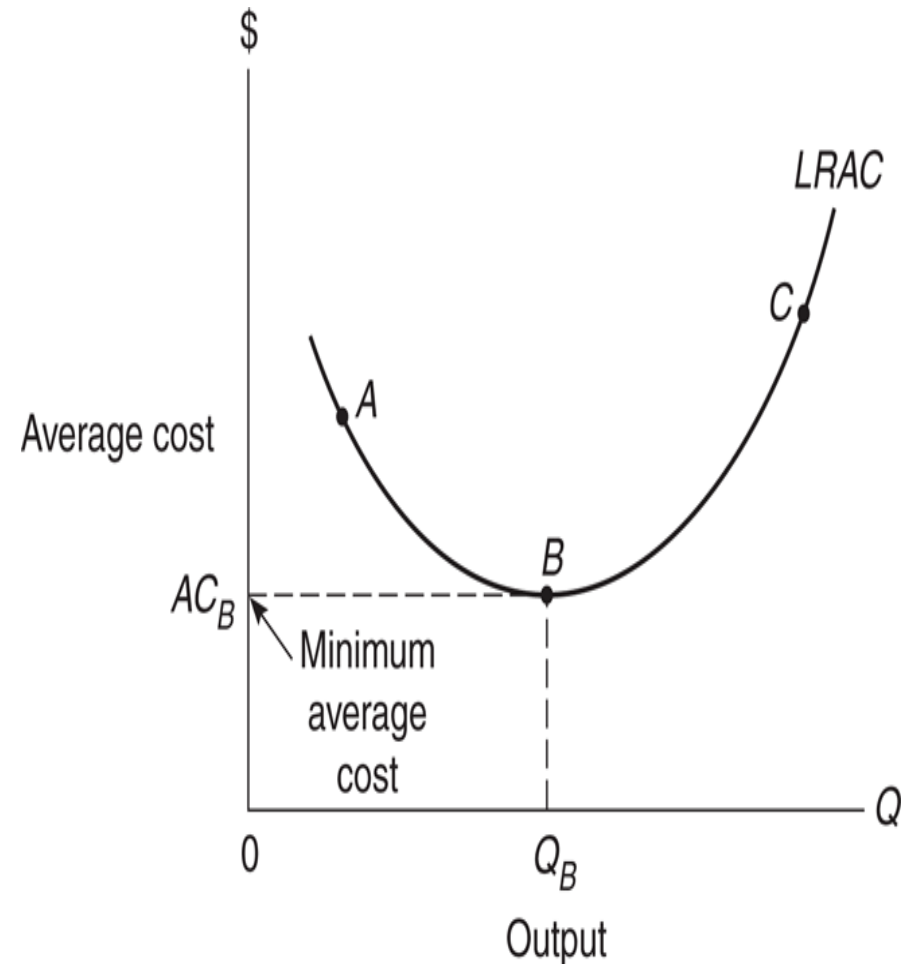
Economies of Scale

Figure 6-3 The Long Run Average



Average Costs and Economies of Scale

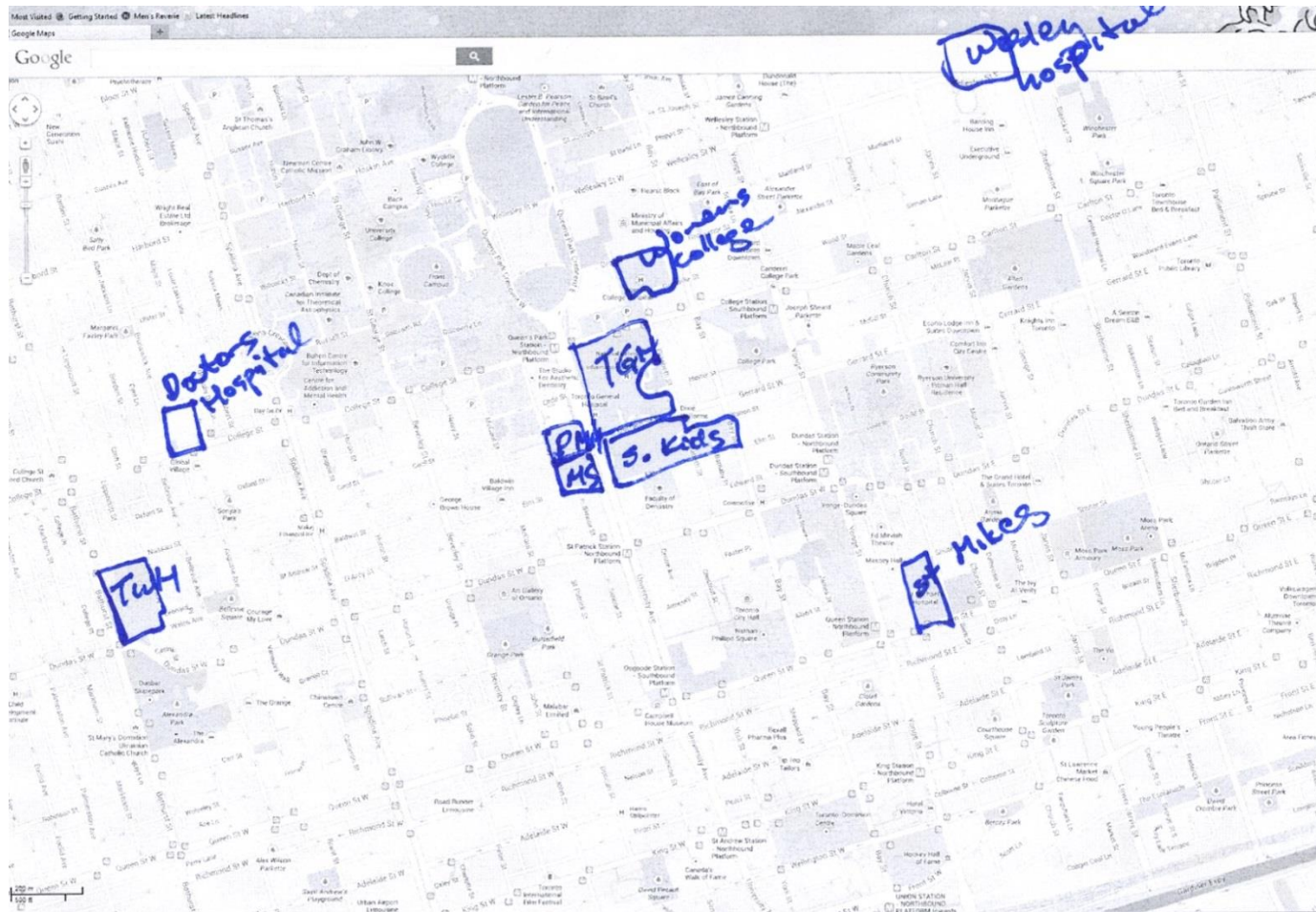
- When long-run average cost falls the firm is said to experience economies of scale and when long-run average cost increases the firm is said to experience diseconomies of scale.



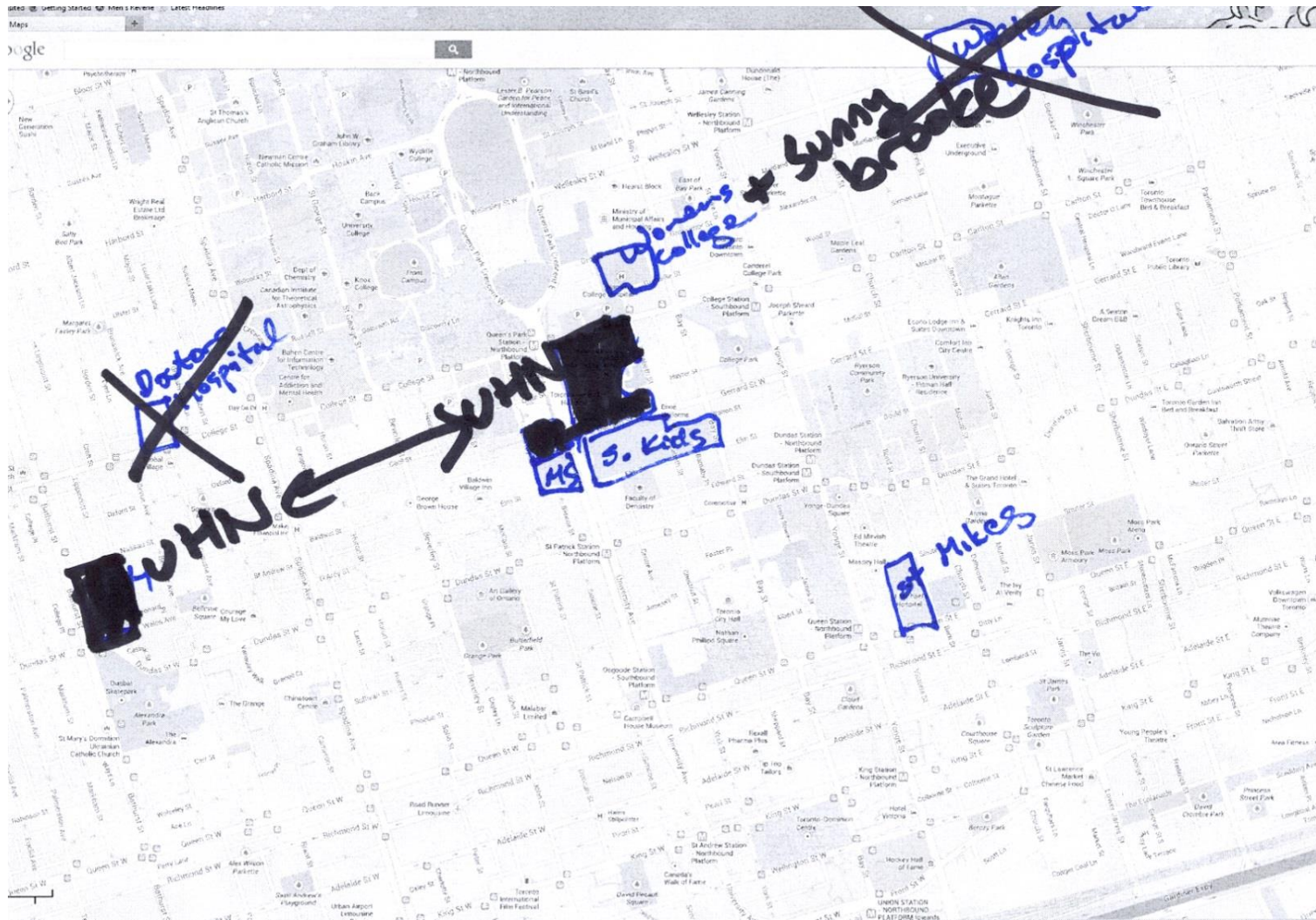
An example of Returns to Scale in Ontario Hospital Sector

- During the early- to mid-1990s the province of Ontario faced a budget crisis as expenditures and government debt increased
- The progressive conservative government led by premier Mike Harris decided to pursue some restructuring and reform in the hospital sector as part of their efforts to reduce government spending.
 - They closed and merged hospitals, especially in Toronto

Policy Implications of Economies of Scale: Hospitals Before Restructuring



Policy Implications of Economies of Scale: Hospitals After Restructuring



Economic Interpretation of Restructuring of Hospital Sector

- The sector might have been at a point like C on the LRAC, i.e., a point where there was decreasing returns to scale, so closing hospitals would have been like moving down the LRAC to a point like B in the diagram
- The merging of hospitals, is also an attempt to save costs, it would be exploiting economies of scope,

Economies of Scope

- By definition, economies of scope are possible only for a multiproduct firm and because many health care firms are multiproduct in nature, the concept is highly relevant. Economies of scope occur whenever it is possible to produce two or more goods jointly more cheaply than they can be produced separately.

Why Would Economies of Scale and Scope Be Important?

- The concepts of economies of scale and scope are of considerable interest to both public policy and to managerial policy.
- Simply put, society gains when firms are big enough to produce at the lowest average cost possible.

How can a hospital generate cost savings?

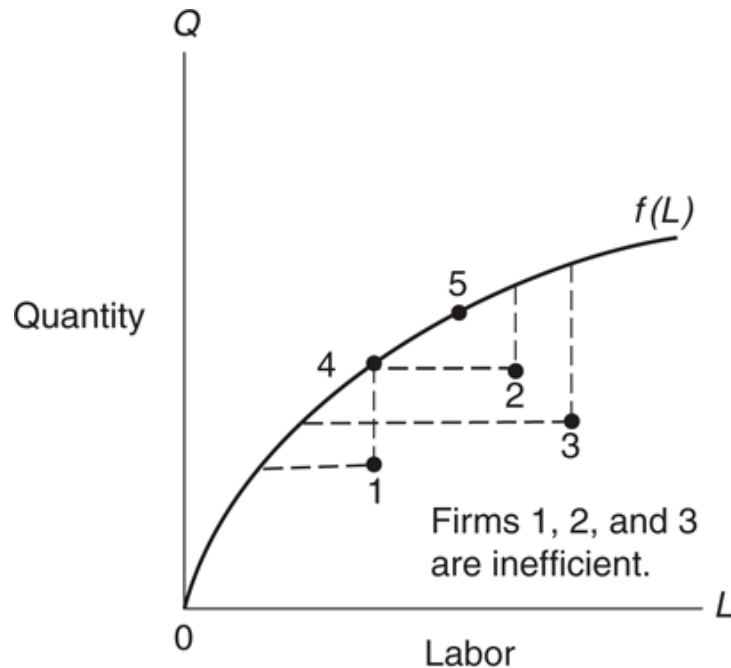
- Some hospitals provide specialized care, e.g., rehabilitation, cancer treatment, others are general hospitals, which provide a wide range of care (i.e., multi-output firms);
- In a general hospital, you could generate cost savings if some of the facilities are idle for part of the week (e.g., some surgeons only perform surgery on one day of the week) so you can get efficiency if you have greater use of existing facilities

How can a hospital generate cost savings?

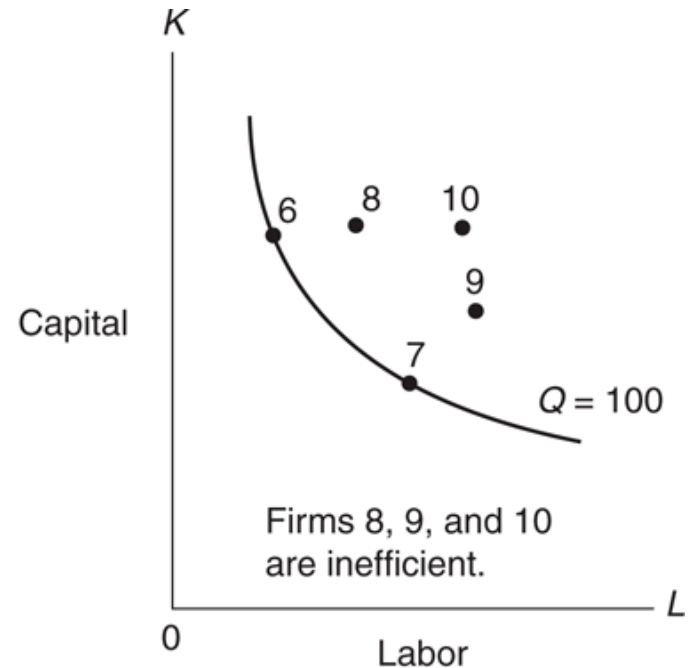
- Another way to generate cost savings in a general hospital is through learning
 - For example, general surgeons develop some laparoscopic surgical techniques, which have quicker recovery times and lower rates of infection, and teach (or bring it to the attention of) other surgeons with other specialities (e.g., orthopedic or urological cancer surgeons) who use it to replace more traditional surgical methods that have longer recovery times and higher rates of infection.

TECHNICAL AND ALLOCATIVE INEFFICIENCY

Figure 6-5 Technical Inefficiency and the Inefficiency at the Firm Level



A. One Input

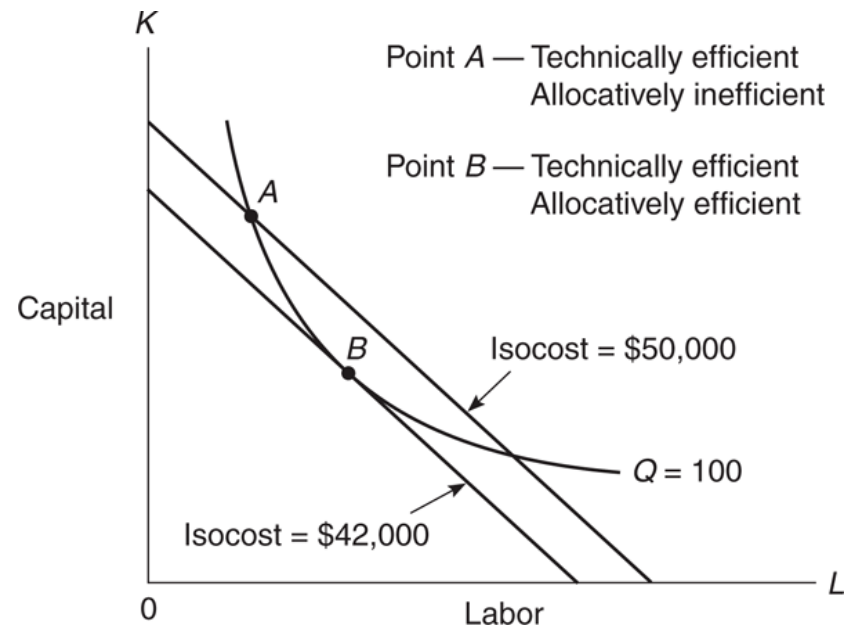


B. Two Inputs

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

Figure 6-6 Technical Allocative Inefficiency

- Allocative efficiency requires the efficient allocation of inputs between firms and between outputs. Essentially, it requires that each type of capital and labor be put to its most rewarding use in society.



Empirical Evidence

- Reported overall efficiency has been quite high.
- Generally, most studies have reported technical efficiency levels of about 90 percent
- Estimates of technical and allocative inefficiency tends to be only a little more than 10 percent.