
Productivity, Output, and Employment, Part 1

3-1

Agenda

- The Production Function
 - The Demand for Labor
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The Production Function

- A **production function** shows how businesses transform factors of production into output of goods and services through the applications of technology.
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The Production Function

- **Factors of production:**
 - Capital (K)
 - Labor (N)
 - Other (raw materials, land, energy, etc.)
 - The **productivity** of factors depends on technology and management (A).
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The Production Function

- The economy's production function is:

$$Y = AF(K, N)$$

- Shows how much output (Y) can be produced from a given amount of capital (K) and labor (N) and a given level of technology (A).
- The parameter A is “**total factor productivity**” or the effectiveness with which K and N are used.

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The Production Function

- A more specific production function that works well in macroeconomics is the Cobb-Douglas production function.

$$Y = AK^\alpha N^{(1-\alpha)}$$

- For the U.S. economy it would be:

$$Y = AK^{0.3}N^{0.7}$$

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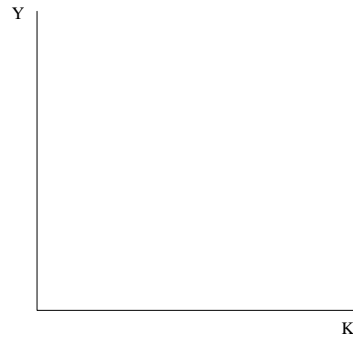
The Production Function

- The Production Function: Output and Capital

- Shows how Y depends on K for a given N and A .

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The Production Function: Output & Capital



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The Production Function

- The Production Function: Output and Capital
 - Two main properties of this production function:
 - Exhibits **increasing returns** to capital.
 - Slopes upward because more K produces more Y .
 - Exhibit **diminishing marginal product** of capital.
 - Slope becomes flatter because each additional increment of K produces less additional Y .

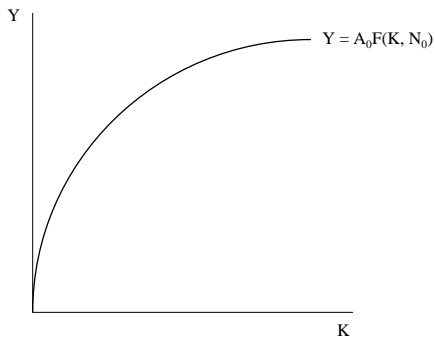
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The Production Function

- The Production Function: Output and Capital
 - **Marginal product of capital**, $MPK = \Delta Y / \Delta K$.
 - Equals the slope of production function graph (Y vs. K).
 - MPK is always positive.
 - MPK declines as K increases.

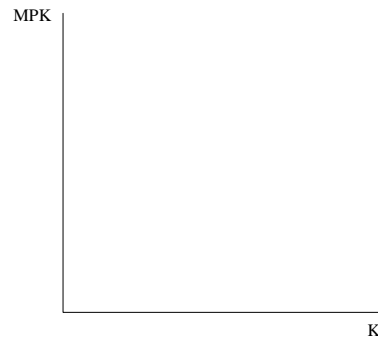
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The Marginal Product of Capital



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The Marginal Product of Capital



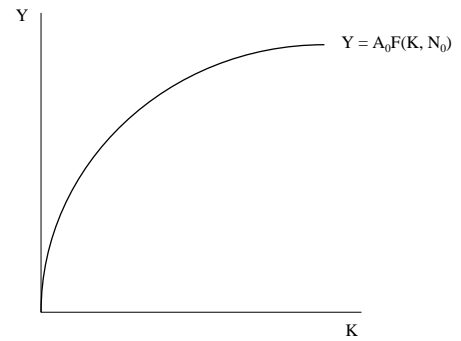
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The Production Function

- The Production Function: Output and Capital
 - What happens if N or A changes?

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The Production Function: Output & Capital



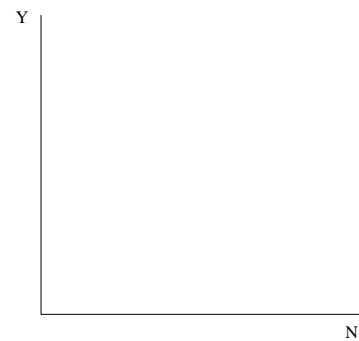
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The Production Function

- The Production Function: Output and Labor
 - Shows how Y depends on N for a given K and A .

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The Production Function: Output & Labor



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The Production Function

- The Production Function: Output and Labor

- Two main properties of this production function:

- Exhibits **increasing returns** to labor.
 - Slopes upward because more N produces more Y .
- Exhibit **diminishing marginal product** of labor.
 - Slope becomes flatter because each additional increment of N produces less additional Y .

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The Production Function

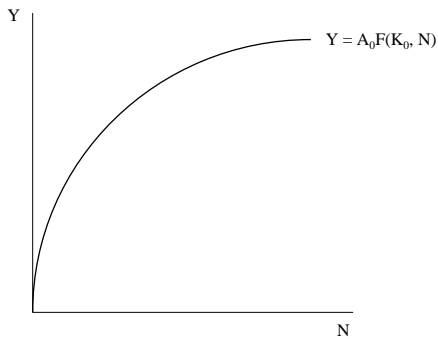
- The Production Function: Output and Labor

- **Marginal product of labor**, $MPN = \Delta Y / \Delta N$.

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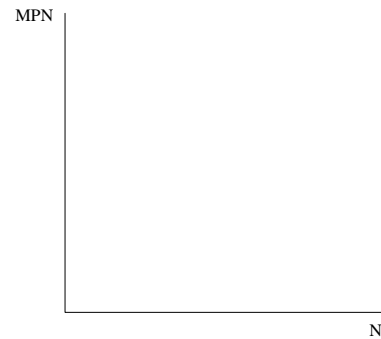
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The Marginal Product of Labor



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The Marginal Product of Labor



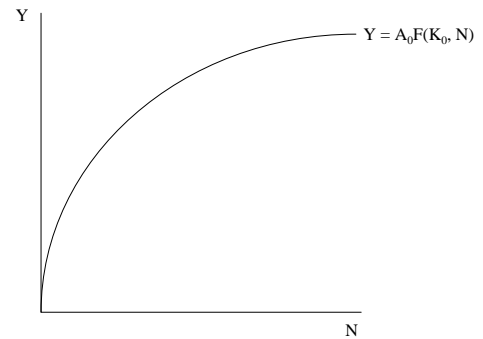
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The Production Function

- The Production Function: Output and Labor
 - What happens if K or A changes?

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The Production Function: Output & Labor



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The Production Function

- Productivity is calculated as a residual:

$$A = \frac{Y}{K^{0.3}N^{0.7}}$$

- Productivity growth is calculated as:

$$\% \Delta A = \Delta A / A * 100$$

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The Production Function

- Observations about productivity growth:

- Productivity moves sharply from year to year.
- Productivity grew strongly from the mid-1950's through 1973, very slowly from 1973 through 1995, and more quickly again since 1995.

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The Production Function

- Supply shocks:
 - **Supply shocks** affect the amount of output that can be produced for a given amount of inputs.
 - Also called **productivity shocks**.

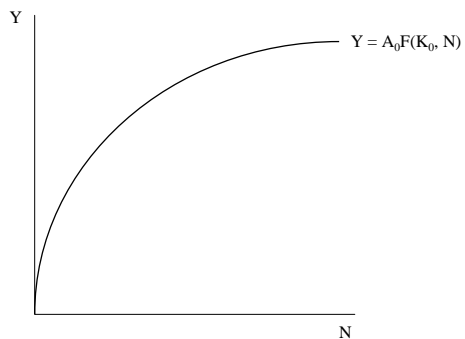
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The Production Function

- Supply shocks:
 - Supply shocks shift the production function.
 - **Negative or adverse shock**: A decline in A usually causes the slope of production function to decrease at each level of input.
 - **Positive or beneficial shock**: An increase in A usually causes the slope of production function to increase at each level of input.

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Effects of an Adverse Supply Shock



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The Demand for Labor

- The demand for labor is determined by individual business firms.
 - The **aggregate demand for labor** is the sum of all the business firms' demand for labor.
- The demand for labor depends on the costs and benefits of hiring additional workers.

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The Demand for Labor

- How much labor do firms want to use?
 - Assumptions:
 - The capital stock fixed, i.e., a short-run analysis.
 - Workers are homogeneous.
 - The labor market is competitive.
 - Firms maximize profits.

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The Demand for Labor

- What is the cost of hiring one more worker?
 - The marginal cost of hiring one more worker is the cost of that worker to the firm, i.e., the nominal wage:

W

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The Demand for Labor

- What is the benefit of hiring one more worker?
 - The benefit of hiring one more worker is the additional income that the worker generates, i.e., the marginal revenue product of labor:

$$MRPN = P * MPN$$

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The Demand for Labor

- How much labor do firms want to use?
 - A profit-maximizing firm will hire additional workers up to the point where the marginal revenue product of labor equals the nominal wage:

$$W = MRPN = P * MPN$$

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The Demand for Labor

- How much labor do firms want to use?

➤ This equilibrium condition:

$$W = MRPN = P * MPN$$

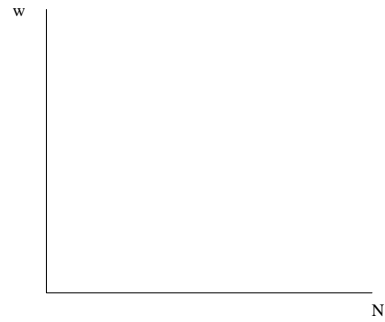
➤ can be re-written as:

$$w = MPN$$

- because $w = W/P$ and $MRPN = P * MPN$.

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Marginal Cost of Hiring an Extra Worker



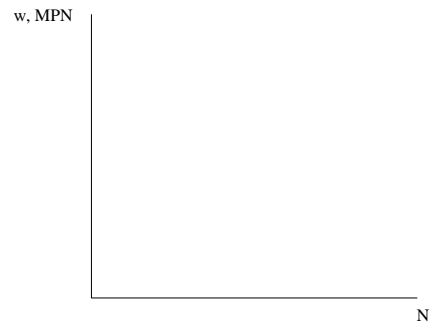
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Marginal Benefit of Hiring an Extra Worker



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The Determination of Labor Demand



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The Demand for Labor

- How much labor do firms want to use?
 - Costs and benefits of hiring one extra worker.
 - If $w > MPN$, profits rise if number of workers declines.
 - If $w < MPN$, profits rise if number of workers increases.
 - When $w = MPN$, profits are maximized.

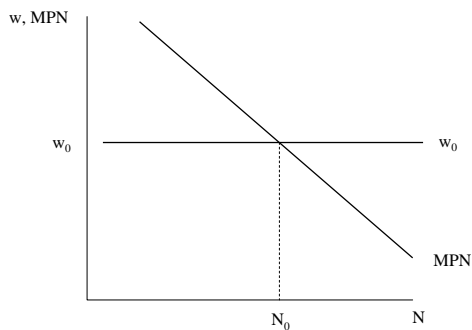
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The Demand for Labor

- How much labor do firms want to use?
 - The labor demand curve shows the relationship between the real wage rate (w) and the quantity of labor demanded (N).

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Determination of the Labor Demand Curve



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The Demand for Labor

- The Labor Demand Curve, N_D .
 - Changing the real wage rate:
 - An increase in the real wage rate means $w > MPN$ unless N is reduced so the MPN increases.
 - A decrease in the real wage rate means $w < MPN$ unless N is increased so the MPN decreases.

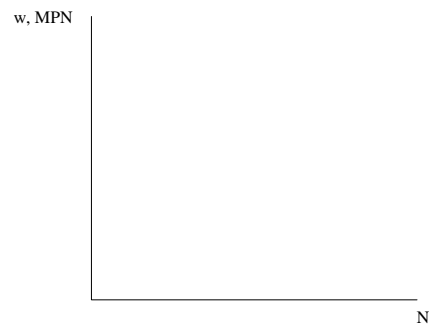
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The Demand for Labor

- The Labor Demand Curve, N_D .
 - The labor demand curve is downward sloping.
 - The higher the real wage, the less labor firms will hire.
 - Because $w = MPN$ in equilibrium (regardless of what w is), the N_D curve is the same as the MPN curve.

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The (Aggregate) Labor Demand Curve



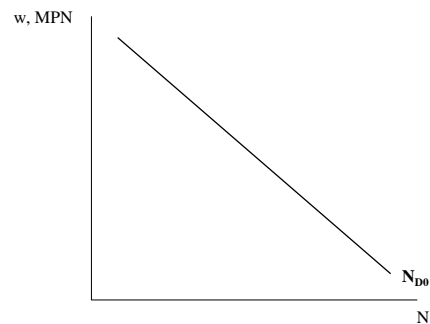
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The Demand for Labor

- Factors that shift the labor demand curve:
 - **Changes in the capital stock, ΔK .**
 - Increases in K raise MPN and shift the labor demand curve to the right.
 - **Supply shocks, ΔA .**
 - Beneficial supply shocks raise MPN and shift the labor demand curve to the right.

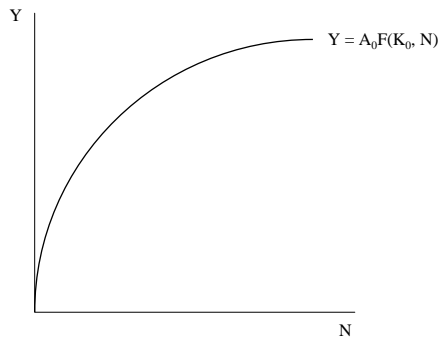
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Effect of an Increase in K or A



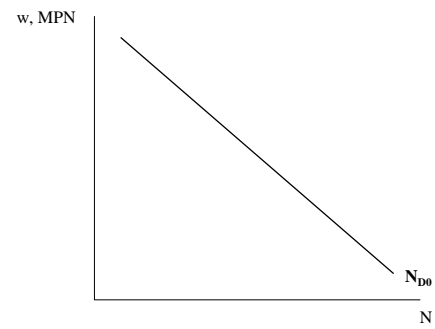
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Key Diagram #1: The Production Function



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Key Diagram #2a: Demand for Labor



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Key Diagrams #1 & #2a.

- Factors that Shift the Production Function and the Demand for Labor:
 - Increases in the capital stock, K , shift the production function higher, increase the MPN and the demand for labor.
 - Increases in productivity, A , shift the production function higher, increase the MPN and the demand for labor.

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