A Closer Look at Production and Costs

CHAPTER

7 Appendix

The Production Function and Efficiency

- **The *production function* identifies the maximum quantities of a particular good or service that can be produced per time period with various combinations of resources, for a given level of technology**

Production Function Using Labor and Capital

Units of Capital Employed per Month	Units of Labor Employed per Month 1	2	3	4	5	6	7
1	40	90	150	200	240	270	290
2	90	140	200	250	290	315	335
3	150	195	260	310	345	370	390
4	200	250	310	350	385	415	440
5	240	290	345	385	420	450	475
6	270	320	375	415	450	475	495
7	290	330	390	435	470	495	510

- **The firm produces the maximum possible output given the combination of resources employed ➔ production is *technologically efficient***
- **Compute marginal product of labor (given capital=1)**
  - **1 →40**
  - **2→90-40=50**
  - **3→150-90=60**
  - **4→ 200-150 =50**

5→240-200=40
6→270-240=30
8→290-270=20

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Production Function

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- **Marginal product of labor first rise → increasing marginal returns**
- **Then declines →diminishing marginal returns**
- **So does the marginal product of capital.**
- **Different combinations of resources yield the same rate of output**
  - **Several combinations of labor and capital yield 290 units of output**
  - **Next slide provides another perspective on this information**

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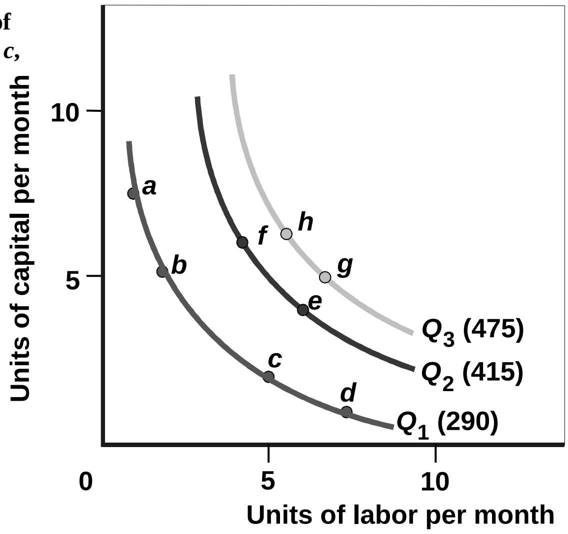
Isoquants

Combinations that yield 290 units of output are presented as points *a, b, c,* and *d*. These points can be connected to form an *isoquant* Q_1

Isoquant shows all the combinations of two resources that produce a certain rate of output **➔ along Q_1, output remains constant at 290 units,**

There will be a different isoquant for every quantity of output.



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Properties of Isoquants

- **A unique isoquant for every output rate**
- **Along a given isoquant, the quantity of labor employed is inversely related to the quantity of capital employed**
  - **isoquants have negative slopes**

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Properties of Isoquants

- **Isoquants do not intersect.**
  - **an intersection would indicate that the same combination of resources produce two different amounts of output→ Inefficient**
- **Isoquants are usually convex to the origin**

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Marginal Rate of Technical Substitution (MRTS)

- **The absolute value of the slope of the isoquant**
  - **= marginal rate of technical substitution, MRTS,**
- **Thus, *the MRTS is the rate at which labor substitutes for capital without affecting output***
- **See next slide**

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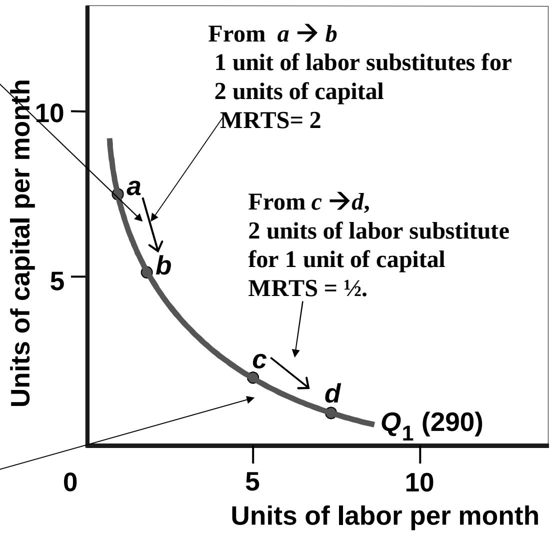
When Isoquant is Convex

When much capital and little labor are used,

It takes much capital to make up for a one-unit reduction in labor

- The marginal productivity of labor is relatively large
- The marginal productivity of capital relatively small



As more labor and less capital are used,
- The marginal product of labor declines
- The marginal product of capital increases

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MRTS and Marginal Productivity

- **MRTS is directly linked to the marginal productivity of each input**
- **From $a \rightarrow b$,**
- **1 unit of labor replaces 2 units of capital,**
  - **labor's marginal product, MP_L must be twice as large as capital's marginal product, MP_C**
- **We conclude MRTS = MP_L / MP_C**

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Perfect Substitute MRTS=Constant

- **If labor and capital were perfect substitutes in production,**
  - **MRTS will be fixed constant**
  - **The isoquant would be a downward sloping straight line**

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Minimize Production Cost Construct Isocost Lines

- **Intuition:**
  - **Given rate of output**
    - **Combination of resources along Isoquant**
  - **Find one combination that minimize the production cost**
- **Suppose**
  - **a unit of labor = $1,500**
  - **a unit of capital costs $2,500**
- **TC = $1,500L + $2,500C**
- **See next slide**

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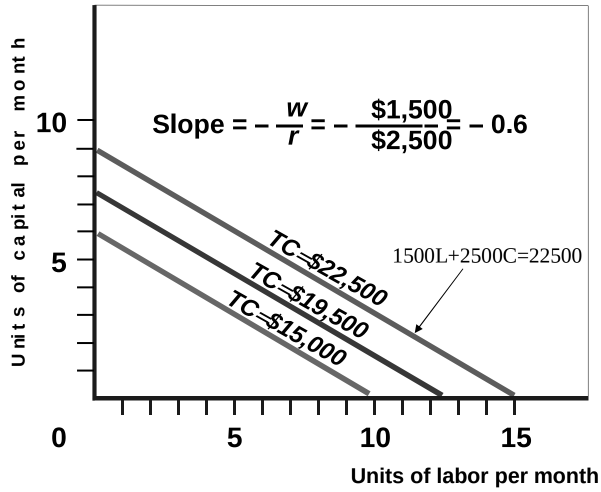
Construct Isocost Lines

Isocost line identifies all combinations of capital and labor for a given total cost



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Choice of Input Combinations

- **To maximizes profit, firm produces its chosen output at the minimum cost**
- **Next figure brings together**
  - **isoquants line → Chosen output**
  - **isocost line → Minimize cost**

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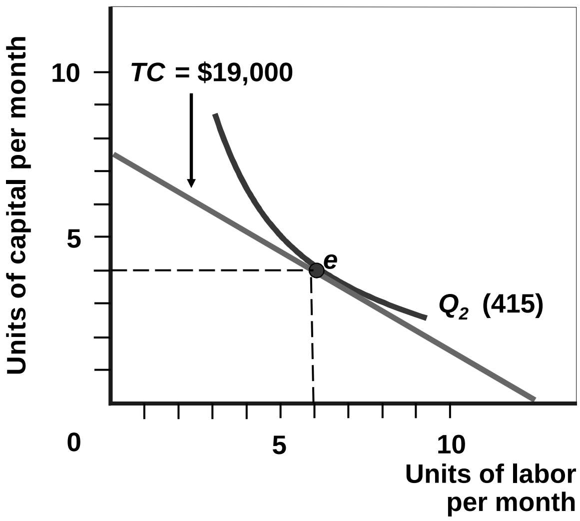
Optimal Combinations of Inputs

Cost minimize at point *e*,

The isoquant is just tangent to the isocost line of $19,000

At *e*, the isoquant and isocost line have the same slope MRTS= the ratio of resources prices

MRTS = w / r = 1,500 / 2,500 = 0.6



Expansion Path

- **Given**
  - **a set of isoquants**
  - **relative cost of resources,**
- **we can determine the optimal combination of resources for producing each rate of output**
  - **The points of tangency between**
    - **isoquant line**
    - **isocost line.**

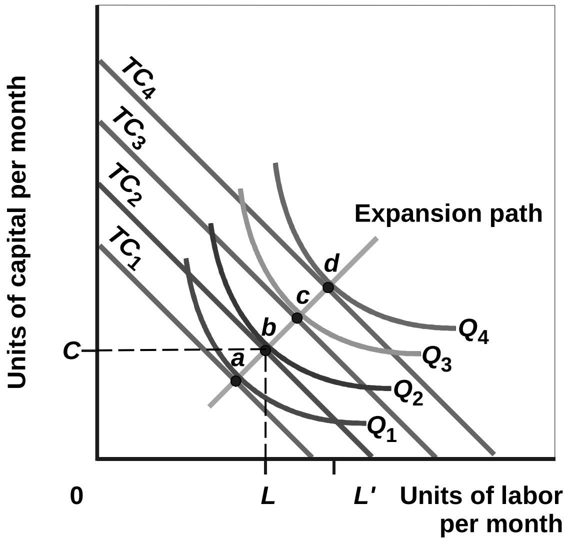
    show the least-cost input combinations for producing several output rates
  - **These points form an expansion path.**
- **See next slide**

Graph of Expansion Path

Expansion path ➔ the lowest long-run total cost for each rate of output.

Long-run average cost curve indicates, at each rate of output, the total cost divided by the rate of output

The expansion path and the long-run average cost curve are alternative ways of portraying costs in the long run



Short Run and the Long Run Adjustment

The firm decide to produce Q_2 at point *b* requires
C units of capital
L units of labor.

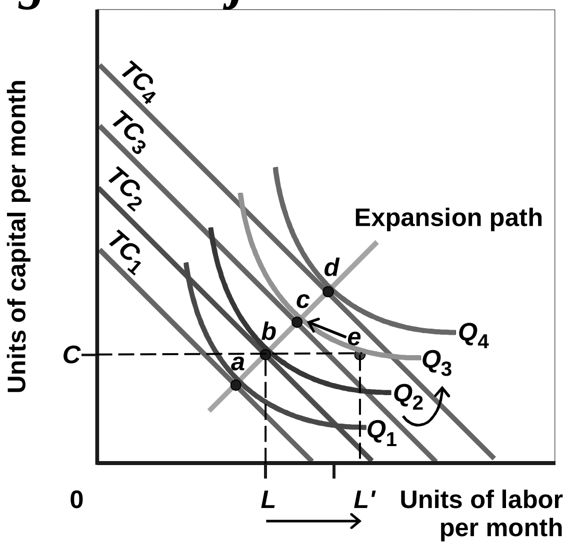
In the short run, the firm wants to increase output to Q_3.

Capital is fixed (C) in the short run, Increasing labor to L' (point *e.)*

Point e is not the cheapest way to produce Q_3 because it is not a tangency point.

In the long run, capital is variable,

It should minimize total cost by adjusting from point *e* to point *c*



Expansion Path

- **Relative prices of resources change,**
  - **→ the least-cost resource combination will also change**
  - **→the firm's expansion path will change**

- **If the price of labor increases, →capital becomes relatively less expensive**
  - **→ the efficient production will call for less labor and more capital**

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