Labor Demand: Second Lecture

LABOR ECONOMICS (ECON 385)

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Long run labor demand

- In the long run (when both inputs are variable), the firm wants to minimize its costs for any given level of output. Once this objective is accomplished, it chooses a level of output that maximizes profit.
- Minimizing costs requires that the ratio of marginal products (the "rate of technical substitution") equal the ratio of input prices:

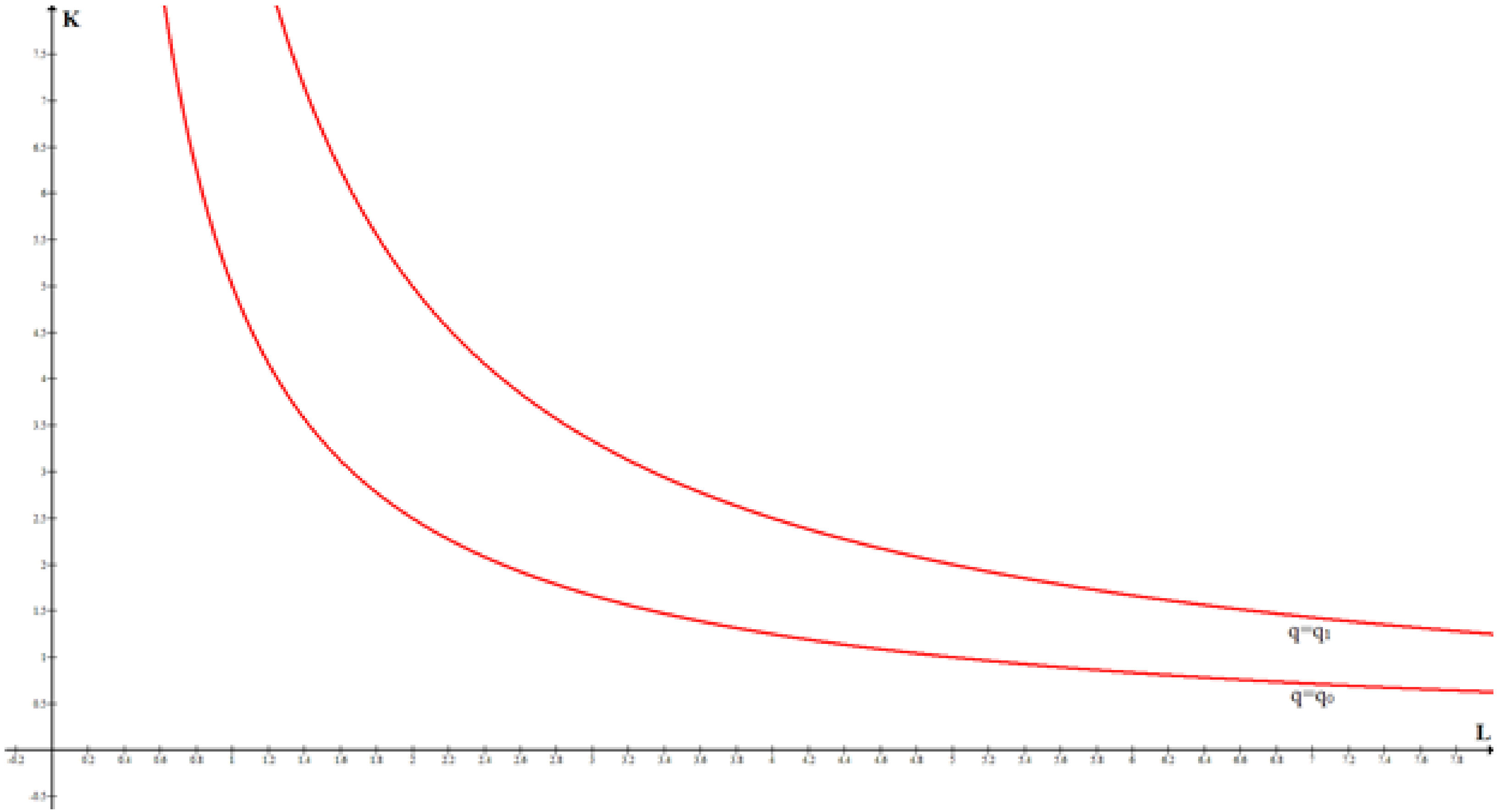
$$RTS \equiv \frac{MP_L}{MP_K} = \frac{w}{r}.$$

- This can be shown graphically by examining the sets of isoquants and isocost lines for a point of tangency.

Isoquants

- An isoquant is a line that connects all input combinations that yield the same level of output. They are graphed in "input space," i.e., with the levels of each input on the horizontal and vertical axes, and have the following properties:
  - Isoquants must be downward sloping.
  - Isoquants do not intersect.
  - Higher isoquants are associated with higher levels of output.
  - Isoquants are convex ("bowed inward toward") to the origin.
- For example, two representative isoquants for a production function may look like the ones on the next slide.

Isoquants (continued)



Isoquants (concluded)

- The absolute value of the slope of an isoquant is called the marginal rate of technical substitution (RTS). And it is equal to the ratio of the two inputs' marginal products.

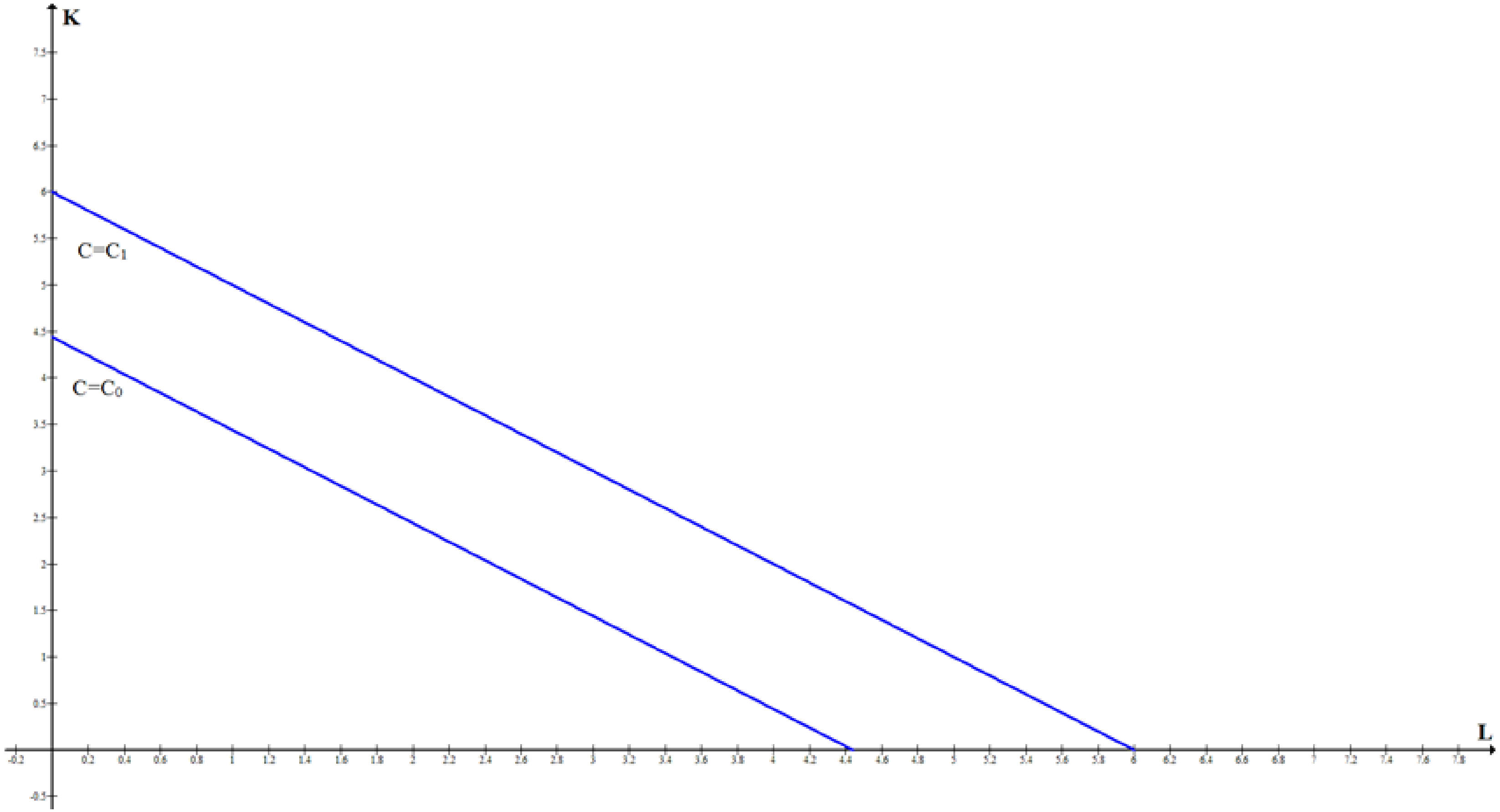
$$-\frac{MP_L}{MP_K} = \frac{dK}{dL}$$

- Isoquants get their convexity from diminishing marginal product. At the top of an isoquant, the firm is using a "capital intensive" production: MP_K is low and MP_L is high, so the ratio is large (steep slope). The reverse is true at the bottom of an isoquant; they "flatten out" as you move from left to right.

Isocost lines

- A firm's costs can be depicted in input space also using isocost lines—lines that connect all input combinations that are equally costly. These are easy to sketch when the input prices are constants, because the isocost lines are actually linear.
- Their intercepts, for a given cost C_0, are $\frac{C_0}{r}$ (vertical) and $\frac{C_0}{w}$ (horizontal). Consequently the slope is: $-\frac{w}{r}$.

Isocost lines (continued)



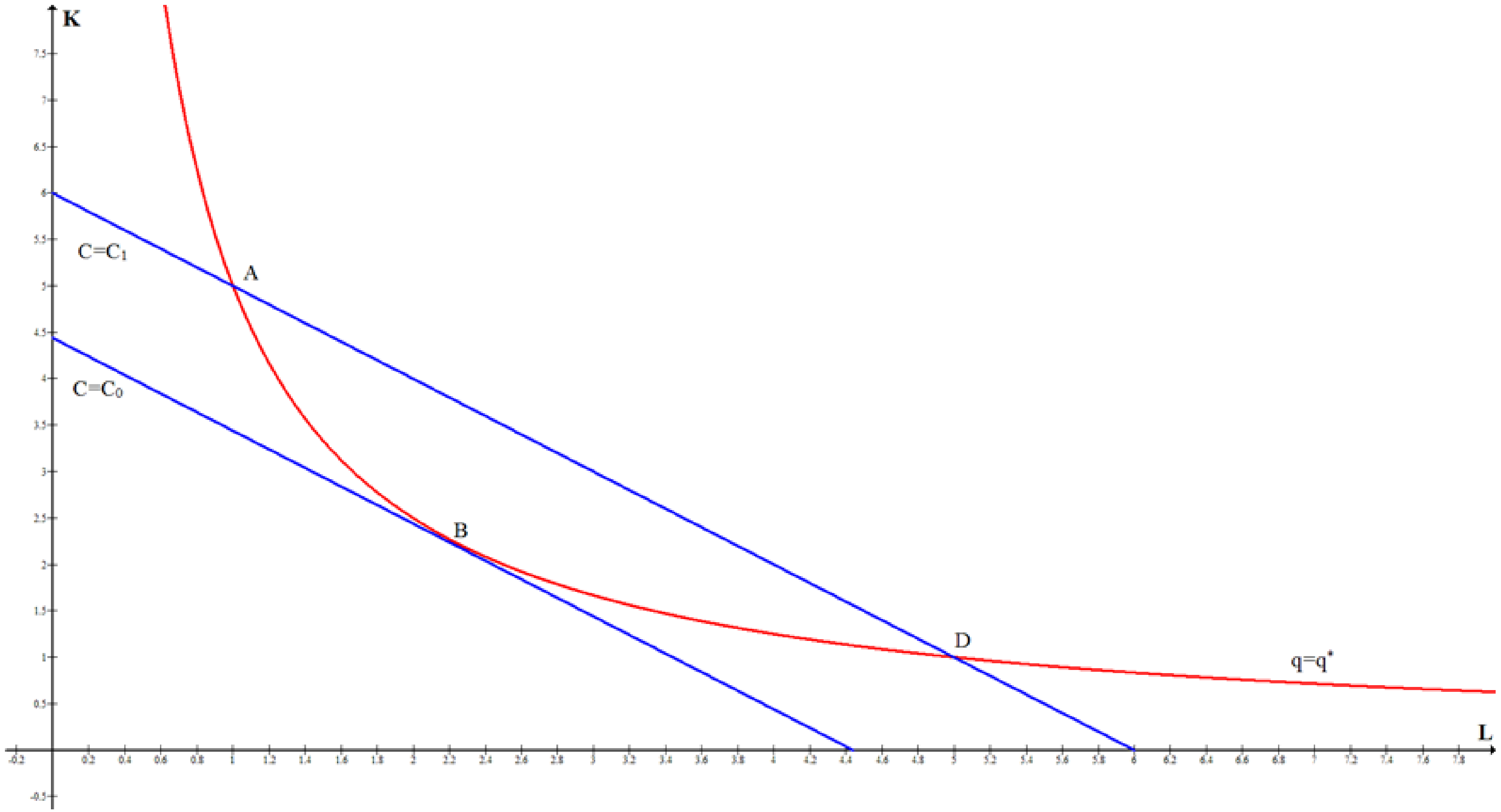
Cost minimization

- Whichever output level will maximize a firm's profit must be produced at minimal cost, i.e., an input combination must be chosen that puts the firm on the lowest (closest to the origin) isocost line. This occurs at the point of tangency between the isocost and the profit-maximizing isoquant.
  - At the tangency point, the slopes of the two curves are equal, and

$$RTS = \frac{w}{r} \Leftrightarrow \frac{MP_L}{w} = \frac{MP_K}{r}.$$

This is depicted in the graph on the next slide (point B).

Cost minimization (continued)



Toward labor demand

- How does labor demanded respond, then, to a change in the wage? This entails a pivoting of the isocost lines about their vertical axes. For a wage decrease (increase), the isocost lines turn counter clockwise (clockwise).
  - This has two effects: it makes labor relatively cheaper compared to capital, and it simply lowers the marginal cost of all units of output. The first of these is called the substitution effect and the second is called the scale effect.
  - At the end of the movement the firm will be on a higher isoquant and be using a lower ratio of capital to labor.
    - Their cost level will also generally change, so the new isocost line may have a higher or lower K intercept. This is a subtle point, but re-optimization is unlikely to conclude with an output level that leaves total costs unchanged.

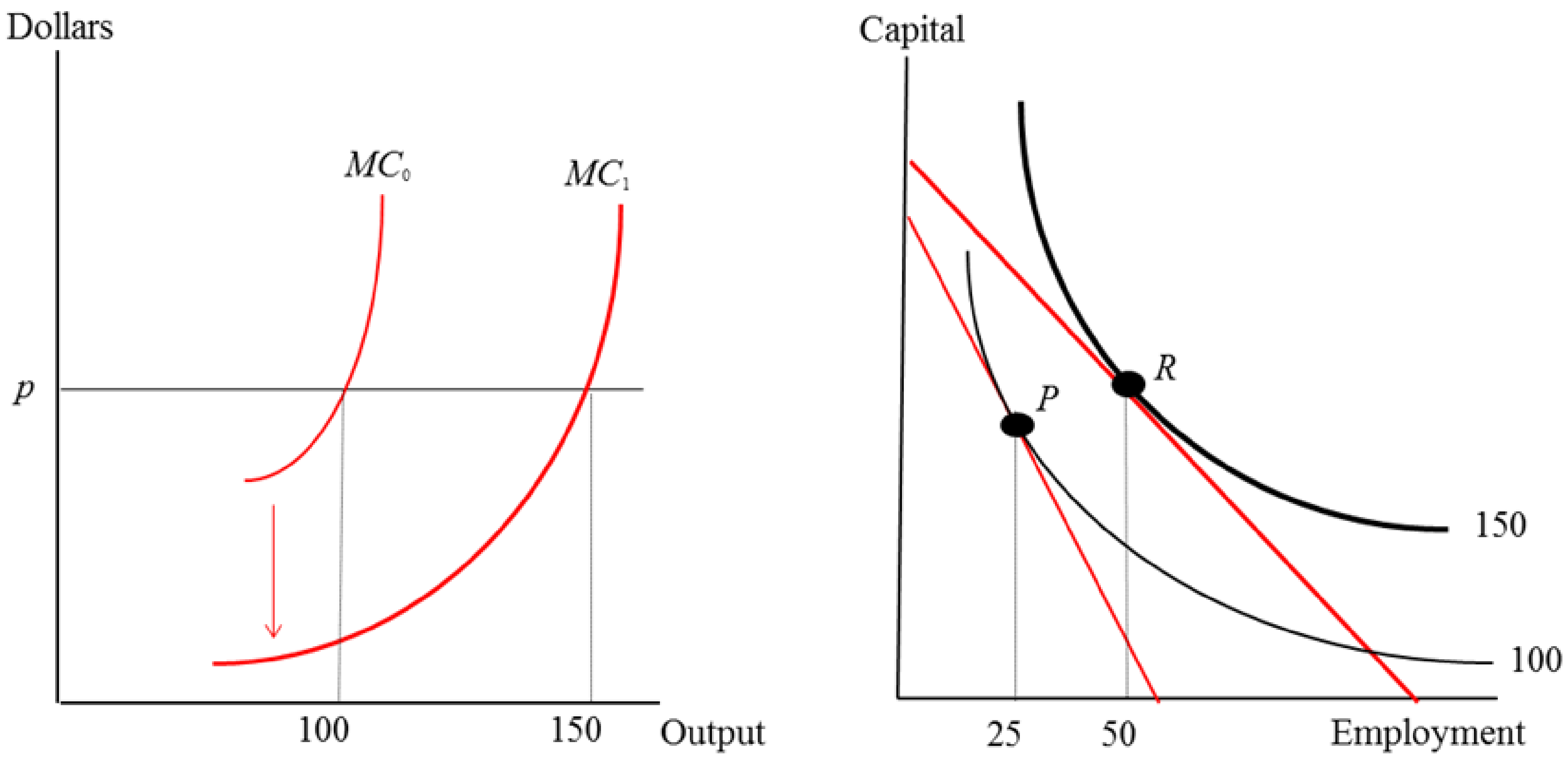
LR labor demand

- As long as labor is a “normal”* input, both effects go the same direction. A wage decrease will have a positive substitution *and* scale effect on labor demand. So the long run labor demand is still downward-sloping.
- The response is more elastic, though, in the long run. This is because the firm is constrained by its fixed capital stock in the short run. It is, consequently, less free to attain the optimal output level as well as the optimal input combination for a given level. Both of these constraints are relaxed in the long run, and the firm can adjust both its output and combination of inputs more freely in response to input price changes.

- Estimates of labor’s own price elasticity from Hamermesh (via Borjas) tend to be near (-1). Estimates of the short run elasticity are closer to the range [-0.5, -0.4].
  - Hamermesh, Daniel S. Labor Demand. 1993, Princeton University Press.

*In the sense of using more as more output is produced. Like normal goods in consumer theory.

LR labor demand (continued)



Input substitutability

- The shape of the isoquants will vary depending on how substitutable *K* and *L* are. Two extreme cases are shown below: perfect substitutes and perfect complements.

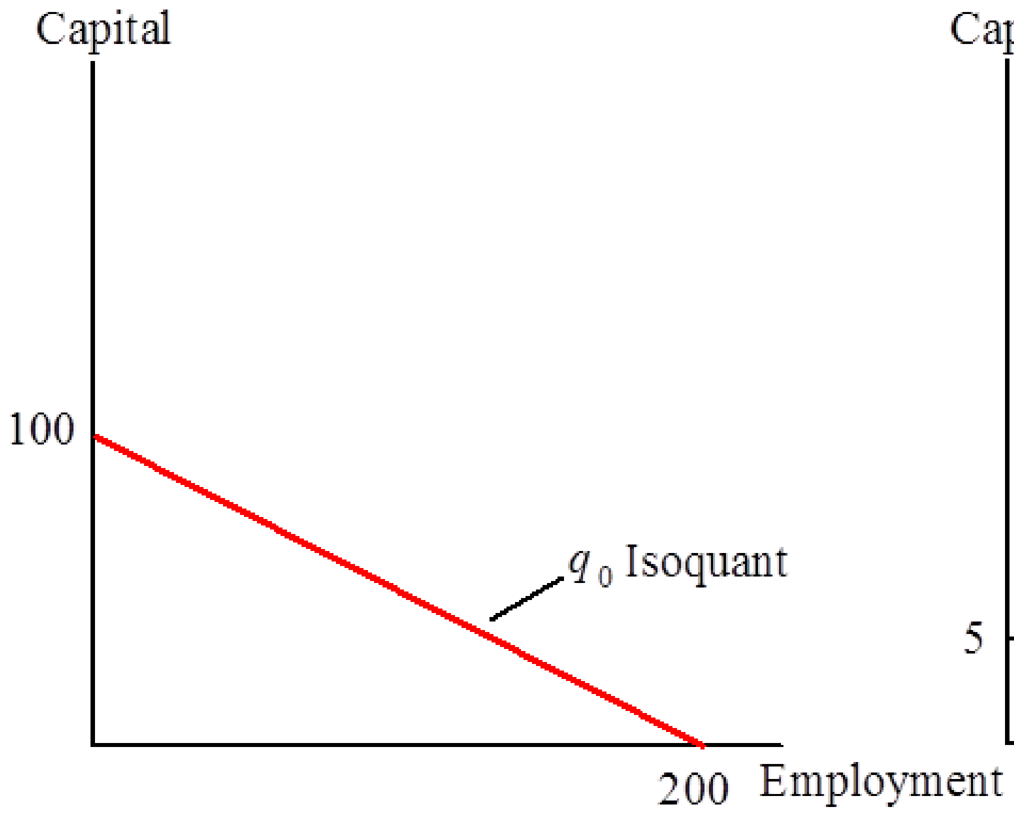
- The production functions for these, respectively, are:

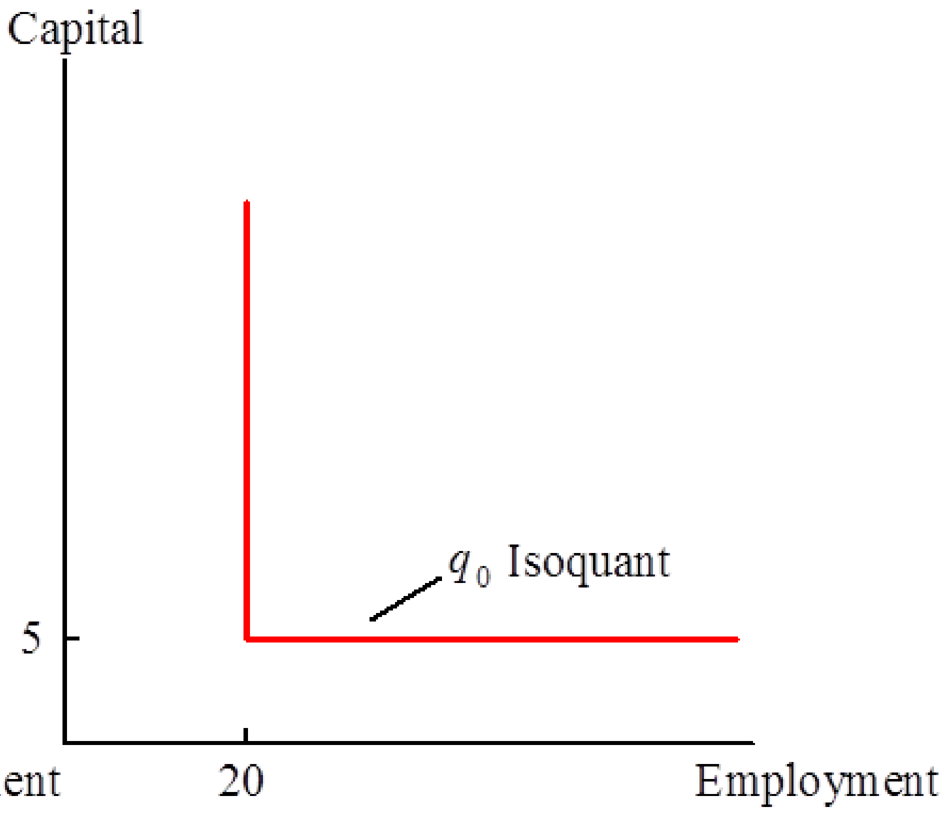
$$q(L,K) = aL + bK, \text{and } q(L,K) = \min(aL, bK).$$

- They both belong to a family of functions called "CES" (Constant Elasticity of Substitution), which takes the form,

$$q(L,K) = \left[aL^{\frac{\sigma-1}{\sigma}} + bK^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}, \text{where } \sigma \text{ is the elasticity of substitution.}$$

Perfect substitutes and perfect complements





Input substitutability

- For all CES functions:

$$\sigma = \frac{\%\Delta\left(\frac{K}{L}\right)}{\%\Delta RTS};\ \sigma \geq 0.$$

- Since the RTS doesn't change for perfect substitutes, this corresponds to a case where σ is infinitely large. Perfect complements is the opposite end of the scale, at which σ is zero (the firm uses K and L in fixed proportions that do not change). The Cobb-Douglas form is also an example, in which $\sigma = 1$.
  - The elasticity of substitution determines whether two inputs are net substitutes ($\sigma > 1$) or net complements ($\sigma < 1$).
  - Input substitutability is also reflected in the <u>cross elasticity of input demands</u>. This is analogous to the cross price elasticity of demand in consumer theory, in which the effect of one good's price on demand for a second good is measured.

Cross elasticity

- Cross elasticity of demand can be generalized to *n* inputs. For any pair of inputs, *i* and *j*, the cross elasticity is:

$$\delta_{ij} = \frac{\%\Delta \text{ input } i}{\%\Delta \text{ price input } j}.$$

$$\delta_{LK} = \frac{\%\Delta\, L}{\%\Delta\, r}, \text{for an example of the two input case.}$$

  - Generalizing the production function to *n* inputs would take the form,

$$q = f\left(x_1, x_2, \ldots, x_n\right).$$

Labor demand and elasticity

- Graphically the effect of increasing the price of a substitute input is shown on the left panel. The effect of increasing the price of a complement is shown on the right.