ECN 280 | Fall 2022

Cost Minimization

Professor McGavock *Module 5.2*

Contents

1 Learning Outcomes for Module 5.2

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After completing this module, you will be able to:

- *Describe* production functions using two or more inputs.
- *Graph* the **Isoquants**, curves representing the combination of inputs used to make the same quantity of output.
- *Calculate* and *describe* the **marginal rate of technical substitution**, the slope of the isoquant.
- *Describe* the total cost function using two or more inputs.

2 Assignments for Module 5.2

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- Watch:
  - 5A Isoquants
- Read:
  - 6.12 - 6.15 and conclusion of Ch. 6
- Turn in: [Turn in problems here.]
  - 5.2.1
  - 5.2.2

3 Lecture Notes

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3.1 Isoquants and MRTS

For some production function with two inputs, $y = f(K, L)$, we can depict the tradeoffs in production in 2D space just like we did with indifference curves. Enter the **Isoquant**. Given some **fixed** level of output $\bar{y}$, the isoquant depicts all of the combinations of the two inputs L and K that can produce that level of output. Think of this as *bundles* of inputs.

- Similarly to how we calculated the MRS as the slope of the indifference curves, the slope of the isoquant tells us how the technological process will allow you to substitute labor for capital and still keep output constant.
- With two inputs that both exhibit diminishing marginal returns, the isoquants will be *convex* to the origin.
- With indifference curves and utility functions, the distance between two indifference curves was not very meaningful – we just cared about the rank (order) of bundles. With isoquants, however, the distance between two isoquants is meaningful – what are the units it is calculated in?
- Increasing, decreasing, and constant returns to scale can be depicted by drawing indifference curves that closer or further apart relative to each other. Keeping in mind the definition of constant returns to scale, can you figure out how?

4 Problems

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***5.2.1 *Production*

For each of the following cases, draw a representative isoquant of the firm. What can you say about the marginal rate of technical substitution (MRTS) in each case?

(a) A firm finds that it can always trade two units of labor for one unit of capital and still keep output constant.

(b) A firm requires exactly two full-time workers to operate each piece of machinery in the factory. Additional workers or machines will stand idle.

(c) A firm needs both workers and machines to produce its product, and finds that one can be substituted for the other. However, when there are a lot of workers, adding more workers does not increase productivity by much. Similarly, when there are few workers, adding more capital does not increase productivity by much.

(d) A firm *can* hire *only* full-time employees to produce its output, or it can hire some combination of full-time and part-time workers. For each full-time worker let go, the firm must hire an increasing number of part-time workers to maintain the same level of output.

***5.2.2 *Marginal Productivity*
Suppose that Toyota can produce the same number of cars with one robot as they can with one worker.

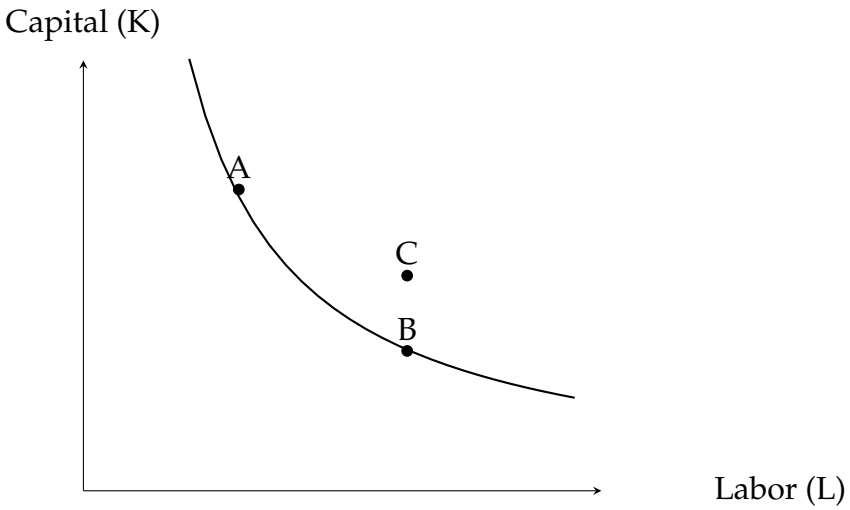
(a) Provide an expression for Toyota's production function and illustrate the technology graphically for Toyota when they produce exactly 10 cars (put capital on the vertical axis). Does this production function exhibit increasing, constant, or decreasing returns to scale?

(b) Find the marginal productivity functions. Do they exhibit diminishing marginal productivity?

(c) Find the marginal rate of technical substitution (MRTS) when capital is exchanged for labor.

(d) Find the MRTS when labor is exchanged for capital.

& & 5.2.3 The graph below shows an isoquant for the production of tractors by U.S. farm equipment manufacturers. Use the graph to answer the questions that follow.



Answer the following. No explanation is required.

(a) At B the production process is _____ labor intensive as at A. Circle your answer:

- more
- less
- equally

(b) The quantity of tractors produced at C is 400. What can you say about the quantity of tractors produced at A?

(c) True or False? The graph shows that there are diminishing returns to labor.

(d) True or False? The graph shows that production requires quantities of K and L to be in *fixed* proportions for best efficiency.

(e) BONUS: Consider point B. If the number of units of capital remains the same but one more worker is added, show on the graph what happens to output.