



MACROECONOMICS

**PRODUCTIVITY, OUTPUT &
EMPLOYMENT**

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HOW MUCH DOES THE ECONOMY PRODUCE?

- The quantity that an economy will produce depends on two things-
 - The quantity of inputs utilized in the production process and
 - The **PRODUCTIVITY** of the inputs
- An economy's productivity is basic to determining living standards.
- In this lecture we shall see how productivity affects people's incomes by helping to determine how many workers are employed and how much they receive.
- Among all the inputs for production, labor is usually considered the most important input.
- Therefore, first we shall study the factors that determine demand and supply of labor and then the forces that bring the labor market into equilibrium.
- Equilibrium in the labor market determines wages and employment; and the level of employment together with other inputs and the level of productivity determines how much output an economy produces.



FACTORS AFFECTING PRODUCTIVITY

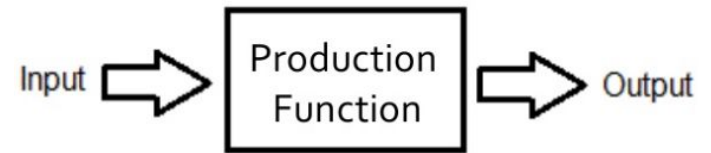
□ Technology

□ Inputs

- Labor
- Capital
- Land
- Raw materials
- Machinery
- Power

□ Time period





THE PRODUCTION FUNCTION

- The quantity of inputs does not completely determine the amount of output produced.
- How effectively the factors of production are used is also important.
- The effectiveness with which factors of production are used may be expressed by a relationship called the production function.
- Mathematically, we express production function as-

$$Y = A f(K, N, L, \dots)$$

- Where, **Y** stands for output, **A** - number that indicated productivity, **K** - capital, **N** – number of labor employed, **L** - land. *Other factors could be, machinery, energy, building etc.*
- The symbol “A” in the equation above captures the overall effectiveness of the factors of production. We call A the “total factor productivity”



EMPIRICAL EXAMPLE: US PRODUCTION FUNCTION

- ▣ Studies show that the relationship between outputs and inputs in the US economy is described reasonably well by the following production function:

$$Y = A \cdot K^{1-\alpha} \cdot N^{\alpha} \quad (R^2 \geq 0.94)$$

- ▣ This type of production function is called the **Cobb-Douglas production function**.
- ▣ Historical GDP data of US for the period 1899 – 1922 showed that the production function for US followed the form:

$$Y = A \cdot K^{0.30} \cdot N^{0.70}$$



CALCULATING “A”

$$Y = A \cdot K^{0.30} \cdot N^{0.70}$$

Year	Real GDP	Capital, K Billion USD	Labor N Millions of workers	A	Growth rate of A
2005	8160	8749	129.6	17.80	
2006	8509	9100	131.5	18.16	2.0
2007	8859	9457	133.5	18.49	1.8
2008	9191	9849	135.2	18.78	1.6
2009	9215	10115	135.1	18.69	-0.5



SHAPE OF THE PRODUCTION FUNCTION

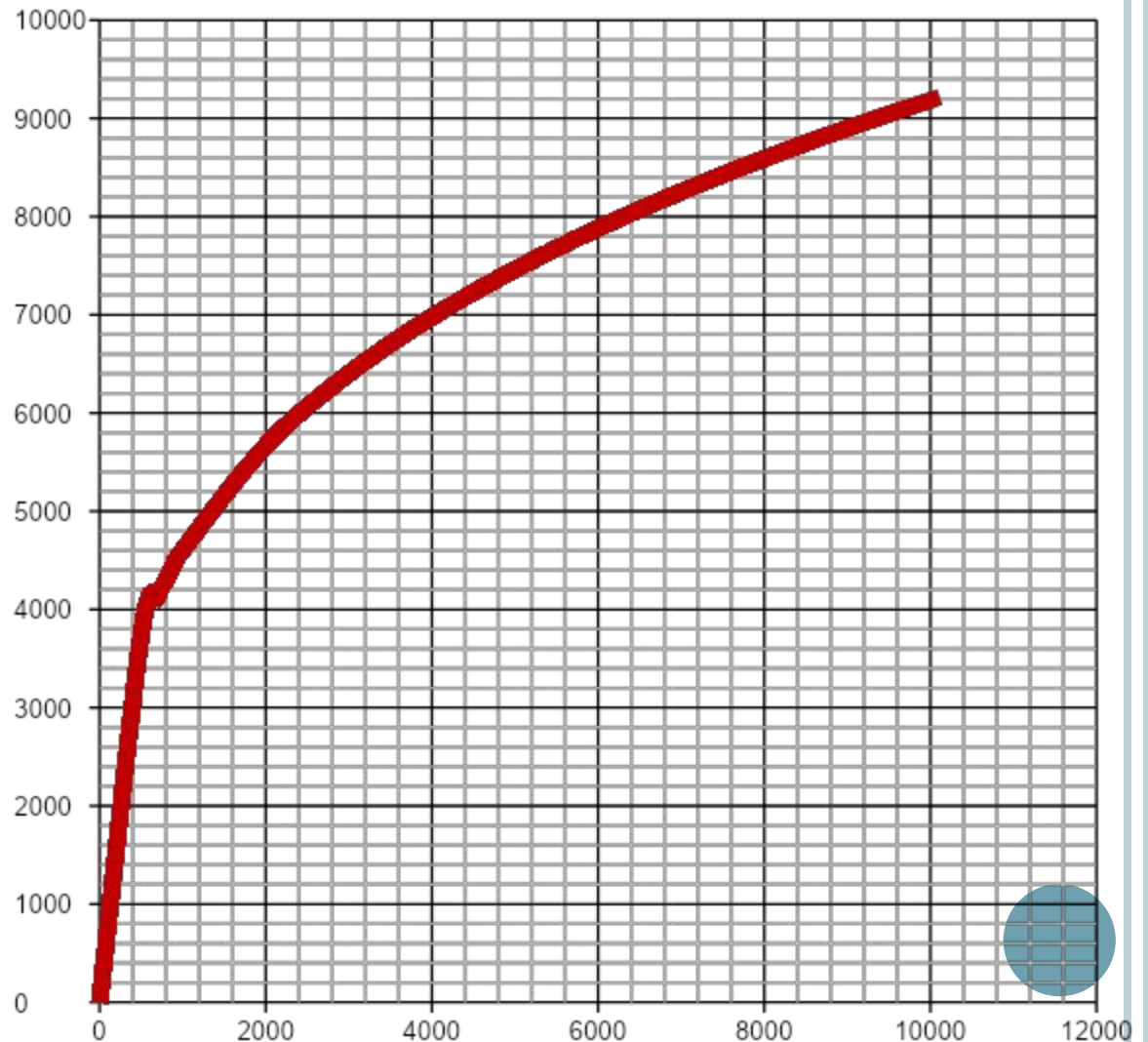
- We can have an idea about the shape of the production function by holding one of the two factors of production and the value of total factor productivity (A) constant.
- For example, if we want to see the relationship between capital and total output for the **year 2009**, then we hold the values of A and N constant for that year and treat K as variable.
- As a result our production function gets the shape as:

$$Y = (18.69)(135.10)^{0.7} (K^{0.3})$$



SHAPE OF THE PRODUCTION FUNCTION

K	Y
0	0
500	3739
700	4136
800	4305
900	4460
1000	4603
2000	5667
3000	6400
4000	6977
5000	7460
6000	7879
7000	8252
8000	8590
9000	8898
10115	9216



SHAPE OF THE PRODUCTION FUNCTION: PROPERTIES

- The production function slopes upward from left to right: this means that as the capital stock increases more output can be produced.
- The slope of the production function becomes flatter from left to right: this means that although more capital always leads to more output, it does so at a decreasing rate.



EFFECT OF INCREASING 1000 UNITS OF CAPITAL EACH TIME

K	Y	Change in Y for every 1000 units of K
2000	5667	...
3000	6400	733
4000	6977	577
5000	7460	483
6000	7880	419
7000	8253	373
8000	8590	337
9000	8899	309
10115	9216	317

Marginal Product of Capital:

$$\frac{\Delta Y}{\Delta K}$$

Marginal product of capital between
K = 2000 and 3000

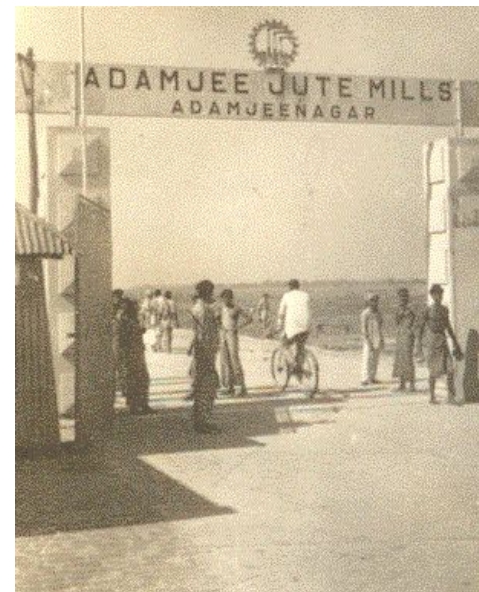
$$\begin{aligned}\frac{\Delta Y}{\Delta K} &= \frac{6400 - 5667}{3000 - 2000} \\ &= \frac{733}{1000} \\ &= 0.733\end{aligned}$$

What is the marginal product of capital between K = 4000 and 5000? Is it less than the previous one? What does it mean?

MARGINAL PRODUCTIVITY

- The previous example shows that marginal productivity is falling as we increase the amount of capital
- Generally, when amount of labor is high compared to the amount of capital, marginal productivity of capital is high. Alternatively, when amount of labor is low compared to the amount of capital, marginal productivity of labor is high

Real life example: Adamjee Jute Mill had many workers employed against every single machine. Therefore, productivity of workers were low as many workers used to sit idle without a machine to work with. If we would have increased number of machines, perhaps, we could have increased production of jute; and as a result productivity of workers would have increased. Unfortunately, we shut down the mill!



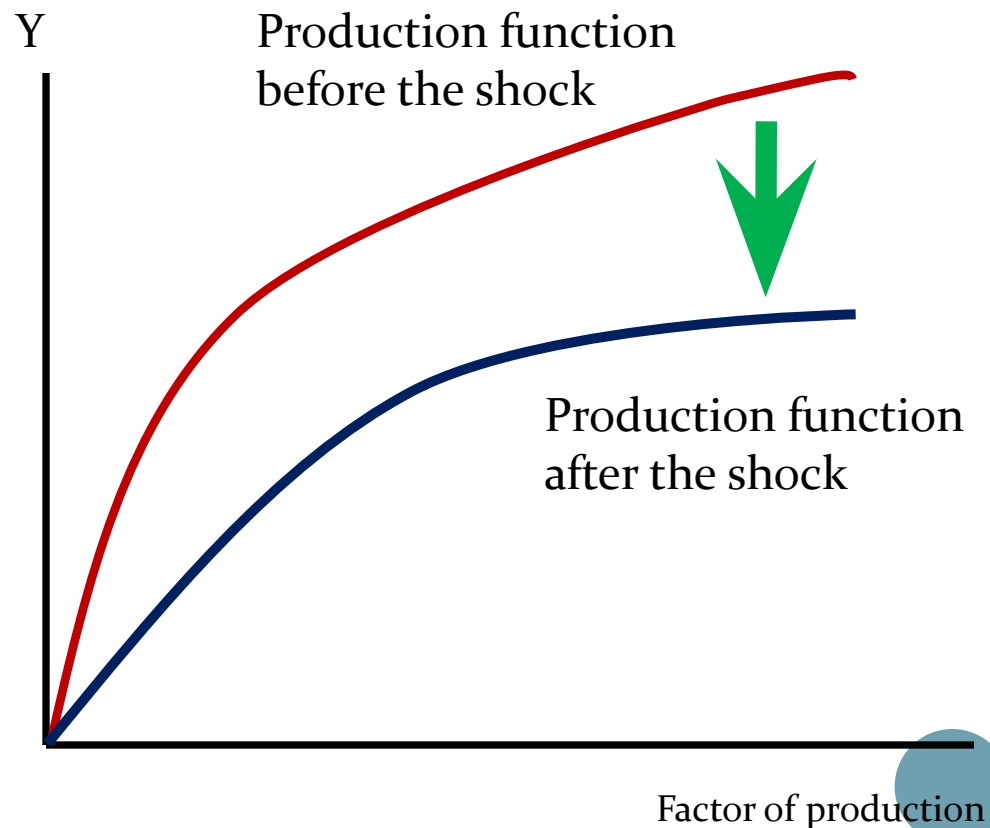
FORMAL DEFINITIONS OF MARGINAL PRODUCTIVITY

- **Marginal Productivity of Capital:** means additional output produced by each additional unit of capital.
- **Marginal Productivity of Labor:** means additional output produced by each additional unit of labor.
- Because of diminishing marginal productivity for both labor and capital the slope of production function becomes flatter from left to right.
- If the marginal productivity were increasing, slope of the production function would become steeper from left to right.
- If the marginal productivity were constant, the slope would be constant and the shape of the curve of production function would be a straight line.



CHANGES IN THE PRODUCTION FUNCTION

- The production function does not remain fixed over time. It may change.
- Economists use the term “supply shock” or “productivity shock” to refer to change in an economy’s production function.
- A positive supply shock raises the amount of output, and a negative supply shock reduces the amount of output.
- Sources of supply shock: natural calamities, changes in governmental regulation, innovations etc.



DEMAND FOR LABOR

- In contrast to the amount of capital, the amount of labor employed in the economy can change quickly.
- Thus, year-to-year changes in production can be traced to the changes in employment.
- Demand for labor determines the level of employment.
- For this reason, understanding demand for labor is important.
- To understand demand for labor we shall make the following assumptions to keep things simple:
 - ❖ Workers are alike
 - ❖ Firms have to pay competitive wage to hire workers
 - ❖ Firms objective is to maximize profit



DETERMINATION OF THE DEMAND FOR LABOR

- Demand for labor is determined based on the marginal product of labor, cost of labor and price of the product that labor produces.
- Example: Suppose, wage rate (**W**) of labor is 80 per/day.

Number of workers (N)	Number of shirts produced (Y)	MPN	MPN X Price (Price is 10 per/shirt)
0	0		
1	11	11	110
2	20	9	90
3	27	7	70
4	32	5	50
5	35	3	30
6	36	1	10

DETERMINATION OF DEMAND FOR LABOR

- To maximize profit the firm will follow the following rules:

Increase employment if for an additional worker	Decrease employment if for an additional worker
$(MPN * price) > W$ or $MPN > W/price$	$(MPN * price) < W$ or $MPN < W/price$

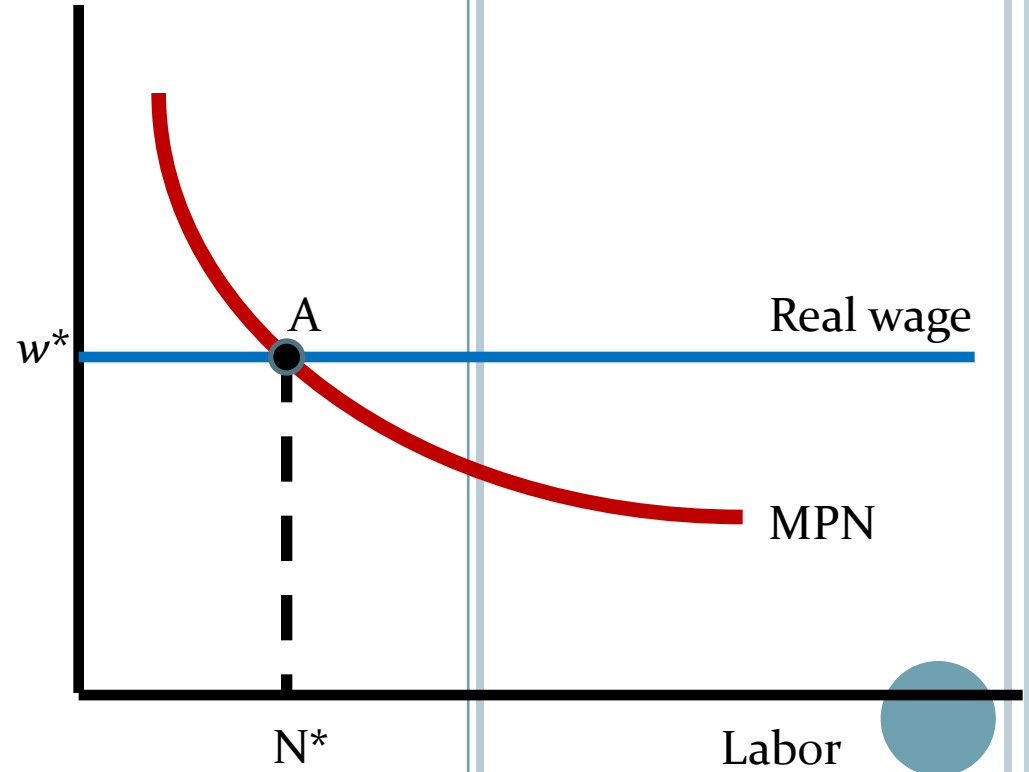
The expression “ $W/price$ ” is called, in economics, “real wage”. Why? Because when we divide wage by price we get a figure that shows the units of physical goods produced by labor.



DETERMINATION OF LABOR DEMAND

- The MPN curve on the right can be thought of as the demand for labor. Because quantity of labor is determined by the price of labor (the real wage).
- What happens when the $MPN > w^*$? Firms hire more labor.
- What happens when $MPN < w^*$? Firms lay-off labor
- What happens at point A? Equilibrium established.

MPN and real wage



FACTORS THAT SHIFT LABOR DEMAND CURVE

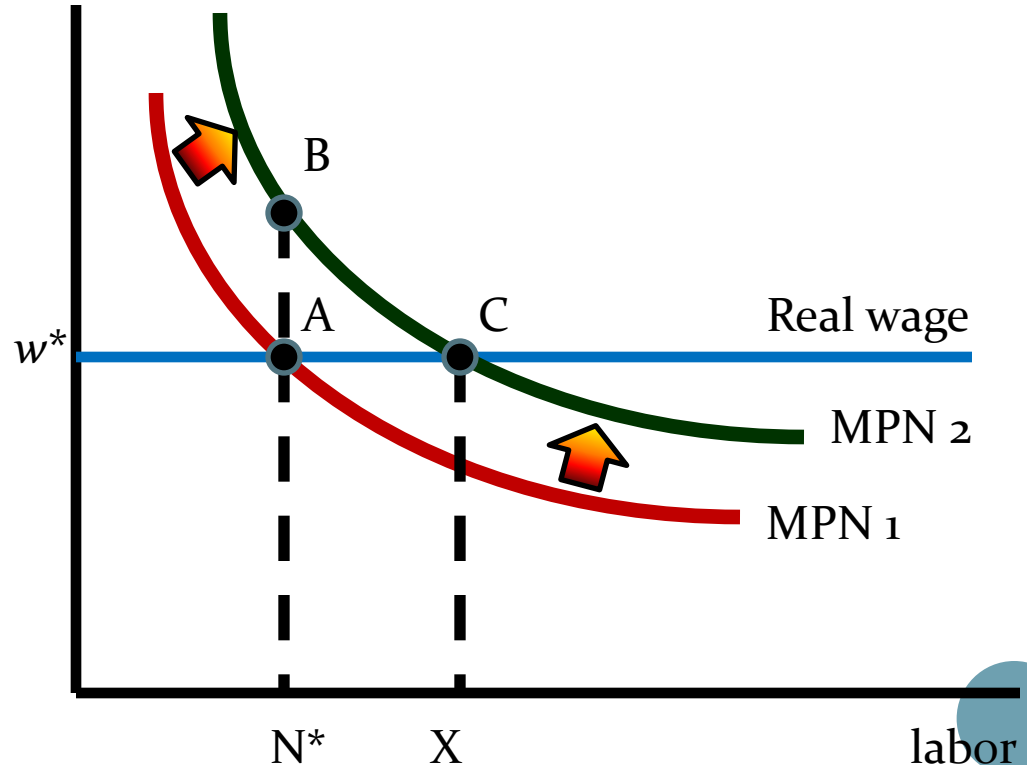
- ❑ Changes in the wage do not shift the labor demand curve. Changes in the wage will cause movement along the labor demand curve.
- ❑ Factors that shift labor demand curve would be something that will change the demand for labor at any given wage.
- ❑ A beneficial shock will shift the labor demand curve to the right.
- ❑ An adverse shock will shift the labor demand curve to the left.



SHIFT OF THE LABOR DEMAND CURVE

- A beneficial supply shock, such as invention of a new technology, will shift the MPN curve to the right.
- Originally, the firm employed N^* amount of labor.
- Now the real wage and the new MPN curve intersects at point C up to which the firm will want to hire labor to maximize profit.
- As a result employment will rise and new employment level will be at X .

MPN and real wage



SUPPLY OF LABOR

- We have seen that firm's demand for labor depend on labor productivity and wage paid to labor.
- However, supply of labor depends on workers' personal choice to work.
- Personal choice about being a part of the labor force generally depends on the following two factors:
 - ❖ Income-leisure trade-off
 - ❖ Real wage



LABOR SUPPLY CURVE

- Labor supply curve looks the same as the supply curve we studied before.
- Usually, we assume that a higher real wage will increase labor supply.
- Labor supply curve will not shift because of a change in the wage.
- Any factor that changes the amount of labor supply at a given wage rate will shift the labor supply curve.



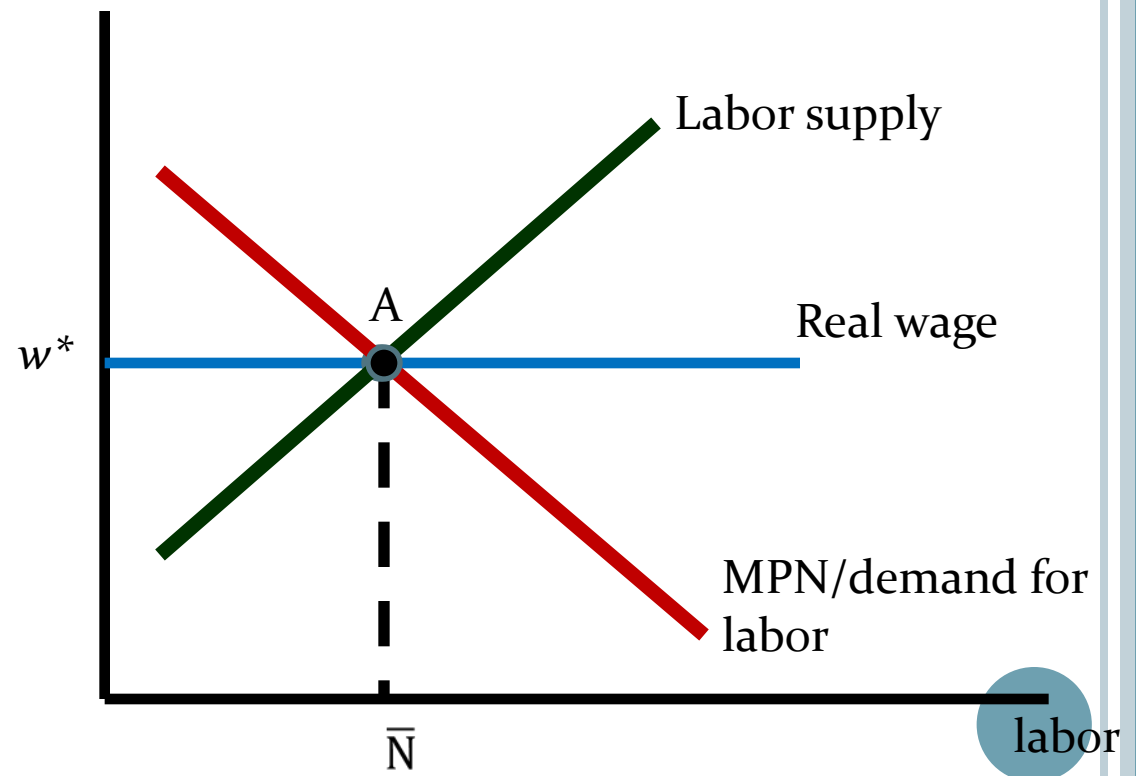
FACTORS THAT SHIFT THE LABOR SUPPLY CURVE

An increase in	Cause the labor supply curve to shift	Reason
Wealth	Left	Increase in wealth increases amount of leisure workers can afford
Expected future real wage	Left	Increase in expected future real wage increases amount of leisure workers can afford
Working-age population	Right	Increased number of potential workers increases amount labor supplied
Participation rate	Right	Increased number of people wanting to work increases amount of labor supplied

LABOR MARKET EQUILIBRIUM

- Equilibrium in the labor market is reached in the same way we found equilibrium in the demand-supply model.
- In case of labor market, equilibrium will be reached at the point where labor demand interacts with labor supply.
- This w^* is not necessarily the wage that maximizes firm's profit.
- \bar{N} is called the **full employment** level of employment.

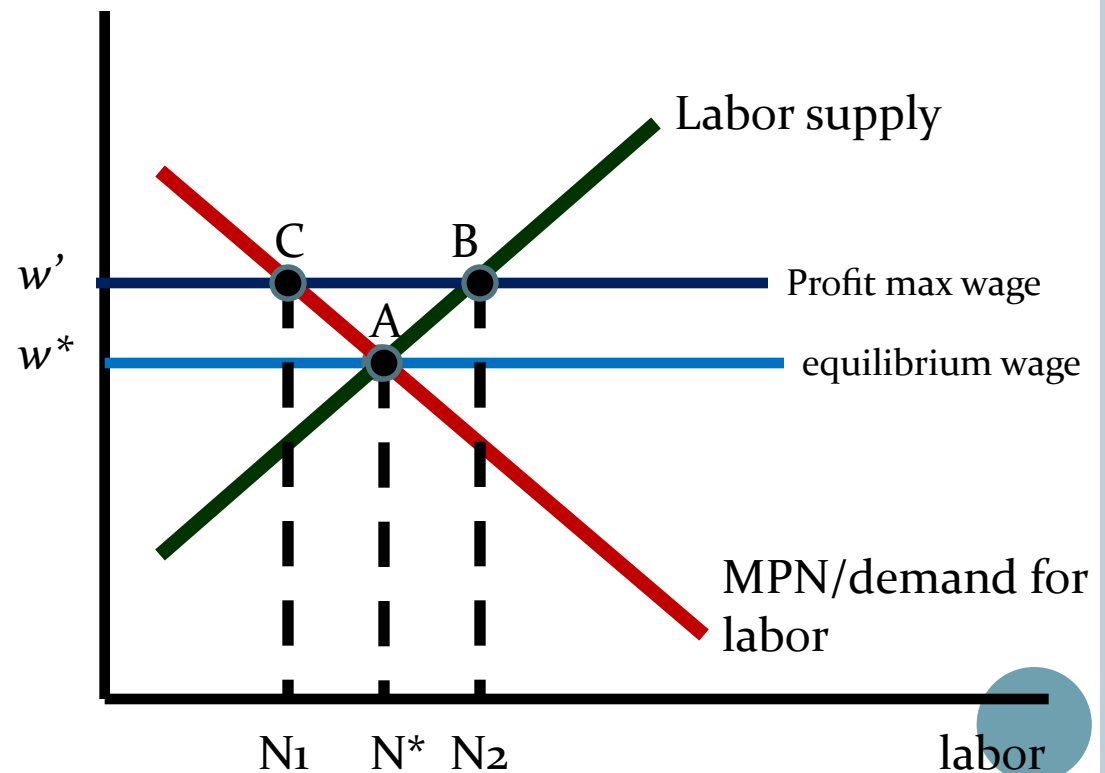
MPN and real wage



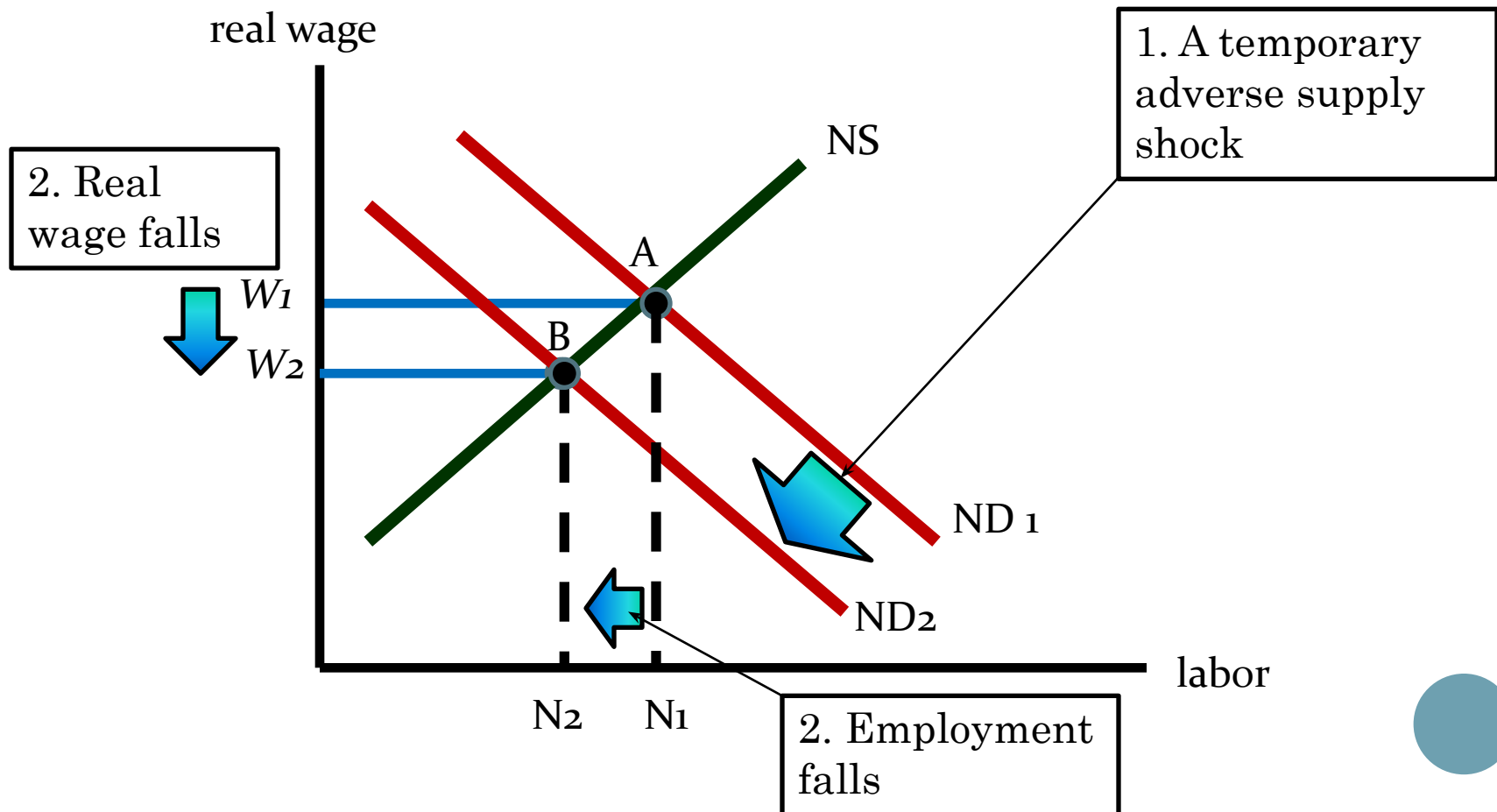
WHEN PROFIT MAXIMIZING WAGE IS HIGHER THAN EQUILIBRIUM WAGE

- Labor market equilibrium is at point A.
- But, as the profit maximizing wage is higher than the equilibrium wage, firms will hire labor that corresponds to point C, where N_1 amount of labor is employed by the firms.
- As a result, although the potential labor supply will be at point B, N_2 amount of labor will not be employed.
- This gives the firm the power to lower wage until equilibrium is reached at point A.

MPN and real wage



EFFECTS OF ADVERSE SUPPLY SHOCK



WHAT IF ALL WORKERS ARE NOT ALIKE?

- We assumed that all workers are alike. By this, we meant that all workers have the same skill level.
- However, if workers have different skill level then supply shocks will not affect all workers in the same way.
- Example: if a production process introduces computer based production, then workers who can operate computers will cope with the new process quickly. On the other hand, workers who cannot operate computers will find it difficult to cope with the process. This will create difference in the marginal productivity level of these two groups of workers. Most likely, the workers who can use computers will get higher wage at cost of those who cannot.
- Therefore, whether a shock will be considered beneficial or adverse depends on the skill/education level of the workers.



UNEMPLOYMENT: THE UNTOLD STORY OF FULL-EMPLOYMENT

- *Full-employment* level implies that all the workers who are willing to work at the equilibrium wage rate will find a job.
- All workers in real life do not find jobs even if they want to. When workers are unemployed for a long time the sum of all such workers constitute “**structural unemployment**”.
- If workers are unemployed for a brief period (for example: the brief period in which they search for a suitable job) we call it “**frictional unemployment**”.
- The rate of unemployment that prevails when output and unemployment rate the full-employment level, we call it **natural rate of unemployment**.
- The difference between actual unemployment rate and natural unemployment rate is called **cyclical unemployment**.
- If workers are not willing to work, this will not constitute unemployment. We shall consider these workers as out of work force.

