The Markets for the Factors of Production

EE211

Factors of Production

Factors of production:

- Inputs used to produce goods and services: labor, land, capital
- Prices and quantities are determined by supply and demand in factor markets.

Derived demand for a factor of production

- A firm's demand for a factor of production is derived from its decision to supply a good in another market.

The Competitive, Profit-Maximizing Firm

Labor market

- Governed by supply and demand

Labor demand is a derived demand

What determines a competitive firm's demand for labor?

How does labor supply depend on the wage? What other factors affect labor supply?

How do various events affect the equilibrium wage and employment of labor?

How are the equilibrium prices and quantities of other inputs determined?

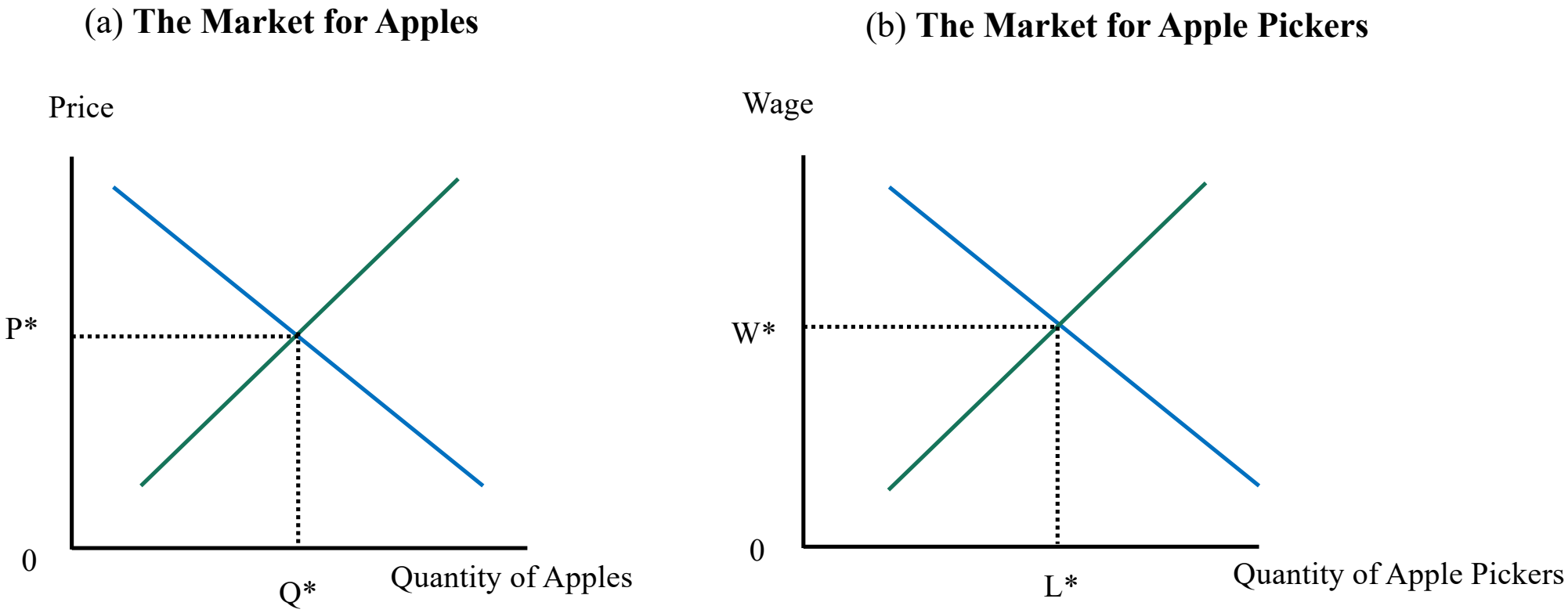
Two Assumptions

1. **All markets are competitive**
   - The typical firm is a price taker
     - In the market for the good it produces
     - And in the labor market (factors of production)
2. **Firms care only about maximizing profits**
   - Each firm's supply of output and demand for inputs are derived from this goal


The Demand for Labor

The Demand for Labor

- Labor demand is **a derived demand**
- Labor services are inputs into the production of other goods
- To understand labor demand, we focus on the firms that hire the labor and use it to produce goods for sale
- The link between the supply of goods and the demand for labor to produce them is crucial in determining equilibrium wages



(a) Shows how the supply and demand for apples determine the price of apples
(b) Shows how the supply and demand for apple pickers determine the wage of apple pickers.

Assumptions for the Firm

Firm is competitive in

- Market for apples (where it is a seller)
- Market for apple pickers (where it is a buyer)

Firm is profit-maximizing

- **Firm's supply of apples and demand for workers are derived from primary goal of maximizing profit**

The Production Function

Production function

- Relationship between the quantity of inputs used to make a good and the quantity of output of that good

Becomes flatter as the quantity of input increases

The Marginal Product of Labor

Marginal product of labor

- Increase in the amount of output from an additional unit of labor

Diminishing marginal product

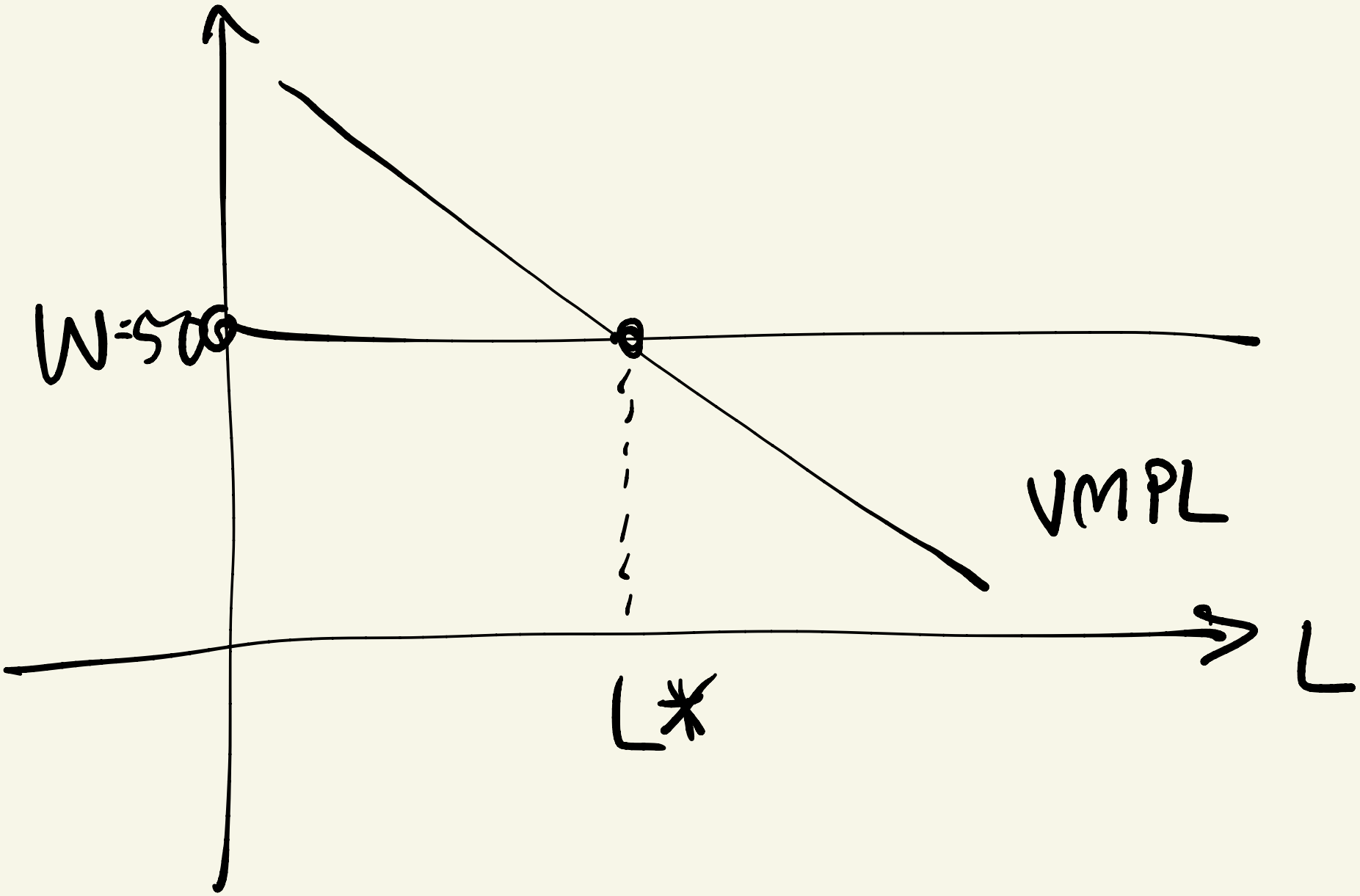
- The marginal product of an input declines as the quantity of the input increases
- Explains the shape of the production function

How the Competitive Firm Decides How Much Labor to Hire

(1) Labor L	(2) Output Q	(3) Marginal Product of Labor MPL = ΔQ/ΔL	(4) Value of the Marginal Product of Labor VMPL= P × MPL	(5) Wage W	(6) Marginal Profit ΔProfit = VMPL-W
0 workers	0 bushels				
1	100	100 bushels	$1,000	$500	$500
2	180	80	800	500	300
3	240	60	600	500	100
4	280	40	400	500	-100
5	300	20	200	500	-300

How the competitive firm decides how much labor to hire

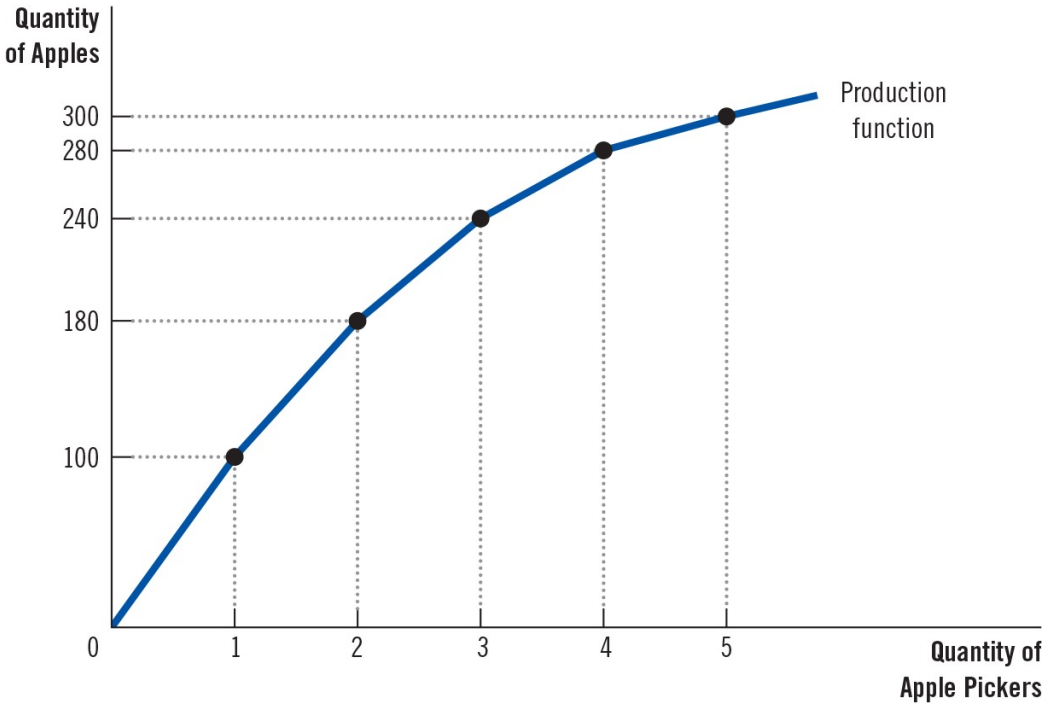
Labor (L)	Output (Q)	Marginal product of labor, MPL= ΔQ / ΔL	Value of the Marginal Product VMPL = PxMPL P=$10 per bushel	Wage (w)	Marginal Profit Δprofit = VMPL - w
0 workers	0 bushels				
		100 bushels	$1,000	$500	$500
1	100				
		80	800	500	300
2	180				
		60	600	500	100
3	240				
		40	400	500	-100
4	280				
		20	200	500	-300
5	300				


W=500
VMPL
L
L*

The Production Function

- The production function shows how an input into production (apple pickers) influences the output from production (apples).

- As the quantity of the input increases, the production function gets flatter, **reflecting the property of diminishing marginal product.**



The Value of the Marginal Product

Value of the marginal product

- Marginal product of an input times the price of the output

Marginal revenue product is the extra revenue the firm gets from hiring an additional unit of a factor of production

The Value of the Marginal Product

Competitive, profit-maximizing firm

- **Hires workers up to the point where the value of the marginal product of labor equals the wage**

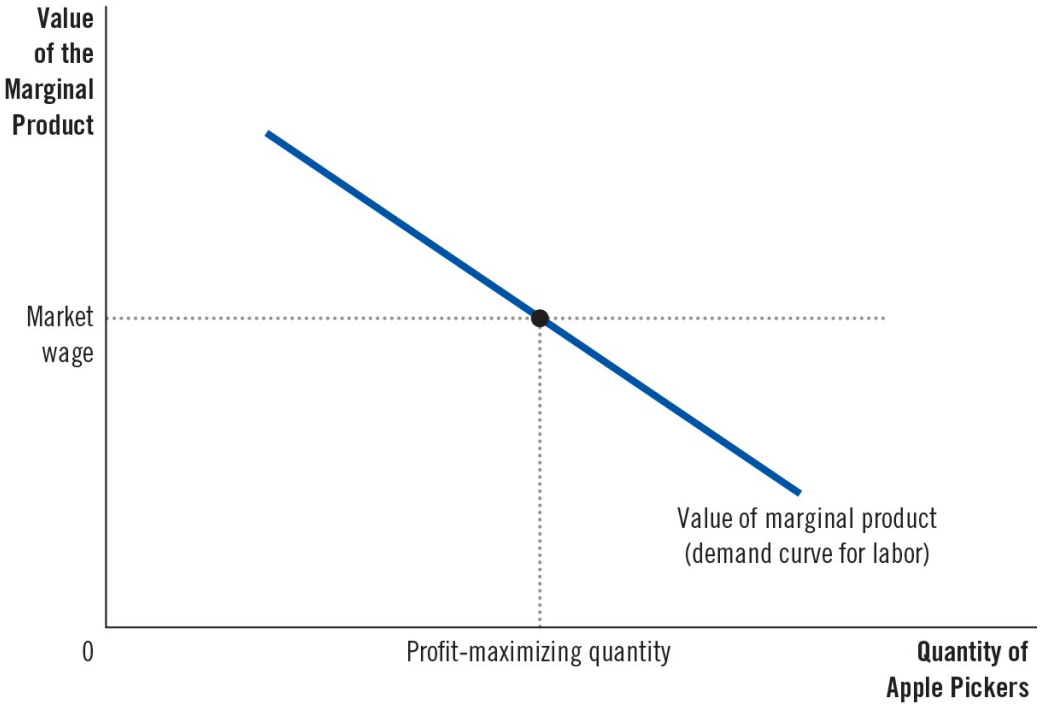
The value-of- marginal-product curve is the labor-demand curve for a competitive, profit-maximizing firm

The Value of the Marginal Product of Labor

- This figure shows how the value of the marginal product (the marginal product times the price of the output) depends on the number of workers.

- The curve slopes downward because of diminishing marginal product.

- For a competitive, profit-maximizing firm, this value-of-marginal-product curve is also the firm's labor-demand curve.



Active Learning 1: Xavier's Truck *MPL* and *VMPL*

- The table which shows Xavier's popcorn truck input and output
- The price of popcorn is P = \$5 per bucket of popcorn
  - **Calculate MPL and VMPL**
  - **Graph a curve with VMPL on the vertical axis, L on horizontal axis**

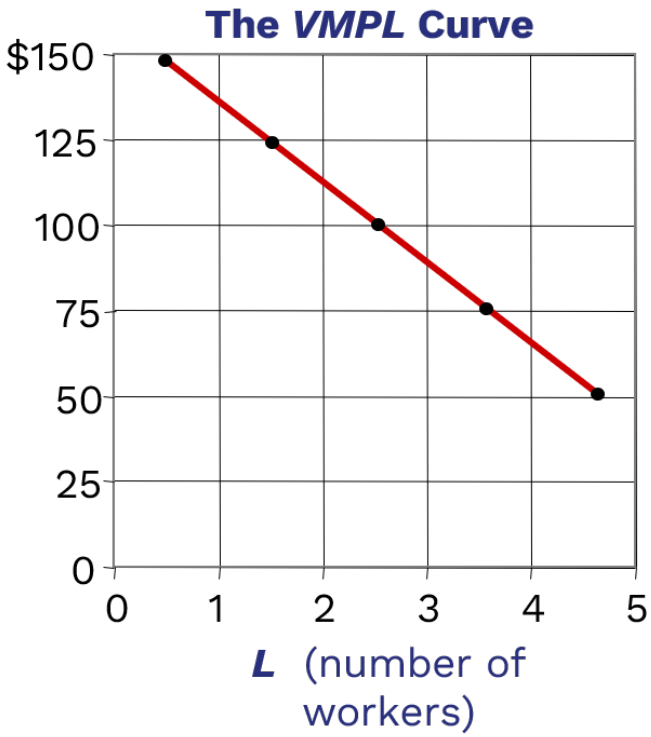
Workers L	Buckets Q
0	0
1	30
2	55
3	75
4	90
5	100

Active Learning 1: Answers

Workers L	Buckets Q	MPL = ΔQ / ΔL	VMPL = P × MPL
0	0		
1	30	30	150
2	55	25	125
3	75	20	100
4	90	15	75
5	100	10	50

Active Learning 1: Answers

Workers L	Buckets Q	MPL = ΔQ/ΔL	VMPL = P× MPL
0	0		
1	30	30	150
2	55	25	125
3	75	20	100
4	90	15	75
5	100	10	50



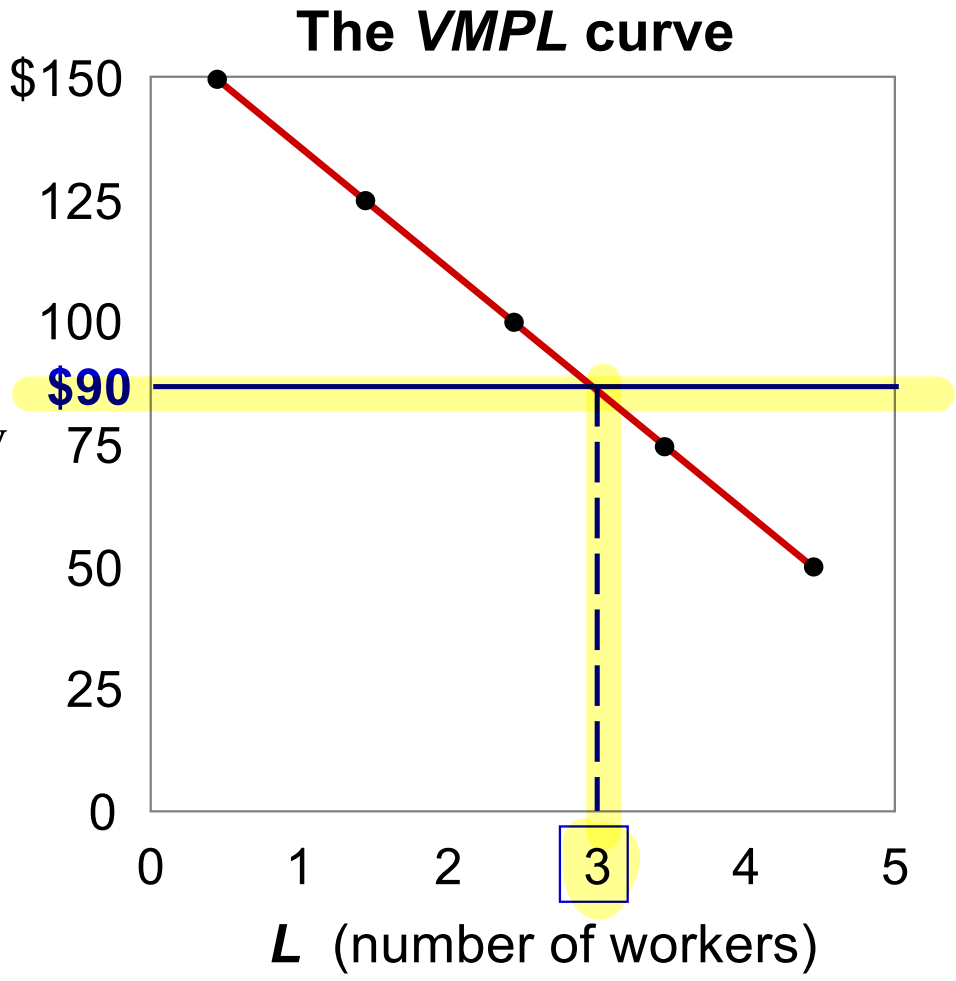
Suppose wage

***W* = $90/day.**

How many workers should Xavier hire?

Answer: *L* = 3

- At any smaller ***L*:** increase profit by hiring another worker
- At any larger ***L*:** increase profit by hiring one fewer worker.



What Causes the Labor-Demand Curve to Shift?

Output price

- When the output price changes, the value of the marginal product changes, and the labor-demand curve shifts

Technological change

- Technological advance can raise MPL, shifting labor-demand curve to the right
- Labor-saving technology can reduce MPL, shifting labor-demand curve to the left

Supply of other factors

- Affect the marginal product of other factors

Recap: Costs and Benefits of One More Worker

- Cost of hiring another worker:
  - The wage = the price of labor
- Benefit of hiring another worker:
  - Produce and sell more output, increasing revenue.
  - The size of this benefit depends on the **production function**: the relationship between the quantity of inputs used to make a good and the quantity of output of that good

The Production Function of the Marginal Product of Labor (MPL)

- The production function – the relationship between the quantity of inputs used to make a good and the quantity of output of that good
- **Marginal product of labor**, $MPL = \Delta Q / \Delta L$
  - **The increase in the amount of output from an additional unit of labor**
  - Where:
    ΔQ = change in output
    ΔL = change in labor
- **Diminishing marginal product**
  - **The marginal product of an input declines as the quantity of the input increases**

The Value of the Marginal Product

- Problem:
  - Cost of hiring another worker (wage) is measured in dollars
  - Benefit of hiring another worker (***MPL***) is measured in units of output
  - Solution: convert ***MPL*** to dollars
- Value of the MPL, $VMPL = P \times MPL$
  - The marginal product of an input (labor) times the price of the output

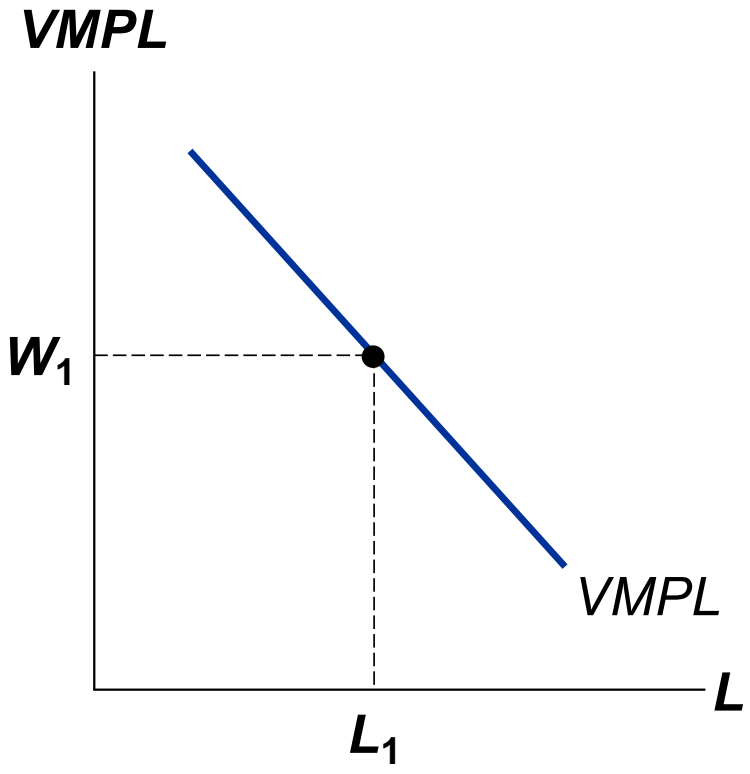
VMPL and labor demand

For any competitive, profit-maximizing firm:

To maximize profits, hire workers up to the point where

$$VMPL = W.$$

The *VMPL* curve is the labor demand curve.




The Supply of Labor

The Trade-Off between Work and Leisure

- People face trade-offs
- Trade-off between work and leisure
- Labor-supply curve
  - Reflects how workers' decisions about the labor-leisure trade-off
  - Respond to a change in opportunity cost of leisure

Labor-Supply Decision

Labor-supply decision

- The income effect reflects the response of hours worked due to a change in a person's level of economic well-being
- The substitution effect reflects the response of hours worked due to a change in the opportunity cost of leisure

The Supply of Labor

Trade-off between work and leisure:

- The more time you spend working, the less time you have for leisure.

Wage

- Is the opportunity cost of leisure
- When wage increases, the opportunity cost of enjoying leisure goes up

PETER C. VEY/THE NEW YORKER COLLECTION/THE CARTOON BANK

"I really didn't enjoy working five days a week, fifty weeks a year for forty years, but I needed the money."

Input Demand & Output Supply

Marginal Cost (***MC***): cost of producing an additional unit of output

$MC = \Delta TC / \Delta Q$, where TC = total cost

In general: $MC = W / MPL$

To produce additional output

- Hire more labor. As L rises, MPL falls…
- causing W / MPL to rise…causing MC to rise.

Diminishing marginal product and increasing marginal cost are two sides of the same coin

Input Demand & Output Supply

The competitive firm's rule for demanding labor: $P \times MPL = W$

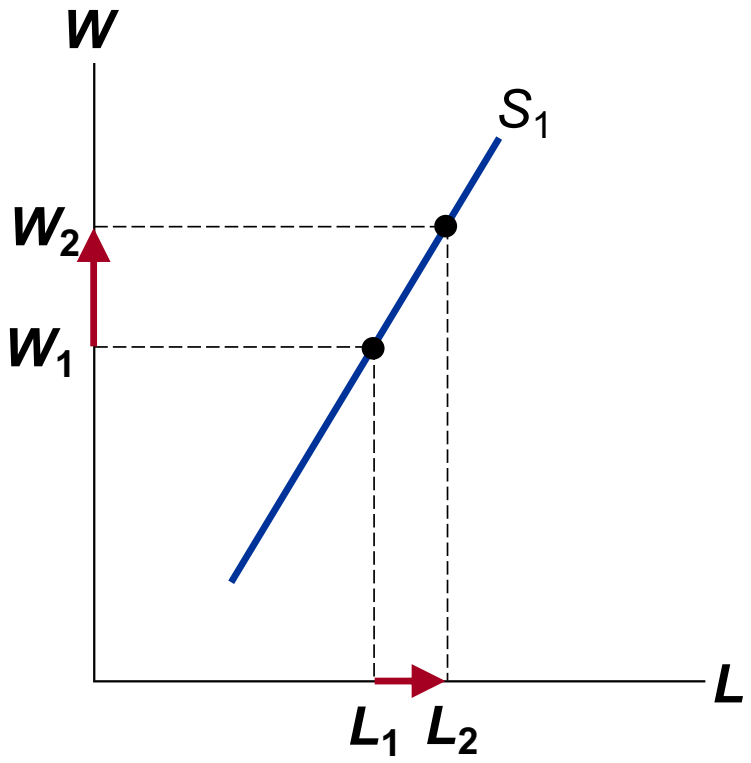
- Divide both sides by MPL: $P = W / MPL$
- Substitute $MC = W / MPL$ from previous slide: $P = MC$
  - **This is the competitive firm's rule for supplying output.**

Hence: Input demand and output supply are two sides of the same coin.

The Labor Supply Curve

An increase in *W*
is an increase in the opportunity cost of leisure.

People respond by taking less leisure and by working more.



What Causes the Labor-Supply Curve to Shift?

- **Changes in preferences**
  - Example: increase in labor force participation of women
- **Changes in alternative opportunities**
  - The supply of labor in any one labor market depends on the opportunities available in other labor markets
- **Immigration**
  - Movement of workers from region to region, or country to country


Equilibrium in the Labor Market

Equilibrium Wage

Any event that changes the supply or demand for labor must change the equilibrium wage and the value of the marginal product by the same amount because these must always be equal

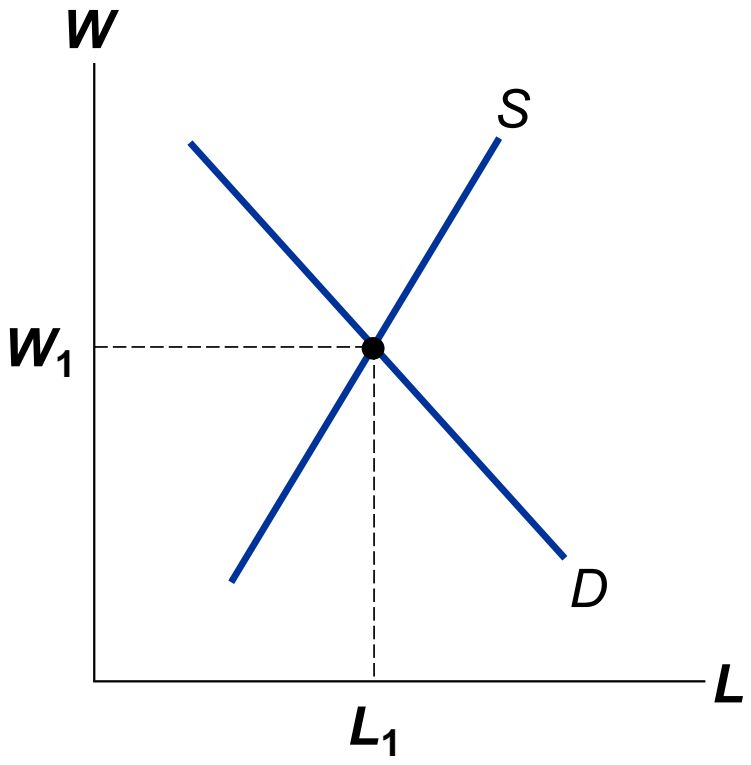
- The wage adjusts to balance the supply and demand for labor
- The wage equals the value of the marginal product of labor

Equilibrium in the Labor Market

Wage: adjusts to balance ***S*** and ***D*** for labor.

The wage always equals the value of the marginal product of labor (***VMPL***).

*Any event that changes the **S** or **D** for labor must change the equilibrium wage and the **VMPL** by the same amount.*



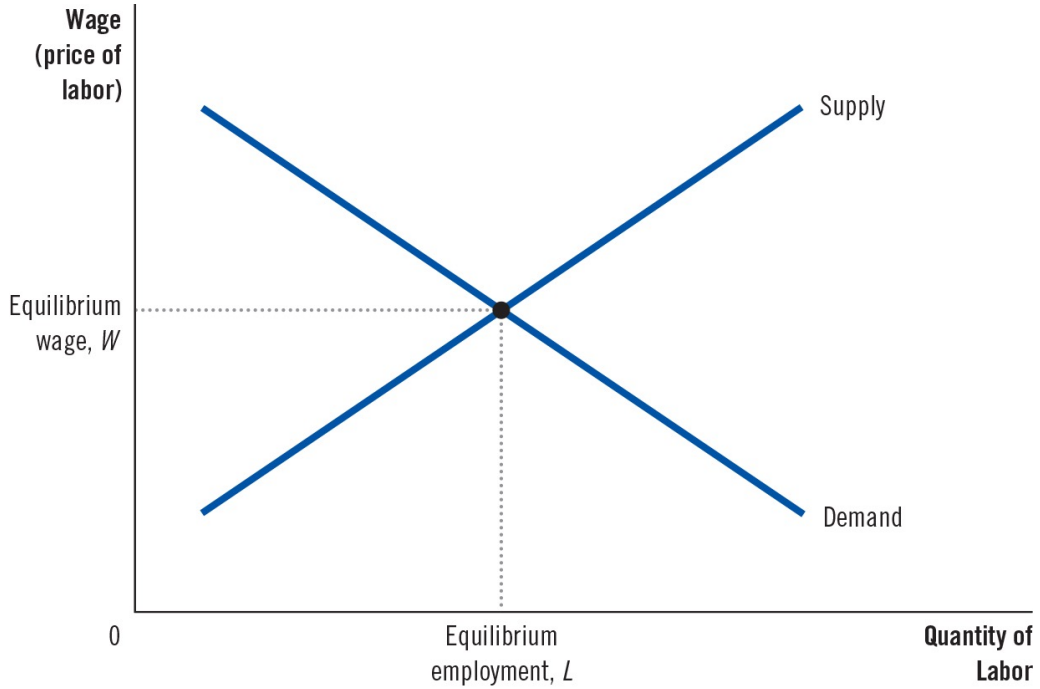
Shifts in Labor Supply

Increase in supply

- Decrease in wage
- Lower marginal product of labor
- Lower value of marginal product of labor
- Higher employment

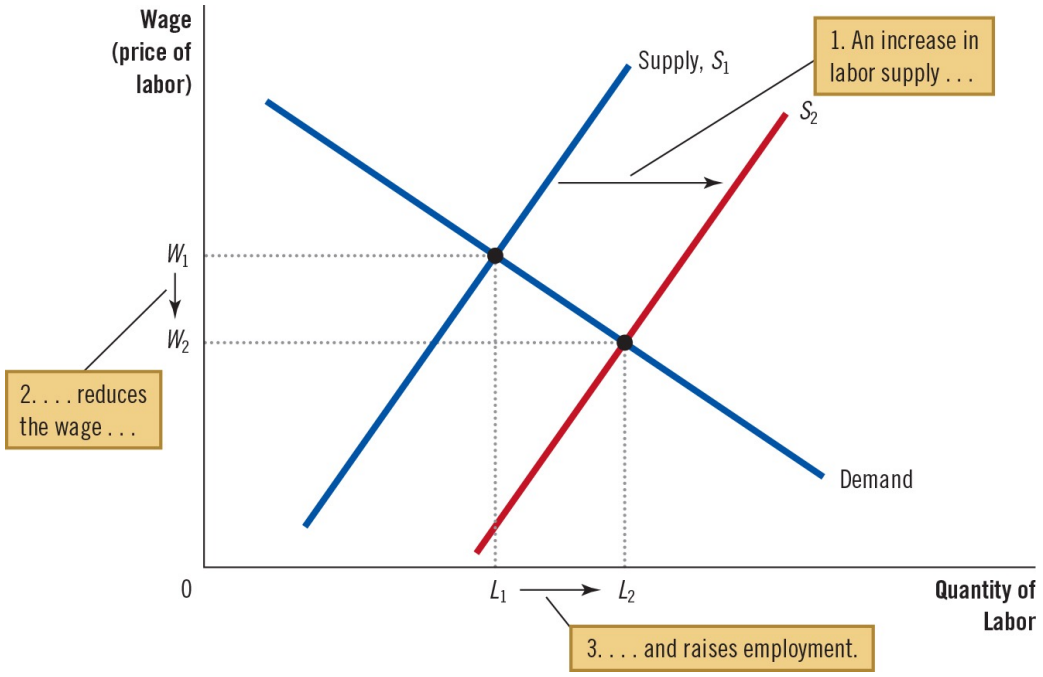
Equilibrium in a Labor Market

- Like all prices, the price of labor (the wage) depends on supply and demand.
- Because the demand curve reflects the value of the marginal product of labor, in equilibrium, workers receive the value of their marginal contribution to the production of goods and services.



A Shift in Labor Supply

- When labor supply increases from S_1 to S_2, perhaps because of an immigration wave of new workers, the equilibrium wage falls from W_1 to W_2. At this lower wage, firms hire more labor, so employment rises from L_1 to L_2.
- The change in the wage reflects a change in the value of the marginal product of labor: With more workers, the added output from an extra worker is smaller.



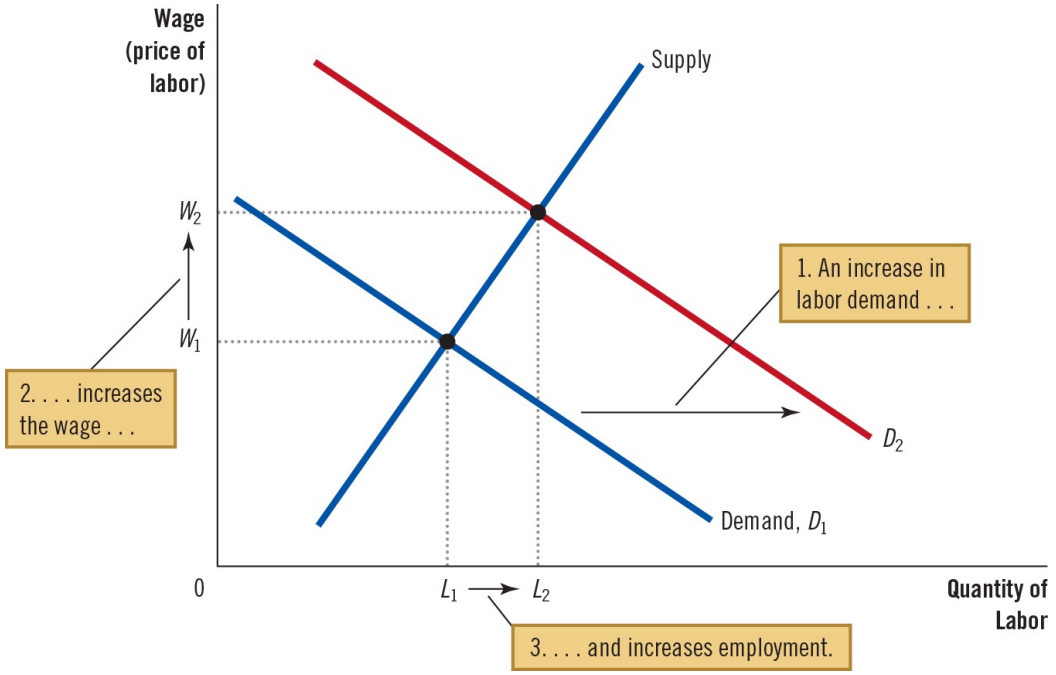
Shifts in Labor Demand

Increase in demand

- Higher wage
- No change in marginal product of labor
- Higher value of marginal product of labor
- Higher employment

A Shift in Labor Demand

- When labor demand increases from D_1 to D_2, perhaps because of an increase in the price of the firm's output, the equilibrium wage rises from W_1 to W_2, and employment rises from L_1 to L_2.
- The change in the wage reflects a change in the value of the marginal product of labor: With a higher output price, the added output from an extra worker is more valuable.



Active Learning 2: Changes in labor-market equilibrium

In each of the following scenarios, use a diagram of the market for (domestic) auto workers to find the effects on their wage and employment.

A. Baby boomers who worked in the auto industry retire.

B. Car buyers' preferences shift toward imported autos.

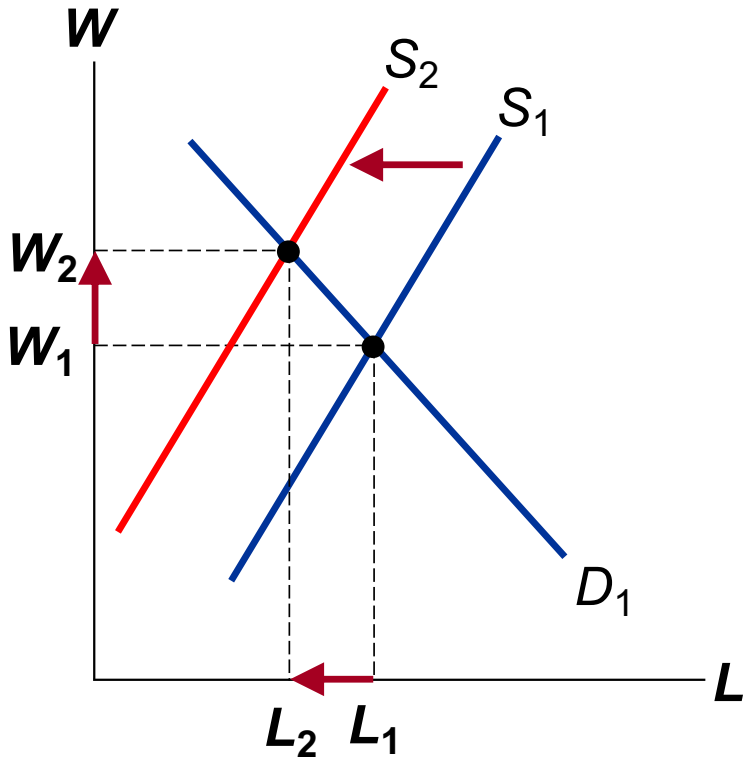
C. Technological progress boosts worker productivity in the auto manufacturing industry.

Active Learning 2: Answers, A

The retirement of baby boomer auto workers shifts supply leftward.

- *W* rises, *L* falls.

The market for autoworkers

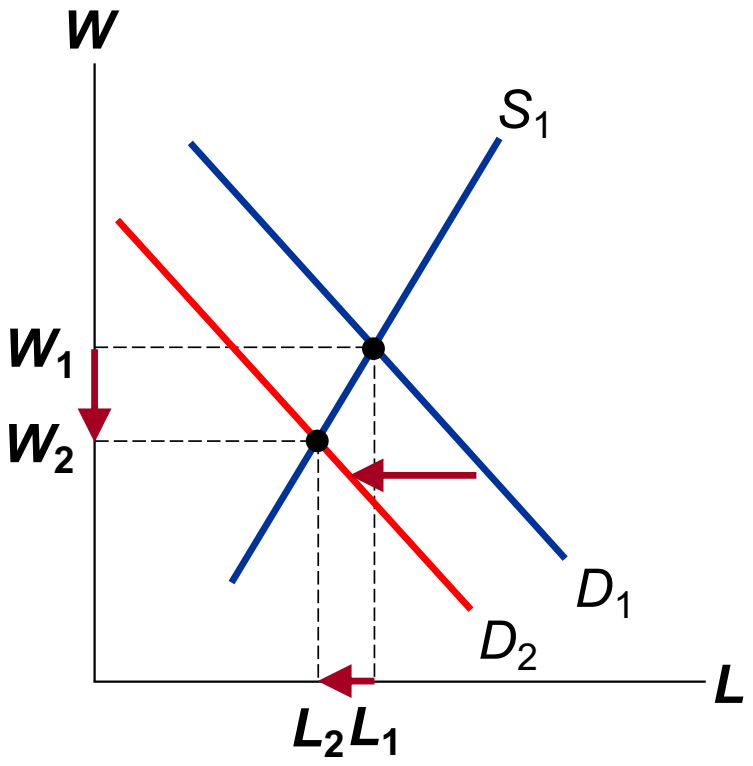


Active Learning 2: Answers, B

A fall in the demand for U.S. autos reduces ***P***.

- At each ***L***, ***VMPL*** falls.
- Labor demand curve shifts left.
- ***W*** and ***L*** both fall.

The market for autoworkers

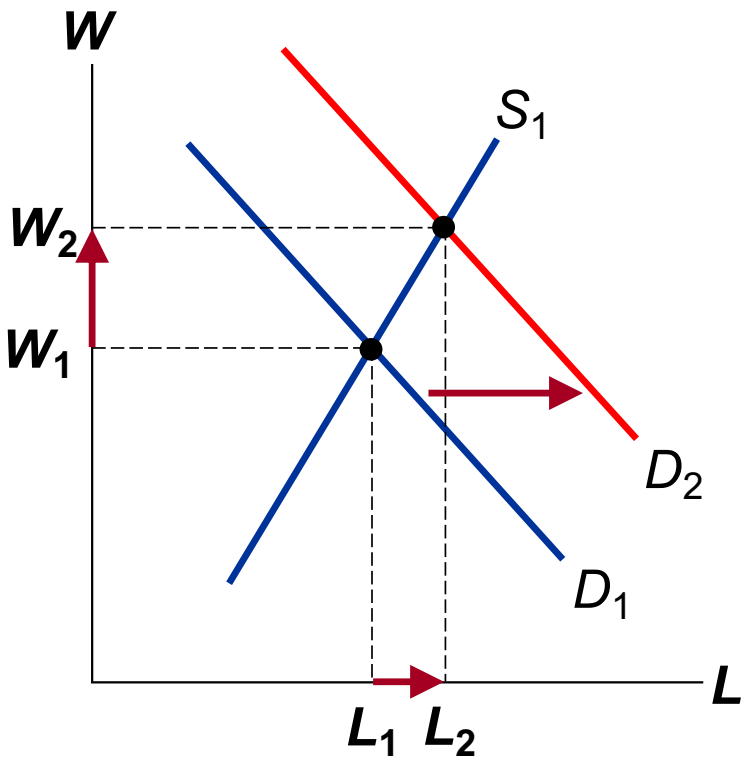


Active Learning 2: Answers, C

At each ***L***,
MPL rises due to tech. progress.

- *VMPL* rises
- Labor demand curve shifts right.
- *W* and *L* increase.

The market for autoworkers



The Other Factors of Production: Land and Capital

The Other Factors of Production: Land and Capital

- With land and capital, must distinguish between:
  - Purchase price: the price a person pays to own that factor indefinitely
  - Rental price: the price a person pays to use that factor for a limited period of time
    - The wage is the rental price of labor
- The determination of the rental prices
  - Analogous to the determination of wages

Equilibrium in the Markets for Land and Capital

Capital

- Equipment and structures used to produce goods and services

Purchase price

- Price a person pays to own that factor of production indefinitely

Rental price

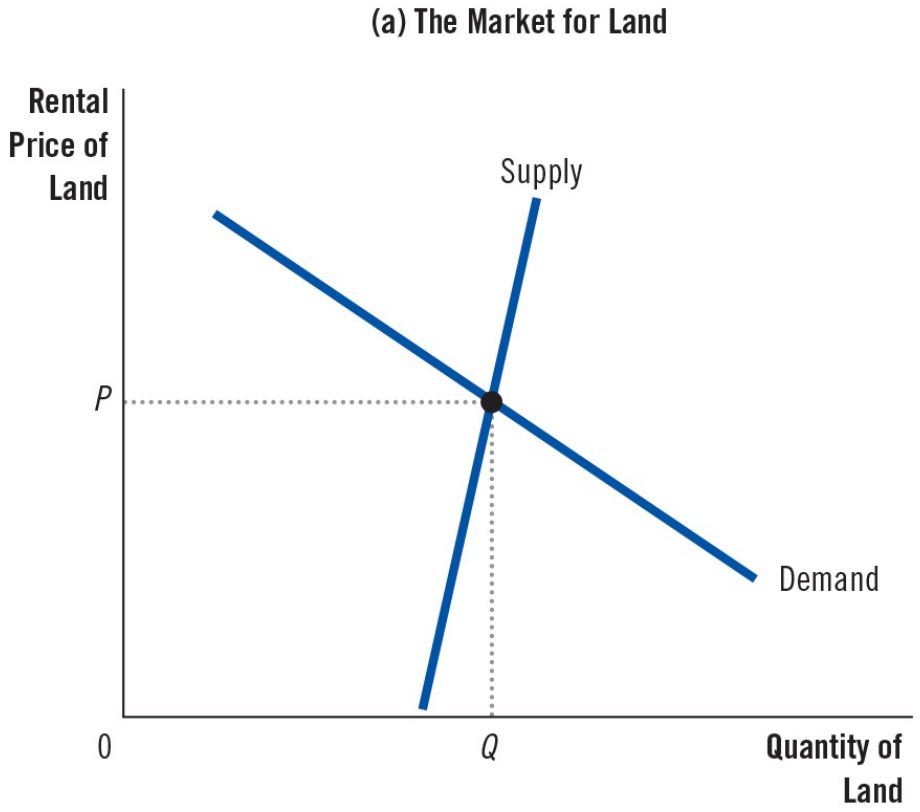
- Price a person pays to use that factor for a limited period of time

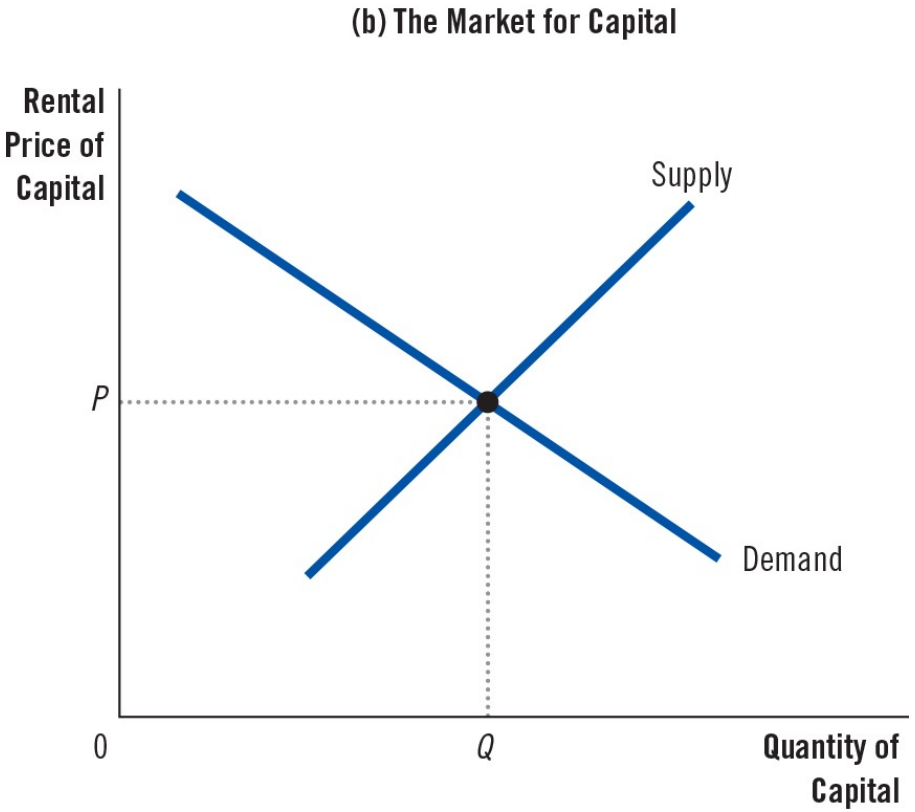
Equilibrium in the Markets for Land and Capital

- As long as the firms using the factors of production are competitive and profit-maximizing, each factor's rental price must equal the value of its marginal product
- Labor, land, and capital all earn the value of their marginal contributions to the production process
- Equilibrium purchase price depends on
  - Current value of the marginal product
  - Value of the marginal product expected to prevail in the future

The Markets for Land and Capital

Supply and demand determine the compensation paid to the owners of land, as shown in panel (a), and the compensation paid to the owners of capital, as shown in panel (b). The demand for each factor, in turn, depends on the value of its marginal product.

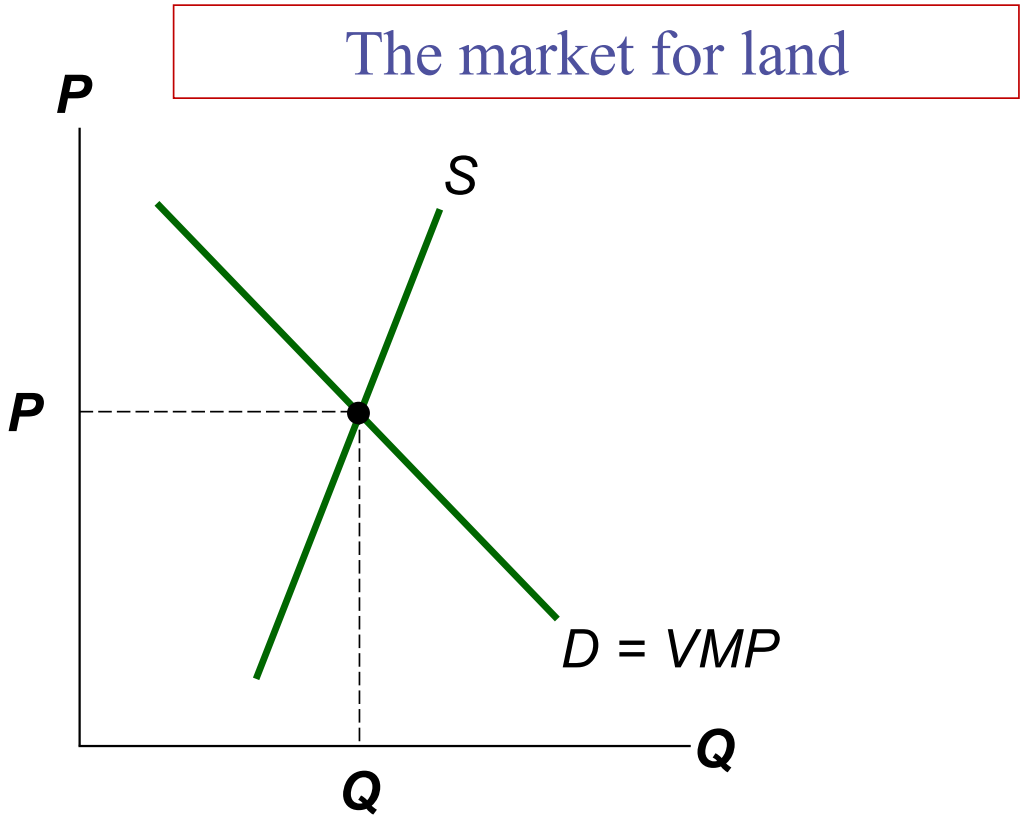




How the Rental Price of **Land** is Determined

Firms increase the quantity of land to rent until the value of the marginal product (***VMP***) of land equals the land's rental price.

The rental price of land adjusts to balance supply and demand for land.

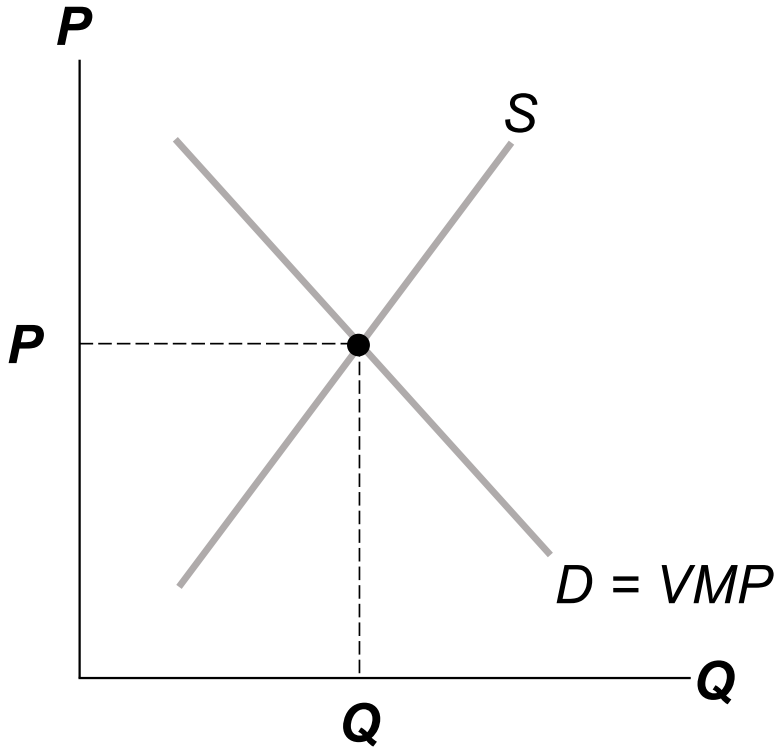


How the Rental Price of **Capital** is Determined

Firms increase the quantity of capital to rent until the value of the marginal product
(***VMP***) of capital equals the capital's rental price.

The rental price of capital adjusts to balance supply and demand for capital.

The market for capital



Rental and Purchase Prices

- Buying a unit of capital or land
  - Yields a stream of rental income
- The rental income in any period
  - Equals the value of the marginal product (***VMP***)
- Hence, the equilibrium purchase price of a factor
  - Depends on both the current ***VMP*** and the ***VMP*** expected to prevail in future periods.

Linkages among the Factors of Production

- Factors of production are used together
  - In a way that makes each factor's productivity dependent on the quantities of the other factors
- Marginal product of any factor depends on
  - Quantity of that factor that is available
  - Diminishing marginal product
- An event that changes the supply of any factor of production can alter the earnings of all the factors

Conclusion

The theory developed in this chapter is called the neoclassical theory of distribution

- The amount paid to each factor of production depends on the supply and demand for that factor
- The demand, in turn, depends on that factor's marginal productivity
- In equilibrium, each factor of production earns the value of its marginal contribution to the production of goods and services

References

Mankiw, N.G., (2024) **Principles of Microeconomics**, 10th ed., Cengage, (ISBN-13: 978-981-5119-30-5)

Class activity I

Smiling Cow Dairy can sell all the milk it wants for $4 a gallon, and it can rent all the robots it wants to milk the cows at a capital rental price of $100 a day. It faces the following production schedule:

Number of Robots	Total Product
0	0 gallons
1	50
2	85
3	115
4	140
5	150
6	155

a. In what kind of market structure does the firm sell its output? How can you tell?

b. In what kind of market structure does the firm rent robots? How can you tell?

c. Calculate the marginal product and the value of the marginal product of each additional robot.

d. How many robots should the firm rent? Explain.

a) The firm can sell all of the milk it wants to at the mkt price of $4 per gallon, Smiling Cow Dairy operates in a perfect competitive output market.

b) Because the firm can rent all the robots it wants to at the market price of $ 100 per day, Smiling Cow Dairy rents robots in a perfectly competitive market.

c), d) The firm should rent robots up to the point where VMP is equal to the wage! Therefore, it should rent 4 robots

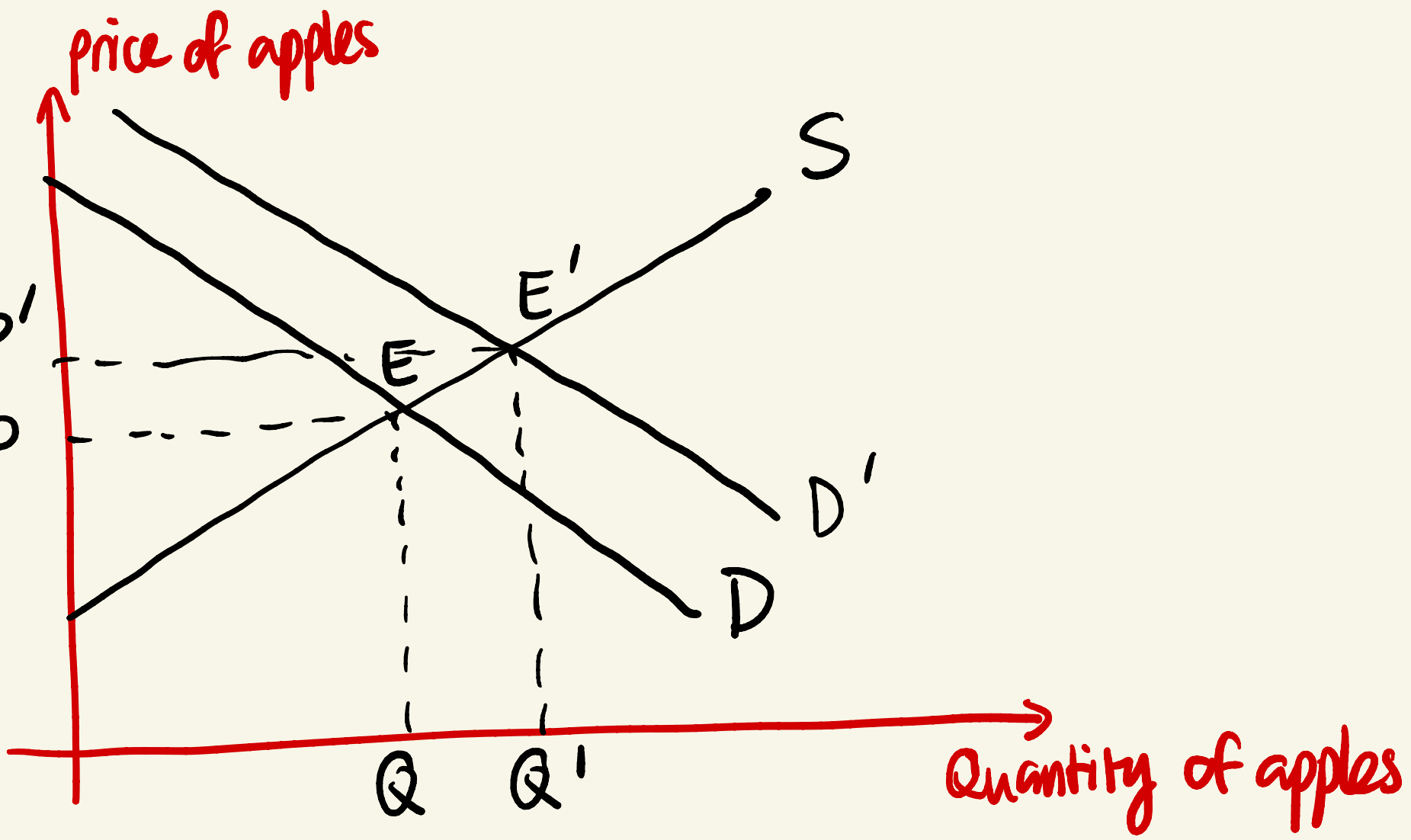
# Robots	Total output	MP	VMP = P × MP
0	0	50	$200
1	50	35	140
2	85	30	120
3	115	25	100
4	140	10	40
5	150	5	20
6	155		

Class activity II

Suppose that the president proposes a new law aimed at reducing healthcare costs: All Americans are required to eat one apple daily.

a. How would this apple-a-day law affect the demand and equillibrium price of apples?
b. How would the law affect the marginal product and the value of the marginal product of apple pickers?
c. How would the law affect the demand and equilibrium wage for apple pickers?

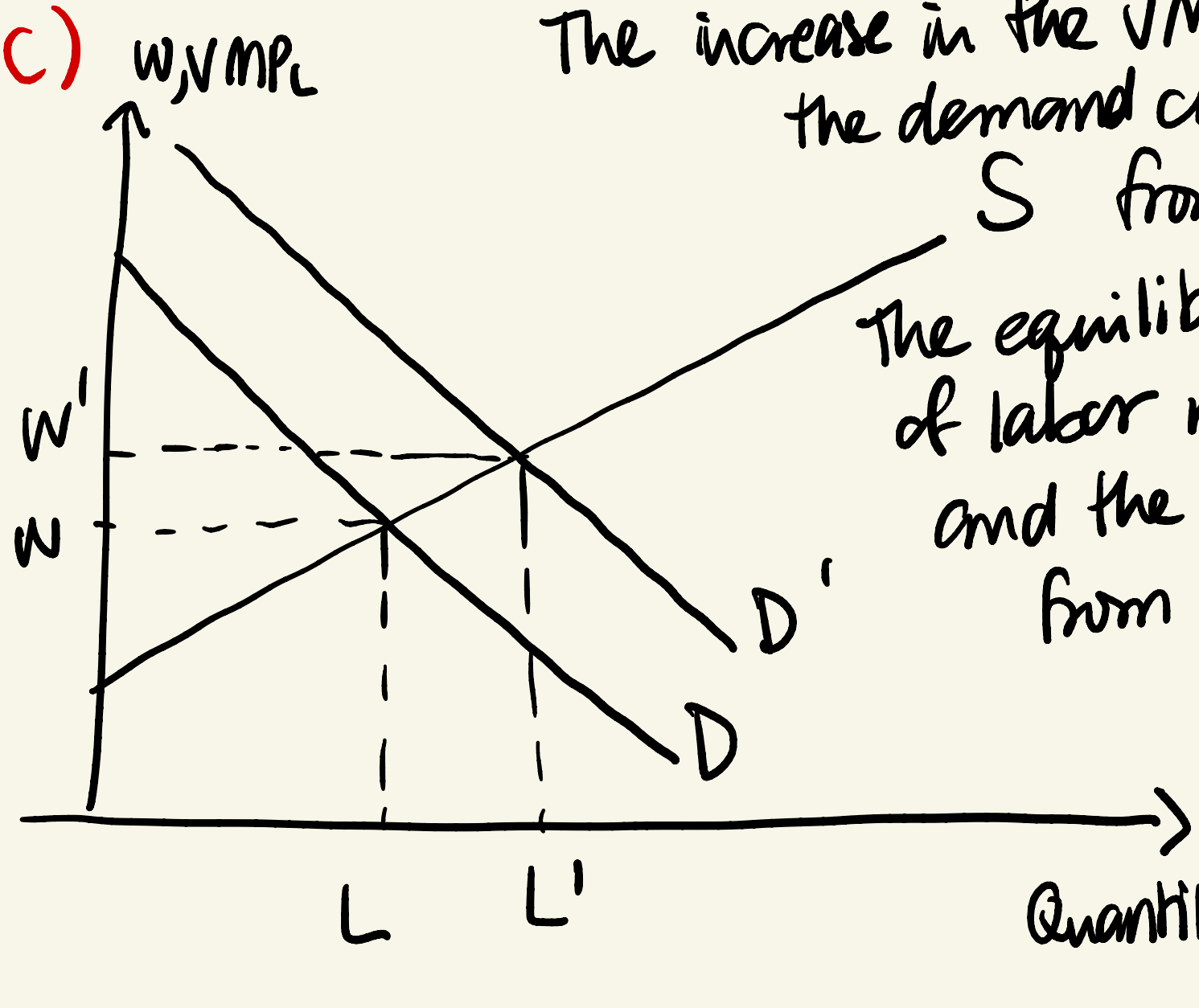
a)



The law requiring people to eat one apple a day increases the demand for apples.
As shown in figure, demand shifts from D to D', increasing the price from P to P', and increasing quantity from Q to Q'.

b) Because the price of apple increases, the VMP increases for any given quantity of labor. There is no change in the MPL for any given quantity of labor. However, firms will choose to hire more workers and thus the MPL at the profit-maximizing level of labor will be lower.

c)



The increase in the VMP_L shifts the demand curve of labor S from D to D'.

The equilibrium quantity of labor rises from L to L' and the wage rises from W to W'.