The Employer's Dilemma

EC 350: Labor Economics

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Winter 2022

Agenda

1. Difference-in-differences, revisited
    - Card and Krueger (1994)
    - Difference-in-differences with regression
    - Parallel trends assumption
    - Discuss Hoynes and Patel (2018)
2. The Employer's Dilemma
    - Labor demand
    - Profit maximization
    - Production technology
    - Short-run demand curve

Difference-in-differences, revisited

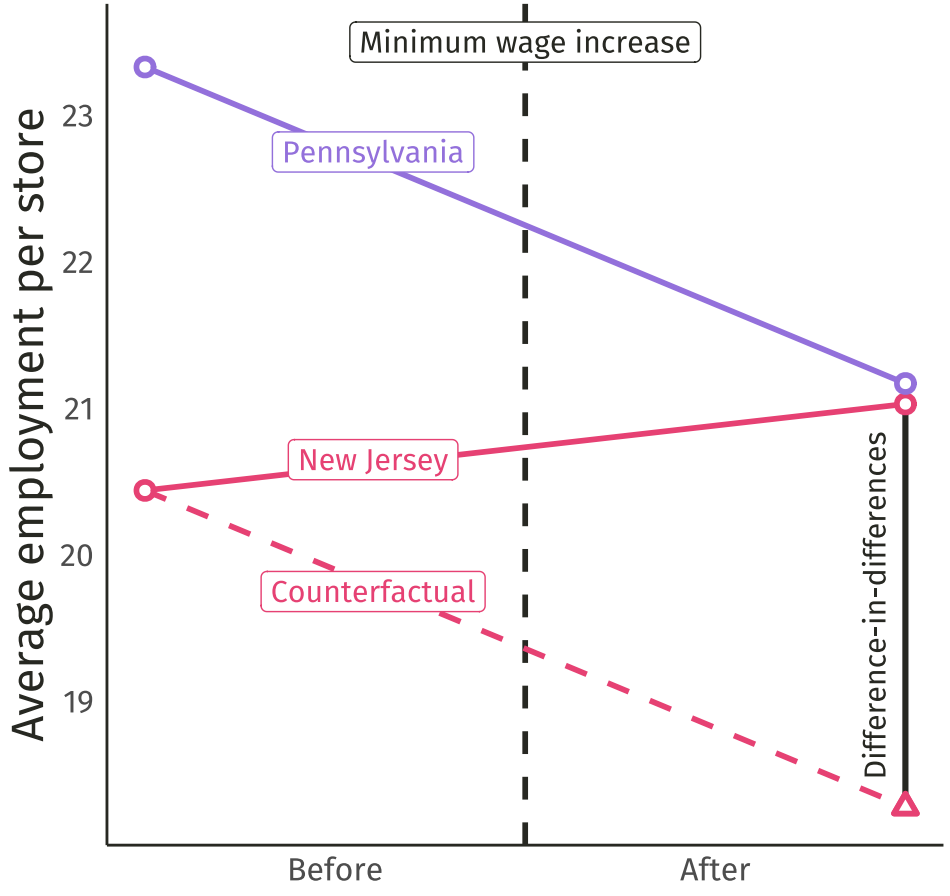
Card and Krueger (1994), revisited

Raw data comparison

Difference-in-differences = 0.59 − -2.16 = 2.75

Average employment per store

Group	After	Before	Difference
Treatment (NJ)	21.03	20.44	0.59
Control (PA)	21.17	23.33	-2.16



Card and Krueger (1994), revisited

Raw data comparison

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Average employment per store

Group	After	Before	Difference
Treatment (NJ)	21.03	20.44	0.59
Control (PA)	21.17	23.33	-2.16

Regression comparison

$$\text{Employment}_{it} = \alpha + \beta\,\text{NJ}_i + \gamma\,\text{After}_t + \delta\,\text{NJ}_i \times \text{After}_t + \varepsilon_{it}$$

Parameter	(1)
Intercept	23.33
	(1.07)
NJ	-2.89
	(1.19)
After	-2.16
	(1.52)
NJ × After	2.75
	(1.69)

Card and Krueger (1994), revisited

Regression $\longrightarrow$ raw data averages

Step 1: Specify the regression model.

$$\text{Employment}_{it} = \alpha + \beta\,\text{NJ}_i + \gamma\,\text{After}_t + \delta\,\text{NJ}_i \times \text{After}_t + \varepsilon_{it}$$

Step 2: Find the expected value of the model for each state and period.

- Average employment in **Pennsylvania** restaurants **before** New Jersey's wage increase

$$\begin{aligned}
&= E\left[\text{Employment}_{it} \mid \text{NJ}_i = 0 \ \wedge \ \text{After}_t = 0\right] \\
&= \alpha + \beta\,(0) + \gamma\,(0) + \delta\,(0) \times (0) + (0) \\
&= \alpha \\
&= 23.33
\end{aligned}$$

Card and Krueger (1994), revisited

Regression $\longrightarrow$ raw data averages

Step 1: Specify the regression model.

$$\text{Employment}_{it} = \alpha + \beta\,\text{NJ}_i + \gamma\,\text{After}_t + \delta\,\text{NJ}_i \times \text{After}_t + \varepsilon_{it}$$

Step 2: Find the expected value of the model for each state and period.

- Average employment in **Pennsylvania** restaurants **after** New Jersey's wage increase

$$\begin{aligned}
&= E\left[\text{Employment}_{it} \mid \text{NJ}_i = 0 \ \wedge \ \text{After}_t = 1\right] \\
&= \alpha + \beta\,(0) + \gamma\,(1) + \delta\,(0) \times (1) + (0) \\
&= \alpha + \gamma \\
&= 23.33 - 2.16 \\
&= 21.17
\end{aligned}$$

Card and Krueger (1994), revisited

Regression $\longrightarrow$ raw data averages

Step 1: Specify the regression model.

$$\text{Employment}_{it} = \alpha + \beta\,\text{NJ}_i + \gamma\,\text{After}_t + \delta\,\text{NJ}_i \times \text{After}_t + \varepsilon_{it}$$

Step 2: Find the expected value of the model for each state and period.

- Average employment in **New Jersey** restaurants **before** New Jersey's wage increase

$$\begin{aligned}
&= E\left[\text{Employment}_{it} \mid \text{NJ}_i = 1 \ \wedge \ \text{After}_t = 0\right] \\
&= \alpha + \beta\,(1) + \gamma\,(0) + \delta\,(1) \times (0) + (0) \\
&= \alpha + \beta \\
&= 23.33 - 2.89 \\
&= 20.44
\end{aligned}$$

Card and Krueger (1994), revisited

Regression $\longrightarrow$ raw data averages

Step 1: Specify the regression model.

$$\text{Employment}_{it} = \alpha + \beta\,\text{NJ}_i + \gamma\,\text{After}_t + \delta\,\text{NJ}_i \times \text{After}_t + \varepsilon_{it}$$

Step 2: Find the expected value of the model for each state and period.

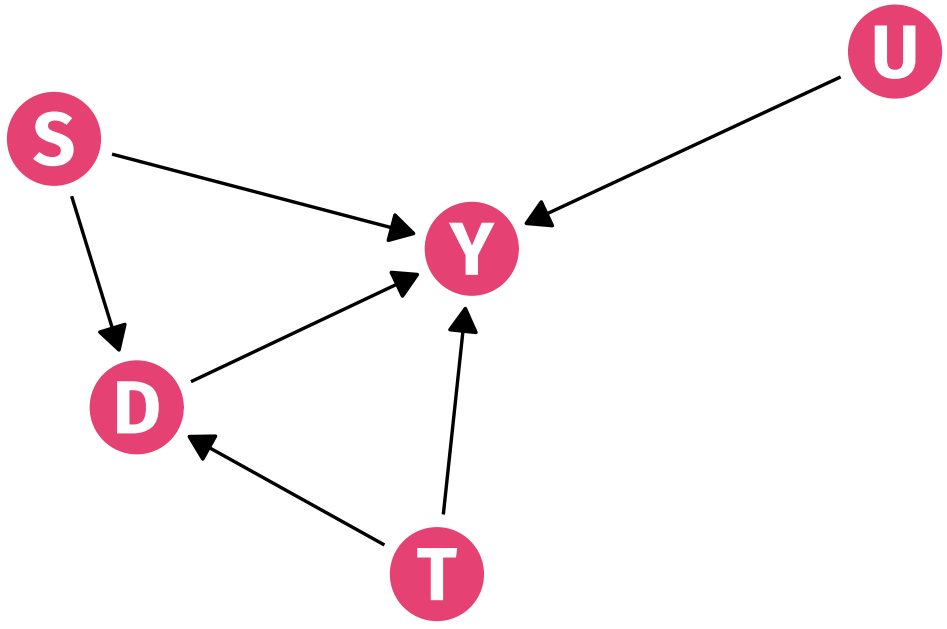
- Average employment in **New Jersey** restaurants **after** New Jersey's wage increase

$$\begin{aligned}
&= E\left[\text{Employment}_{it} \mid \text{NJ}_i = 1 \ \wedge \ \text{After}_t = 1\right] \\
&= \alpha + \beta\,(1) + \gamma\,(1) + \delta\,(1) \times (1) + (0) \\
&= \alpha + \beta + \gamma + \delta \\
&= 23.33 - 2.89 - 2.16 + 2.75 \\
&= 21.03
\end{aligned}$$

Card and Krueger (1994), revisited

Parallel trends assumption

> If New Jersey hadn't increased its minimum wage, New Jersey's fast-food employment would have continued on the same trend as fast-food employment in Pennsylvania.



Variables

- **D** = Minimum wage
- **Y** = Fast-food employment
- **S** = State (NJ or PA)
- **T** = Time (before or after)
- **U** = Unobserved changes within each state

A difference-in-differences comparison explicitly controls for **S** and **T**.

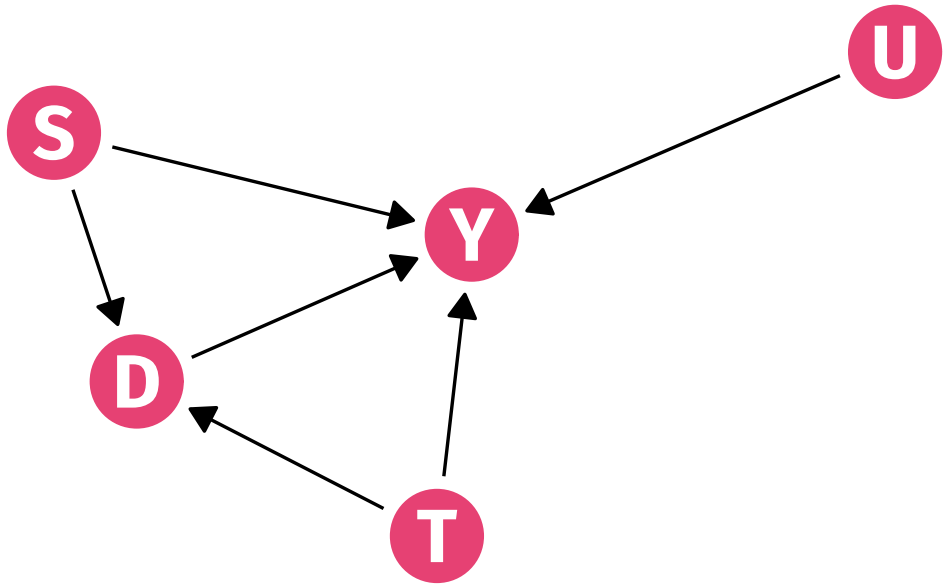
Card and Krueger (1994), revisited

Parallel trends assumption

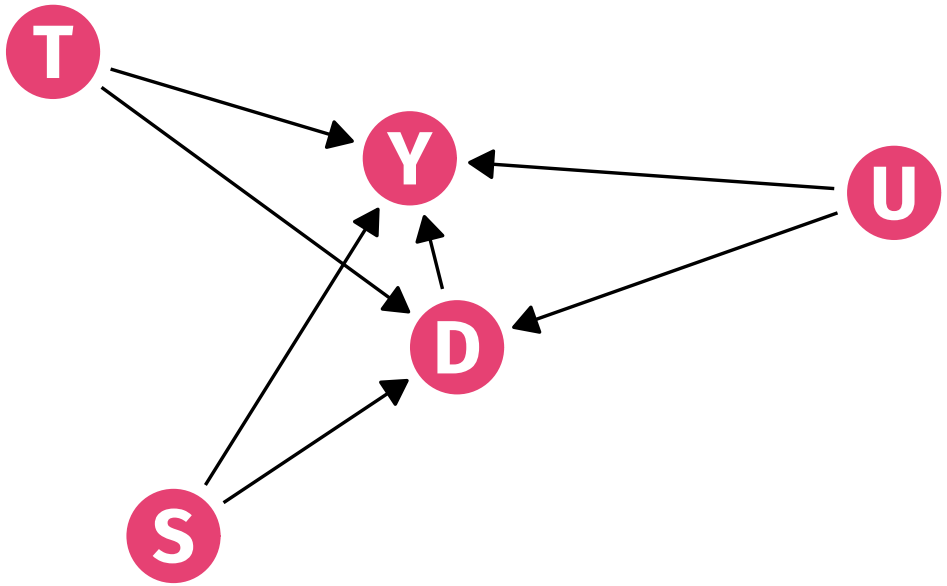
Q: Why is it important to articulate this assumption?

A: Allows us to **direct our skepticism** toward variables that confound the effects of treatment!

Valid difference-in-differences



Invalid difference-in-differences

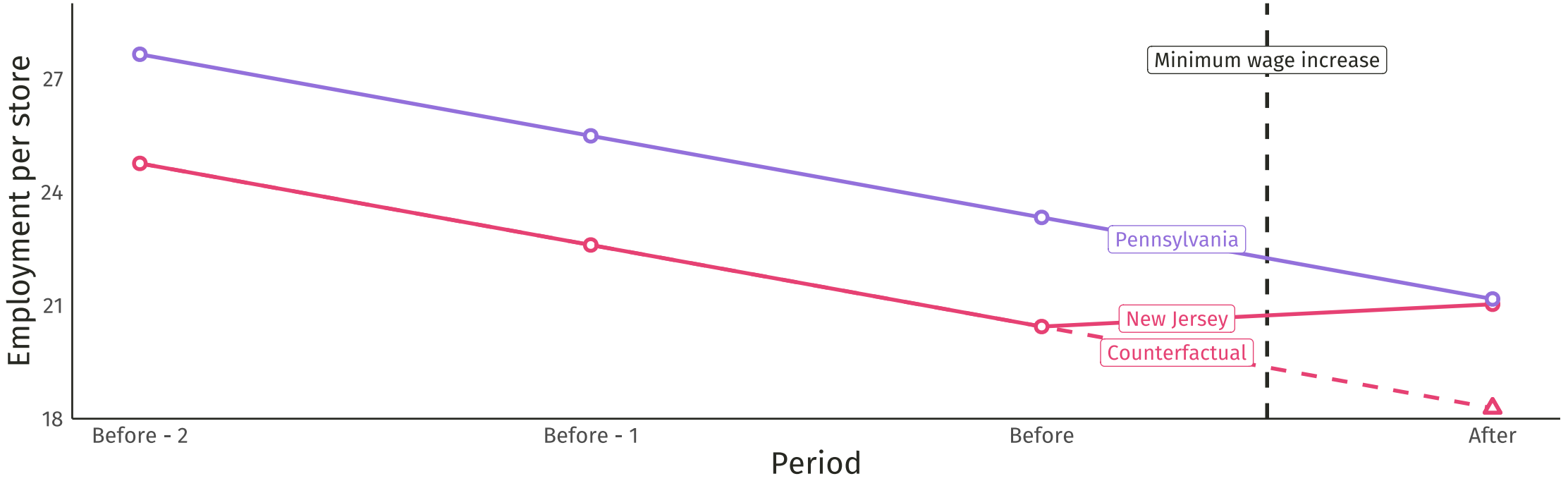


Card and Krueger (1994), revisited

Parallel trends assumption

Fundamentally **untestable**, but **falsifiable** with additional years of data.

Best-case scenario? Parallel trends before treatment $\longrightarrow$ **fail to reject** parallel trends.

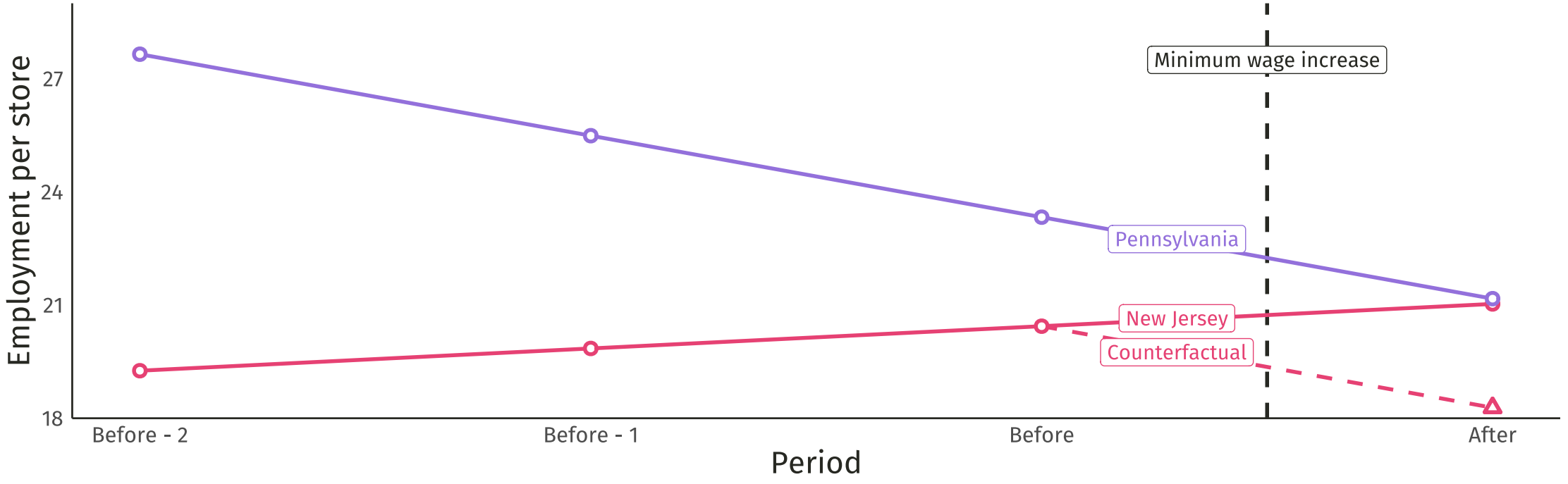


Card and Krueger (1994), revisited

Parallel trends assumption

Fundamentally **untestable**, but **falsifiable** with additional years of data.

Worst-case scenario? Differential trends before treatment $\longrightarrow$ **reject** parallel trends.



Hoynes and Patel (2018)

Discussion

Q_1: What comparisons does the study make?

Q_2: What do those comparisons suggest about the effect of the Earned Income Tax Credit on poverty?

Q_3: What do we need to believe to interpret the results as causal?

Q_4: What are the policy implications?

The Employer's Dilemma

The Employer's Dilemma

Q: How do employers make decisions about hiring (and firing) workers?

- What tradeoffs do employers face in competitive markets?

Q: Why should we care?

- **A:** Labor market outcomes ultimately depend on **interactions** between workers *and* employers!

Before modeling interactions between workers and employers, we will first develop a model of **labor demand**.

Labor demand

Q: How is labor different from the goods and services that consumers demand?

A: Labor is a **derived demand**.

- Consumers don't demand labor itself, but rather the goods that labor producers.

Q: In what ways is labor different from other factors of production?

A: Many!

- **You can't own a worker!** Rather, you can only rent a worker's services.
- **Workers need motivation!** Office supplies don't get bored and browse Reddit, but people do.
- **Workers care about working conditions!** Most robots can handle a 95-degree warehouse, but many people would struggle.

Profit maximization

Objective function

We assume that the employer seeks to maximize profit:

$$\begin{aligned}\Pi &= \text{TR} - \text{TC} \\ &= pq - (wE + rK) \\ &= pq - wE - rK\end{aligned}$$

- Π represents profit, measured in dollars.
- pq represents total revenue, where p is the output price and q is the quantity of output.
- wE represents the wage bill, where w is the market wage and E is the number of full-time equivalent workers.
- rK represents capital expenses, where r is the rental rate of capital and K is the amount of capital.

The employer will choose a **profit-maximizing** level of output to be produced by a **cost-minimizing** bundle of labor and capital.

Profit maximization

Objective function

We assume that the employer seeks to maximize profit:

$$\Pi = pq - wE - rK$$

We will also assume that the employer is a **price-taker**.

- The **choices** of the employer **have no impact on market prices** for the output good, labor, or capital.
- In other words, the market for the output good is **perfectly competitive**, as are the markets for labor and capital.

Production technology

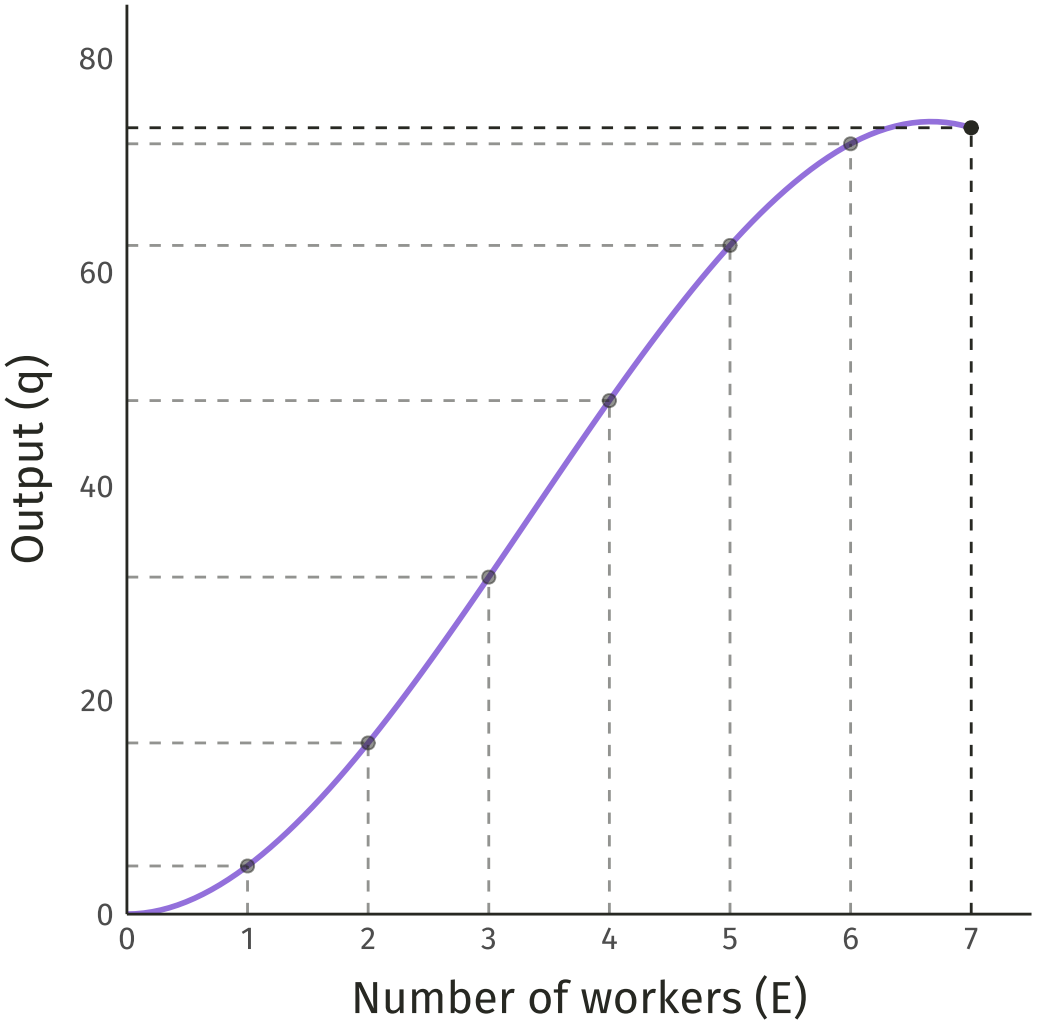
Production function

> A mathematical description of the relationship between inputs and output in an employer's production process.
>
> $$\text{Inputs} \longrightarrow \text{production technology} \longrightarrow \text{output}$$

We will make **three main assumptions** about the **production technology** used by the employer:

1. Labor and capital are the only inputs (*i.e.*, $q = f(E, K)$)
2. Workers are homogeneous
3. Marginal productivity eventually decreases

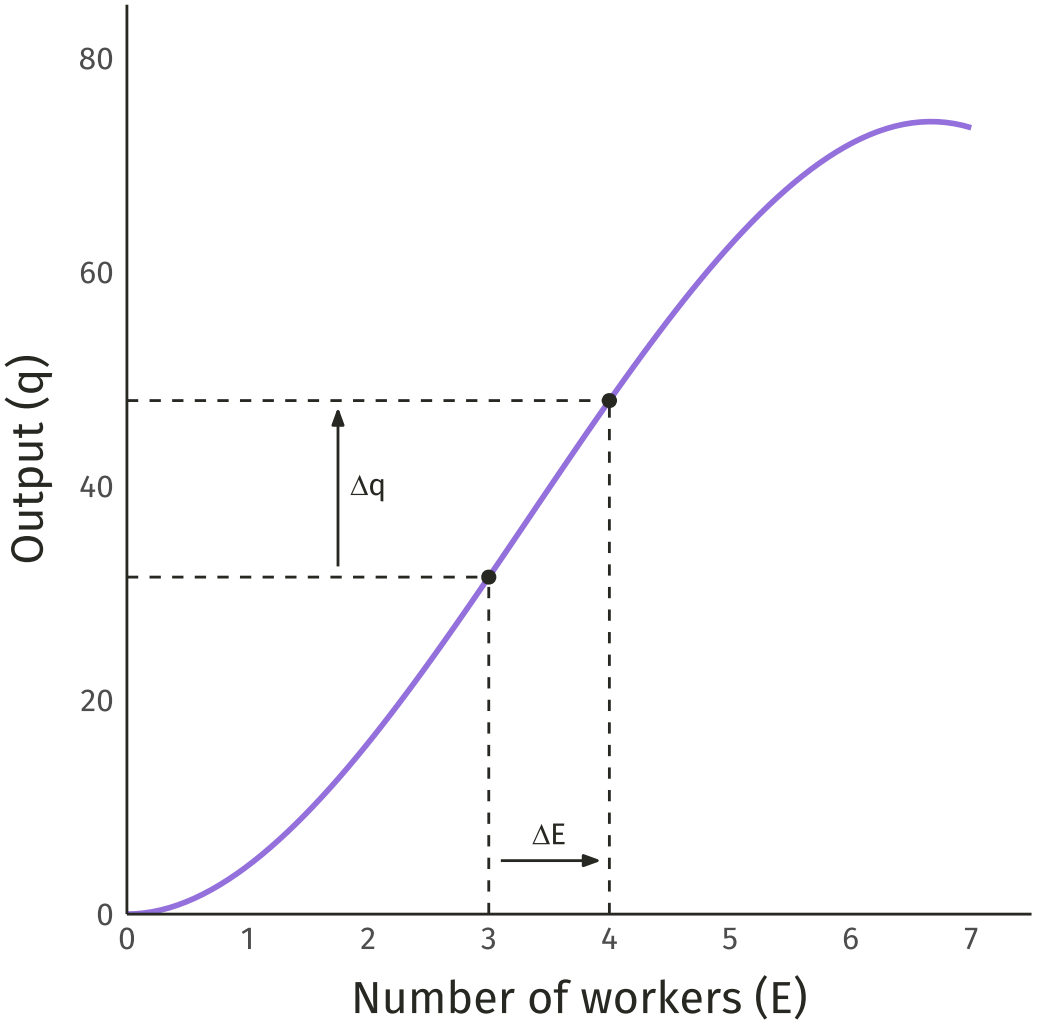
Production technology



Total product of labor

> The amount of output from a given quantity of labor, *holding the amount of capital and other inputs constant.*

Production technology

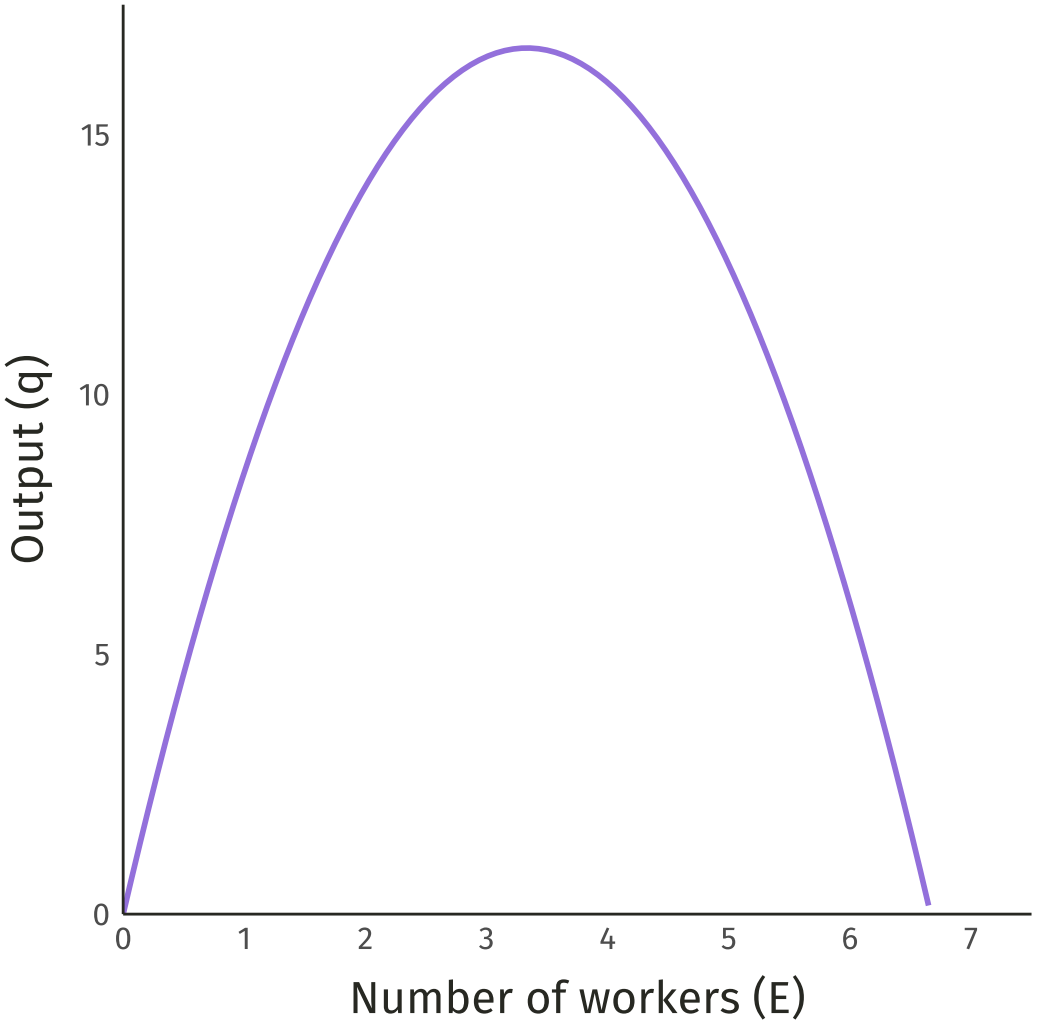


Marginal product of labor

> The change in output from a one-unit increase in labor, *holding the amount of capital and other inputs constant.*

$$\text{MP}_E = \frac{\Delta q}{\Delta E}$$

Production technology

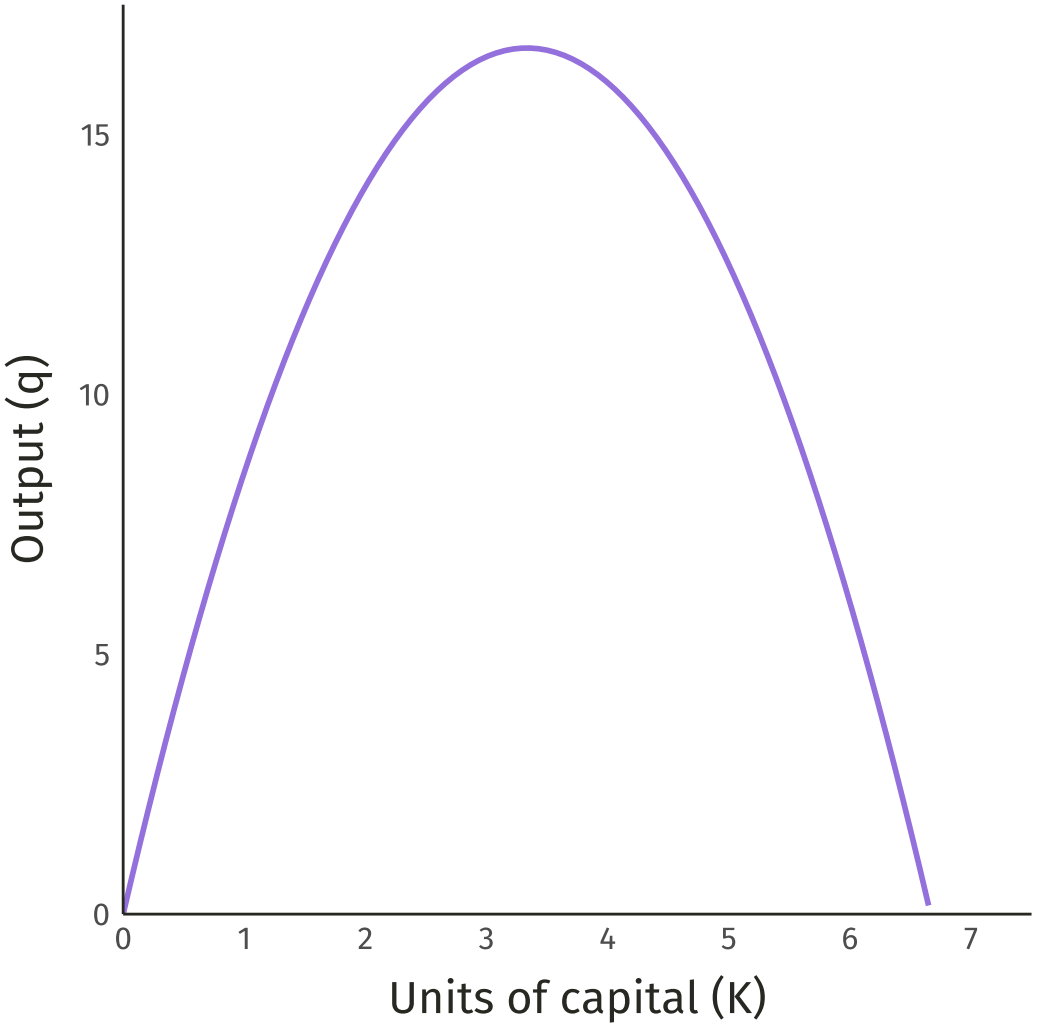


Marginal product of labor

> The change in output from a one-unit increase in labor, *holding the amount of capital and other inputs constant.*

$$\text{MP}_E = \frac{\Delta q}{\Delta E}$$

Production technology

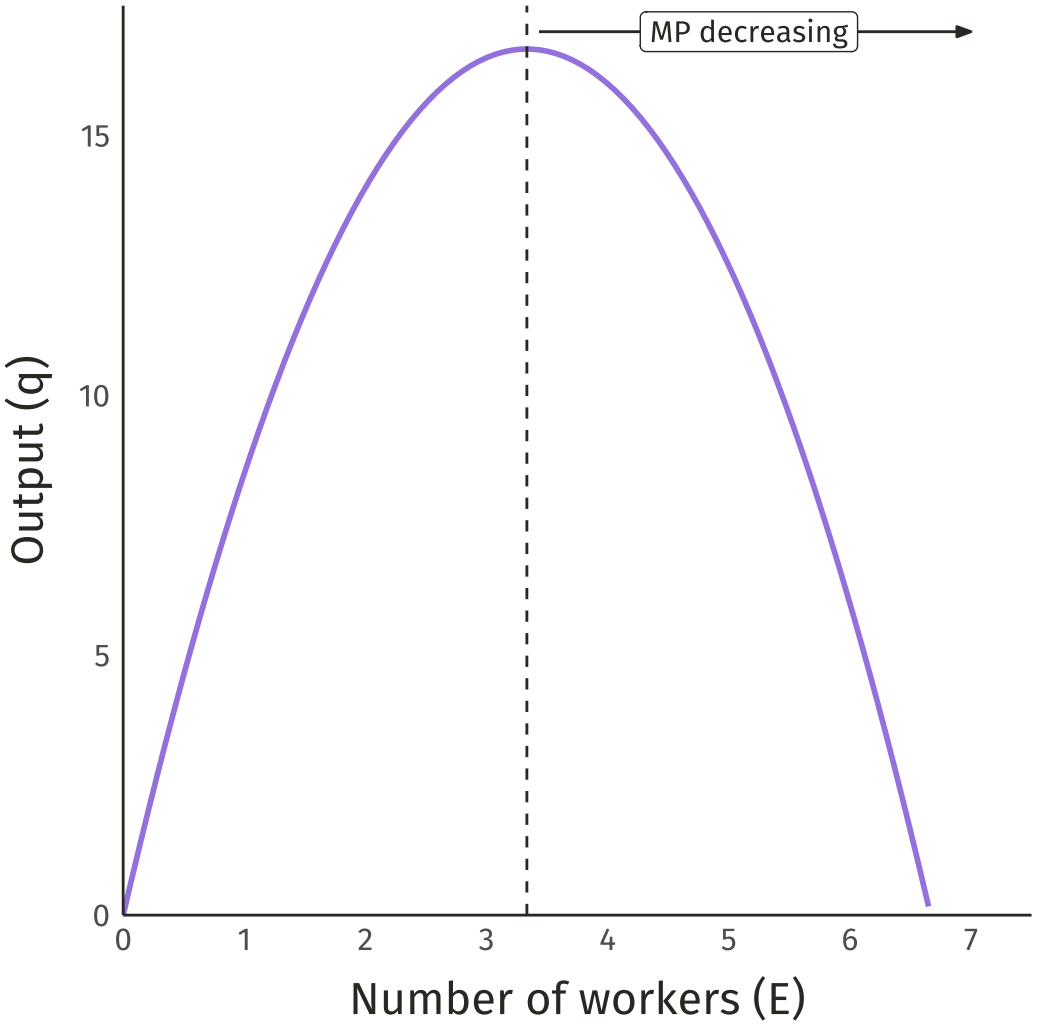


Marginal product of capital

> The change in output from a one-unit increase in capital, *holding the amount of labor and other inputs constant.*

$$\text{MP}_K = \frac{\Delta q}{\Delta K}$$

Production technology



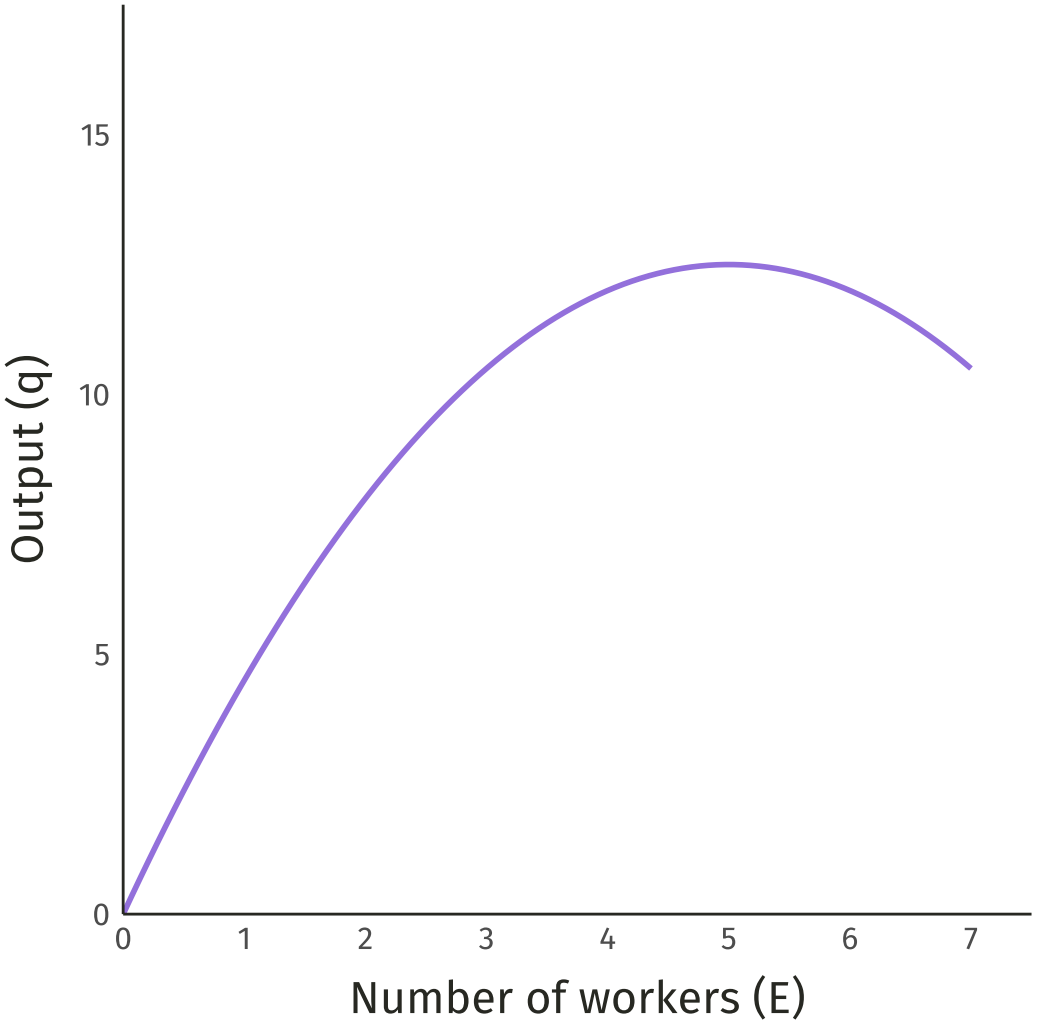
"Law" of diminishing returns†

> For a fixed amount of capital, the **marginal product** of labor **eventually declines** as employment increases.

Early gains from specialization give way to crowded capital inputs.

† Also known as "diminishing marginal productivity."

Production technology

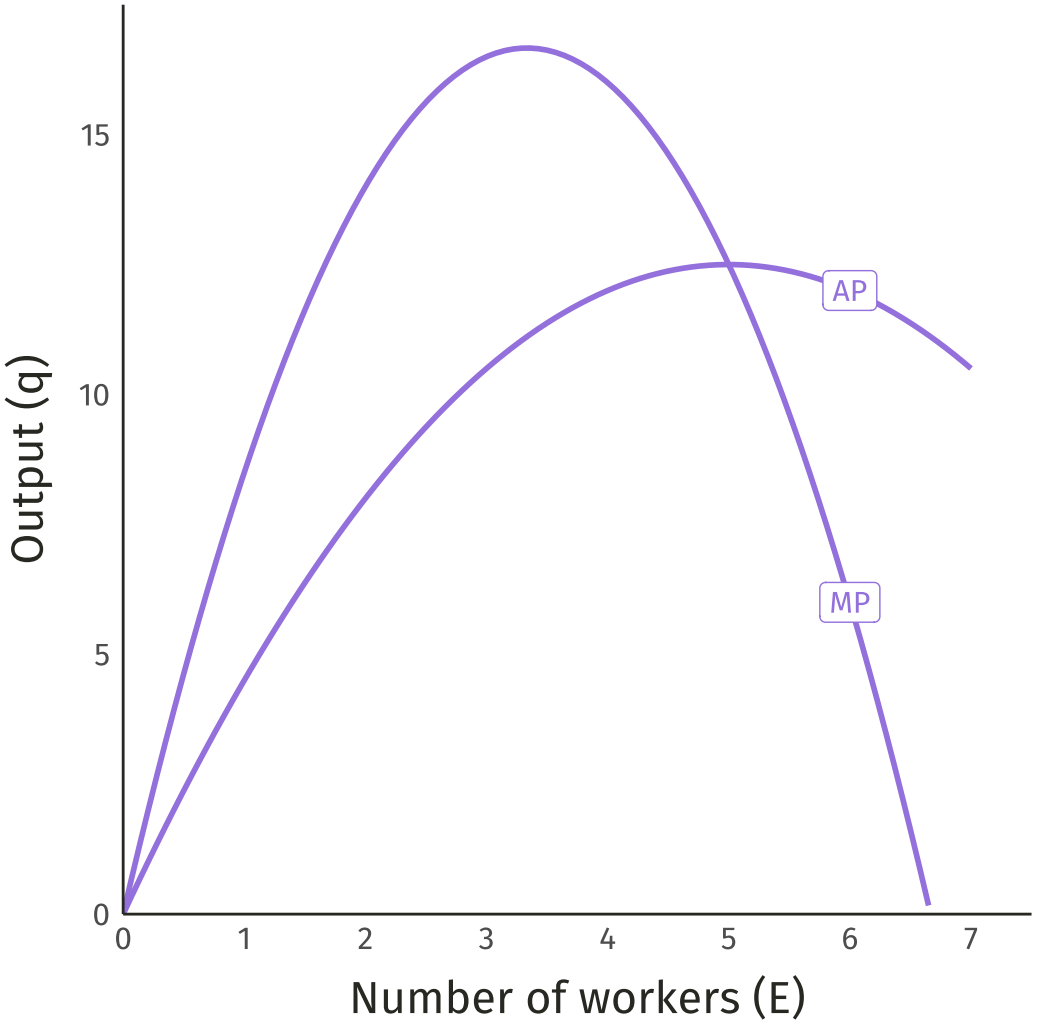


Average product of labor

> The amount of output produced by the typical worker, *holding the amount of capital and other inputs constant.*

$$\text{AP}_E = \frac{q}{E}$$

Production technology



Average product of labor

The marginal product curve intersects the average product curve where average product is maximized.

- When the average product curve is **increasing**, marginal product **is greater than** average product.
- When the average product curve is **decreasing**, marginal product **is less than** average product.

Production technology

Q: What is the marginal product of each worker?

Workers (E)	Output (q)	Marginal product (MP)	Average product (AP)
0	0	—	—
1	1000	1000	
2	1800	800	
3	2400	600	
4	2800	400	
5	3000	200	
6	3000	0	
7	2800	-200	

Production technology

Q: What is the average product for each level of employment?

Workers (E)	Output (q)	Marginal product (MP)	Average product (AP)
0	0	—	—
1	1000	1000	1000
2	1800	800	900
3	2400	600	800
4	2800	400	700
5	3000	200	600
6	3000	0	500
7	2800	-200	400

Valuing production

Marginal revenue product of labor

> The change in total revenue from a one-unit increase in labor, *holding capital and other inputs constant*.

$$\begin{aligned}\text{MRP}_E &= \frac{\Delta \text{TR}}{\Delta q} \times \frac{\Delta q}{\Delta E} \\ &= \text{MR} \times \text{MP}_E\end{aligned}$$

In a **perfectly competitive market** for the output good, price does not depend on a firm's level of output (*i.e.*, $\text{MR} = p$).

- **Implication?** Marginal revenue product is the same as the **value of marginal product of labor**:

$$\text{VMP}_E = \text{MRP}_E = p \times \text{MP}_E$$

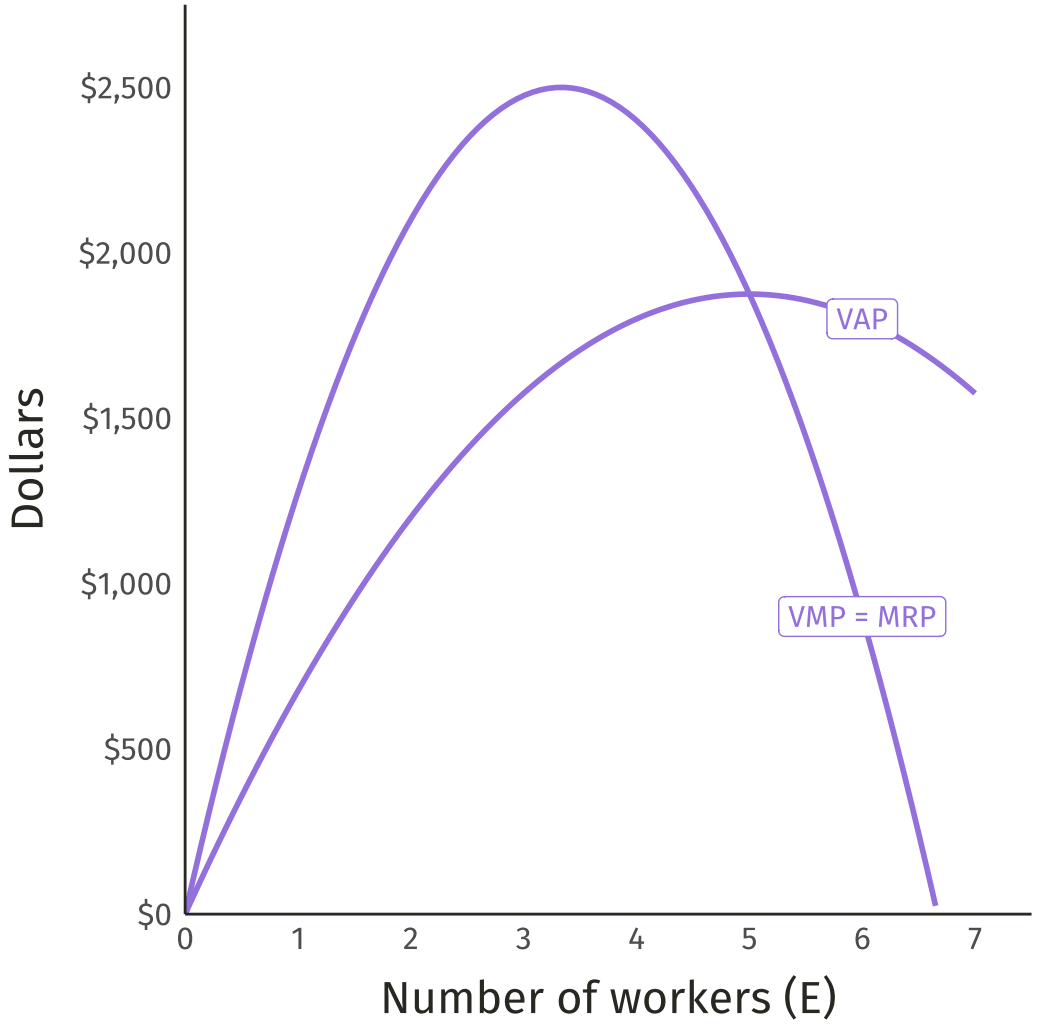
Valuing production

Value of average product of labor

> The amount of revenue the typical worker produces for the firm.

$$\text{VAP}_E = p \times \text{AP}_E$$

Valuing production



The relationship between the value of average product and the value of marginal product is the same as the relationship between average product and marginal product.

The difference? The average product and marginal product curves are now "scaled up" by the price of the output good.

- Vertical axis is now in dollars instead of units of output.
- In this example, p = \$150.

Valuing production

Q: If the price of the output good is $2, what is the marginal revenue product of each worker?

Workers (E)	Output (q)	MP	AP	Marginal revenue product (MRP)	Value of MP (VAP)
0	0	—	—	—	—
1	1000	1000	1000	$2000	
2	1800	800	900	$1600	
3	2400	600	800	$1200	
4	2800	400	700	$800	
5	3000	200	600	$400	
6	3000	0	500	$0	
7	2800	-200	400	-$400	

Valuing production

Q: If the price of the output good is $2, what is the value of average product?

Workers (E)	Output (q)	MP	AP	Marginal revenue product (MRP)	Value of MP (VAP)
0	0	—	—	—	—
1	1000	1000	1000	$2000	$2000
2	1800	800	900	$1600	$1800
3	2400	600	800	$1200	$1600
4	2800	400	700	$800	$1400
5	3000	200	600	$400	$1200
6	3000	0	500	$0	$1000
7	2800	-200	400	-$400	$800

Short run *vs.* long run

Short run

> The time span over which a business can adjust some inputs (*e.g.*, labor), but cannot adjust others (*e.g.*, capital).

In the short run, we will assume that the level of employment **E** can vary, but capital **K** is fixed at an initial level $\mathbf{K_0}$.

- **Example:** A shop foreman can hire or fire workers or adjust hours, but they are unable to expand the factory by adding assembly lines, heavy machinery, or a new building.

Short run *vs.* long run

Long run

> The time span over which a business can adjust all inputs.

In the long-run, we will assume that both the level of employment **E** and capital **K** can vary.

- **Example:** An office manager can hire or fire workers, adjust hours, buy or sell desks and computers, or lease new office space.

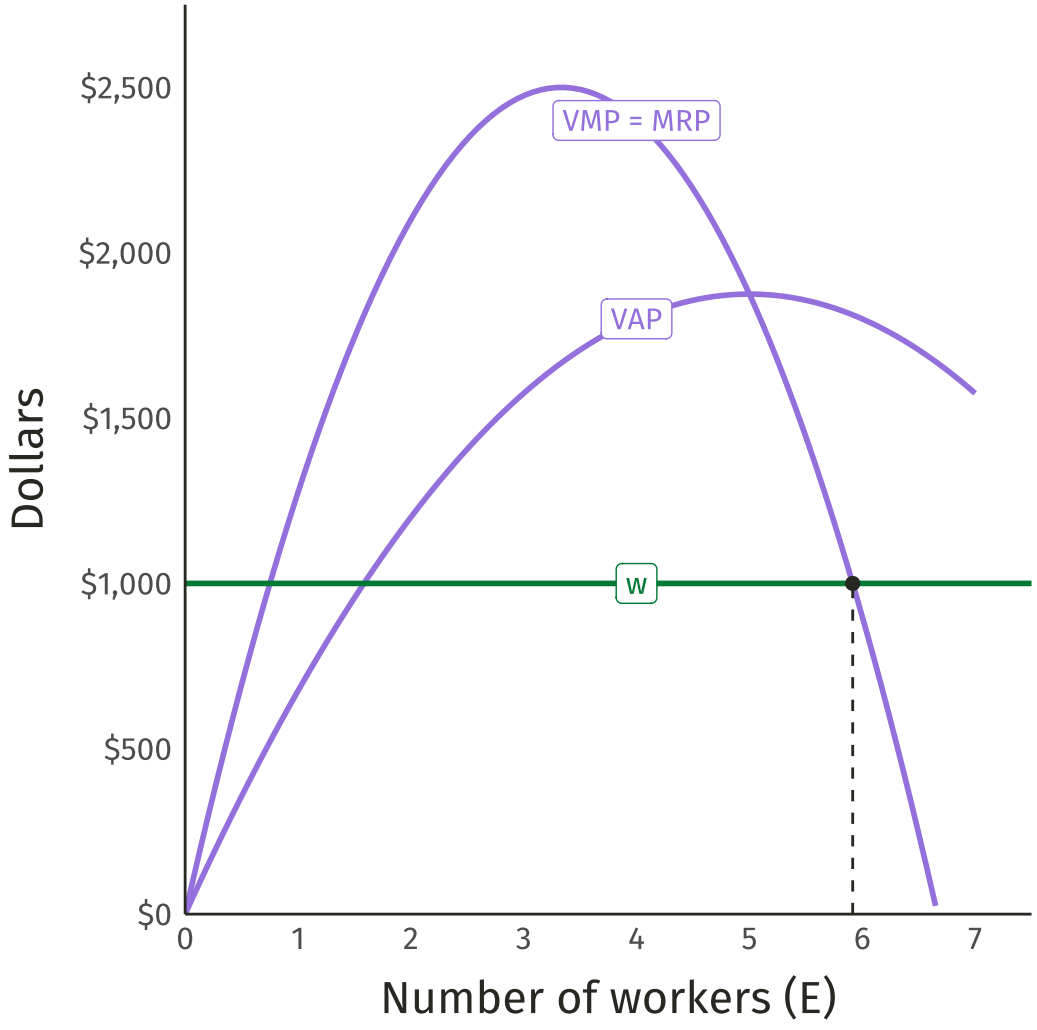
Q: If the price of the output good is $2 and the market wage is $500 per week, how many workers should the employer hire?

Workers (E)	Output (q)	MP	AP	MRP	VAP	Wage (w)
0	0	—	—	—	—	$500
1	1000	1000	1000	$2000	$2000	$500
2	1800	800	900	$1600	$1800	$500
3	2400	600	800	$1200	$1600	$500
4	2800	400	700	$800	$1400	$500
5	3000	200	600	$400	$1200	$500
6	3000	0	500	$0	$1000	$500
7	2800	-200	400	-$400	$800	$500

The employer should **think at the margin** and keep hiring as long as **MRP** $\geq$ **w**.

A: The employer should hire 4 workers.

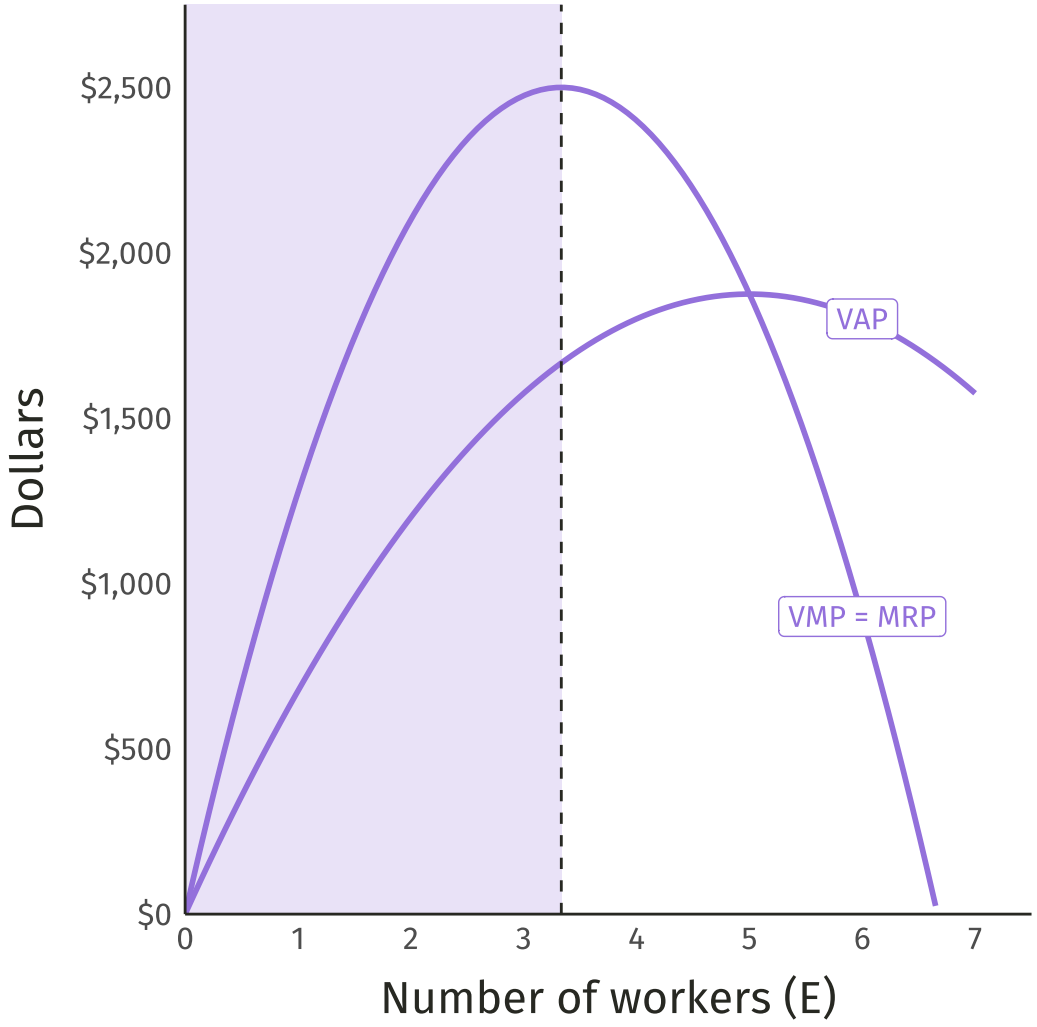
Hiring in the short run



Profit maximization

An employer maximizes profit by hiring E^* workers where $w = \text{MRP}_E$ and MRP_E is decreasing.

Hiring in the short run



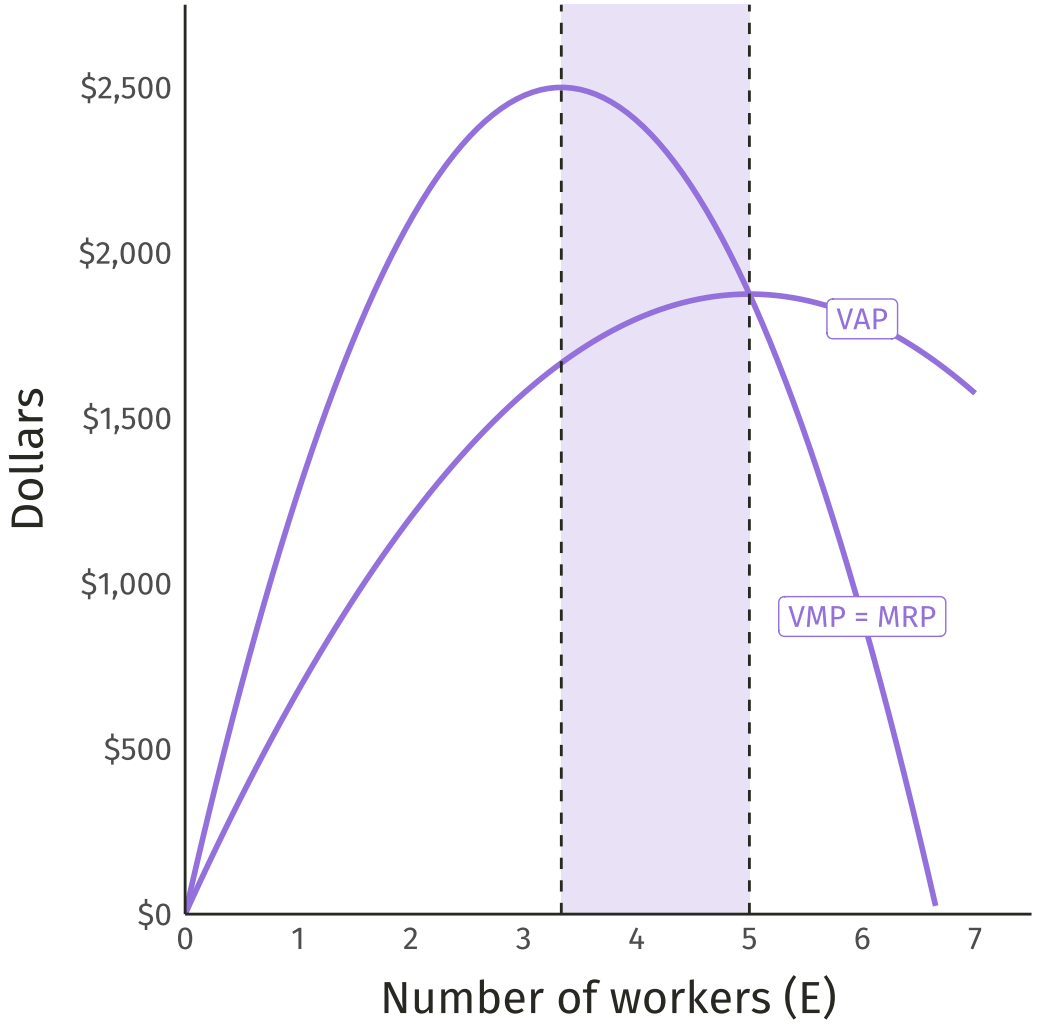
Profit maximization

Q: Why wouldn't an employer stop hiring while marginal revenue product is increasing?

A: Because the employer would be "leaving money on the table."

- The employer could increase profit at the margin by hiring an additional worker.

Hiring in the short run



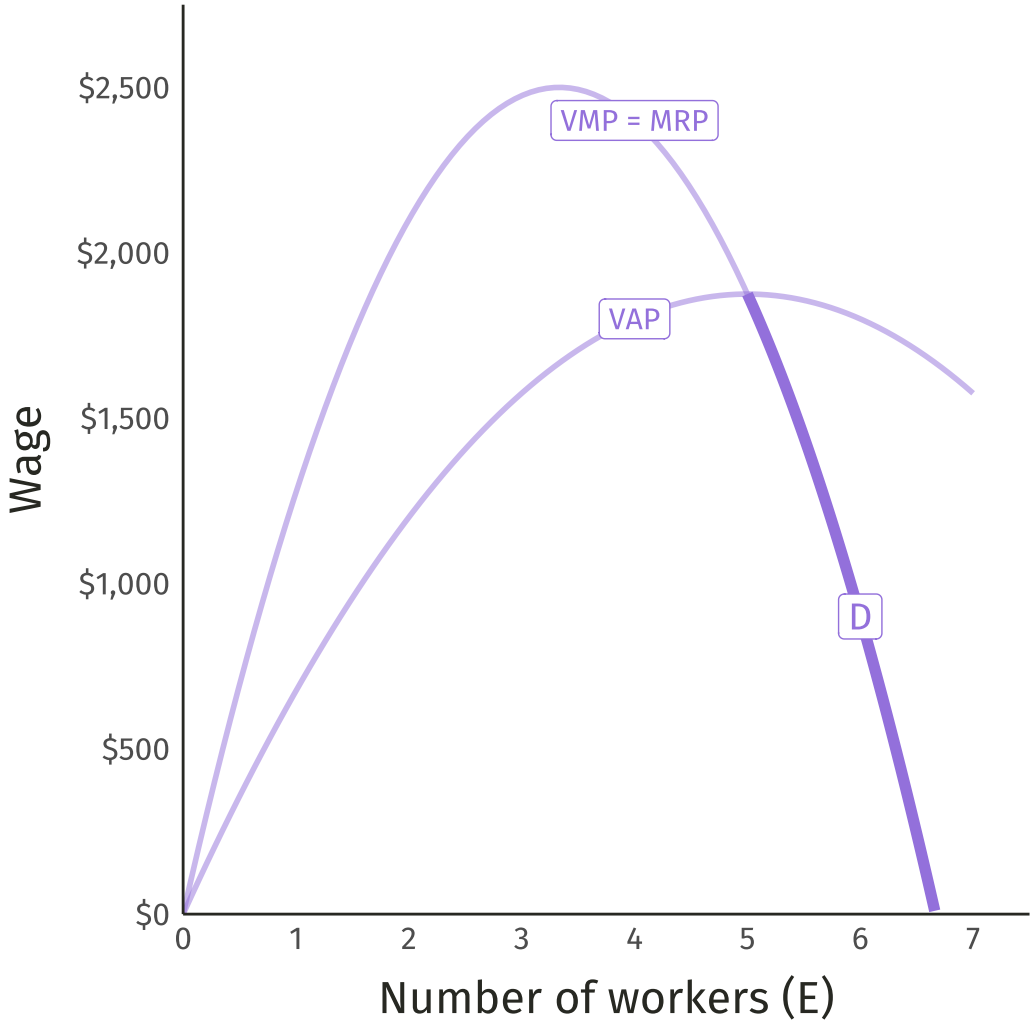
Profit maximization

Q: What happens when marginal revenue product exceeds the value of average product?

A: The employer will shut down the business.

- Any wage that intersects MRP in this region will exceed VAP ⟶ business would operate at a loss!

Hiring in the short run



Labor demand

The portion of the MRP curve below the VAP curve traces out the **short-run labor demand** curve.

- Describes how an employer adjusts employment as the market wage changes, holding other inputs constant.
- **Downward sloping:** An employer wants to reduce staffing as the wage increases, *all else equal*.

Housekeeping

~~In-class~~ online midterm exam on Monday, February 7th.

- Covers material from weeks 1 through 5.
- I will post a midterm review guide and some practice problems.

Problem Set 2 due by Saturday, February 5th by 11:59pm.

- Covers material from weeks 4 and 5.