Elasticity and Its Applications

EE 211

Jan 20 & 27th 2026

- What is the definition of **elasticity?**
- What is the meaning and importance of
  - **price elasticity of demand?**
  - **income elasticity of demand**
  - **price elasticity of supply?**
- What factors influence the size of these various elasticities?
- How the cross-price elasticity of demand measures the responsiveness of demand for one good to changes in the price of another good

In order for investors to know whether they can earn significant profits in the ambulance business, they need to know the price elasticity of demand for ambulance rides.

With this information, investors can accurately predict whether or not a significant rise in the price of an ambulance ride results in an increase in revenue.

Elasticity

- measures how much one variable responds to changes in another variable.
  - One type of elasticity measures how much demand for your websites will fall if you raise your price.

- is a numerical measure of the responsiveness of Q^d or Q^s to one of its determinants.

Price Elasticity of Demand

- is the ratio of the percent change in the quantity demanded to the percent change in the price as we move along the demand curve (dropping the minus sign).

$$Price\ elasticity\ of\ demand = \frac{Percentage\ change\ in\ Q^d}{Percentage\ change\ in\ P}$$

Price elasticity of demand measures how much Q^d responds to a change in P.

Notice that the minus sign that appeared in the calculation of the percent change in the quantity demanded has been dropped when we calculate this last equation, the price elasticity of demand.

The law of demand says that demand curves are downward sloping, so price and quantity demanded always move in opposite directions. In other words, a positive percent change in price (a rise in price) leads to a negative percent change in quantity demanded; a negative percentage change in price (a fall in price) leads to a positive percent change in the quantity demanded. This means that the price elasticity of demand is, in strictly mathematical terms, a negative number.

However, it is inconvenient to repeatedly write a minus sign. So when economists talk about the price elasticity of demand, they usually drop the minus sign and report the absolute of the price elasticity of demand.

PED 1st Approach: ΔQ & P

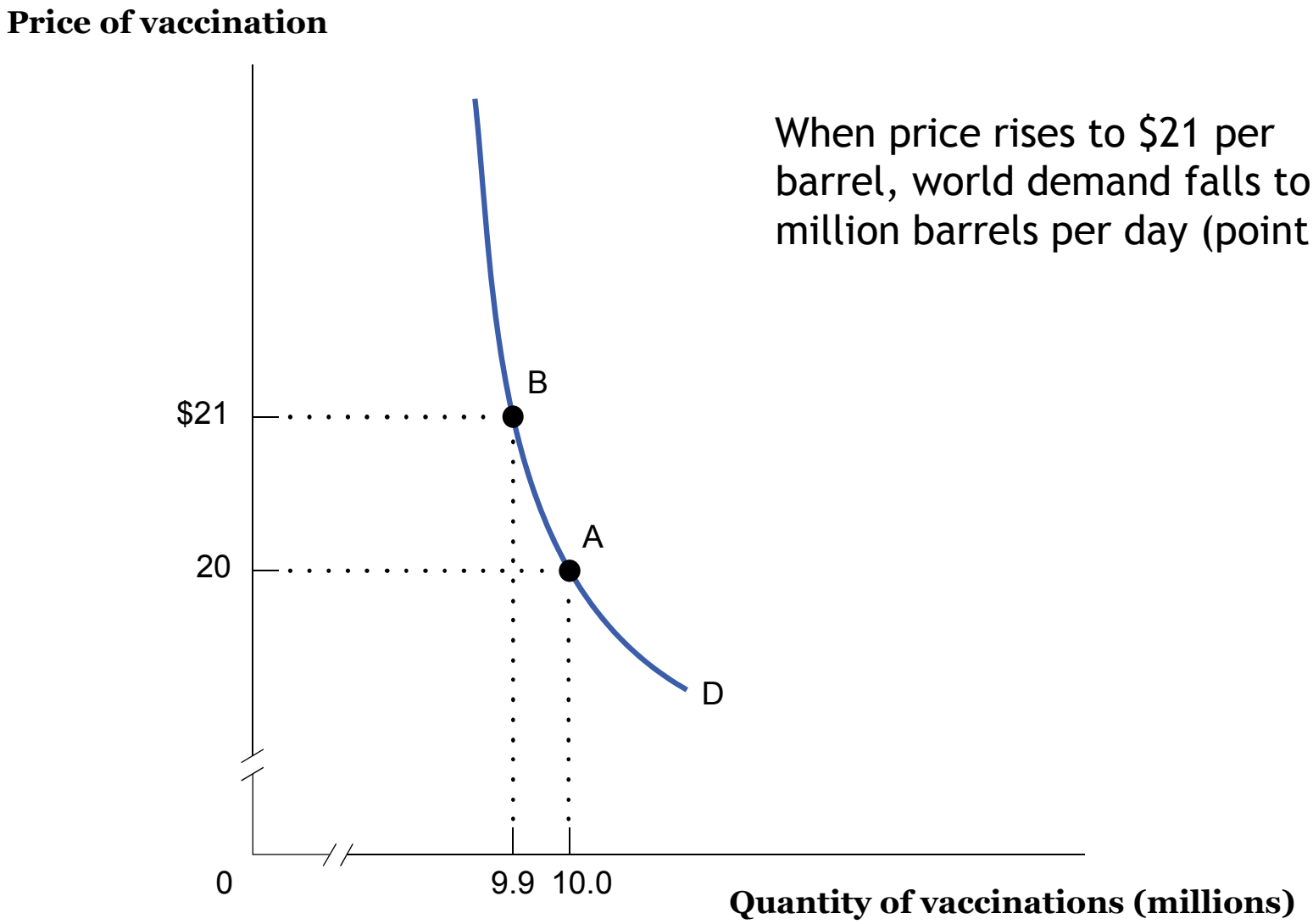
$$\%\text{ change in quantity demanded} = \frac{\text{Change in quantity demanded}}{\text{Initial quantity demanded}} \times 100$$

ΔP

$$\%\text{ change in price} = \frac{\text{Change in price}}{\text{Initial price}} \times 100$$

$$\textbf{Price elasticity of demand} = \frac{\%\text{ change in quantity demanded}}{\%\text{ change in price}}$$

Demand for Vaccinations



When price rises to $21 per barrel, world demand falls to 9.9 million barrels per day (point B).

Calculating the Price Elasticity of Demand

$$\%\ \text{change in quantity demanded} = \frac{-0.1\ \text{million vaccinations}}{10\ \text{million vaccinations}} \times 100 = -1\%$$

$$\%\ \text{change in price} = \frac{\$1}{\$20} \times 100 = 5\%$$

$$\text{Price elasticity of demand} = \frac{\%\ \text{change in quantity demanded}}{\%\ \text{change in price}}$$

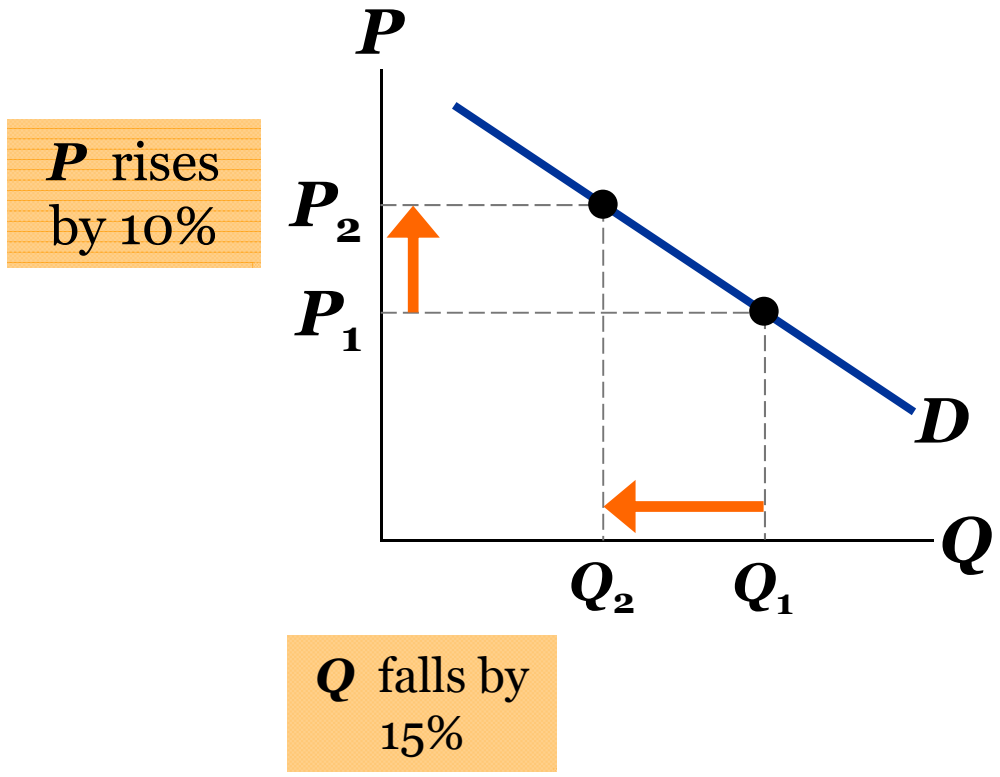
$$\text{Price elasticity of demand} = \frac{1\%}{5\%} = 0.2$$

Price Elasticity of Demand

$$Price\ elasticity\ of\ demand = \frac{Percentage\ change\ in\ Q^d}{Percentage\ change\ in\ P}$$

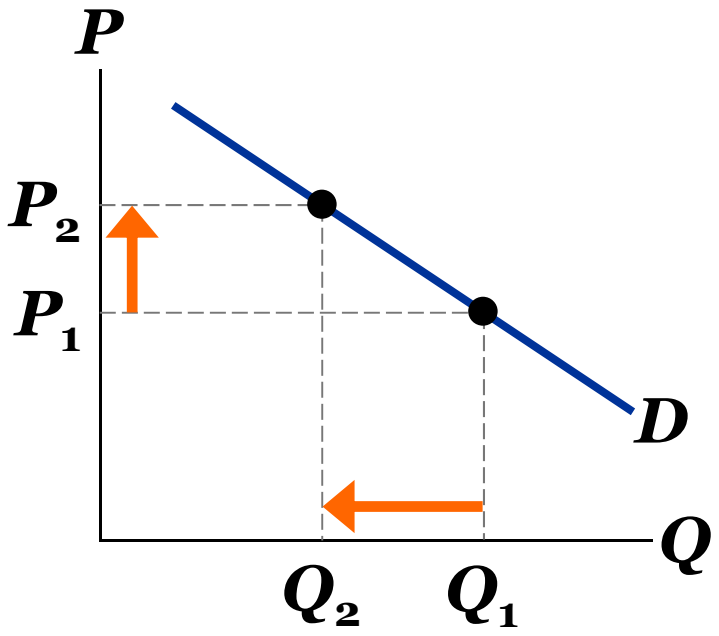
Price elasticity of demand equals

$$\frac{15\%}{10\%} = 1.5$$

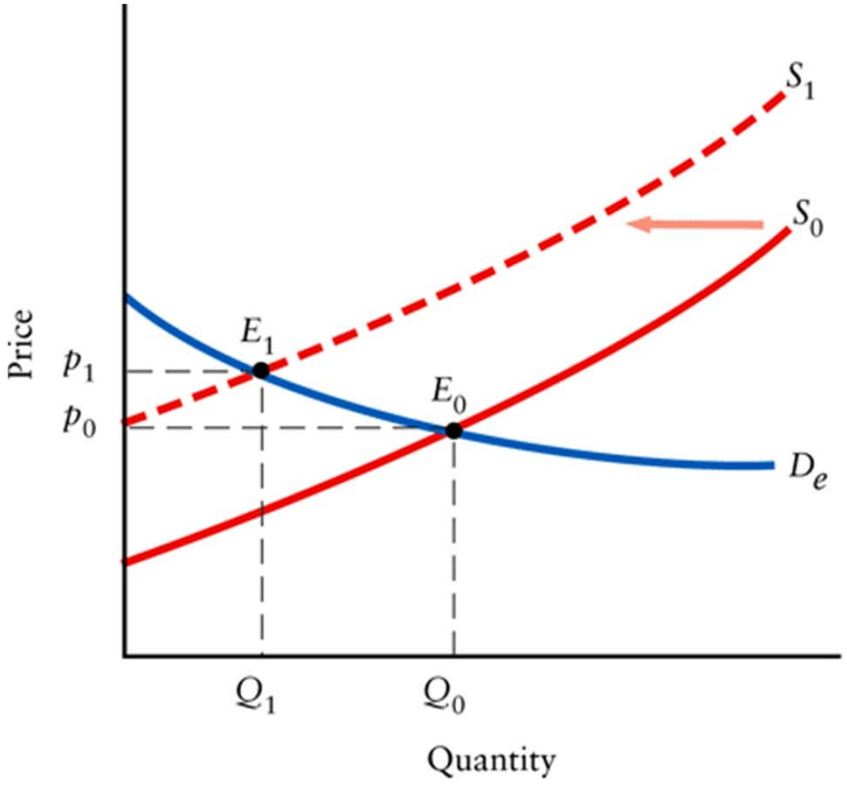


Along a ***D*** curve, ***P*** and ***Q*** move in opposite directions, which would make price elasticity negative.

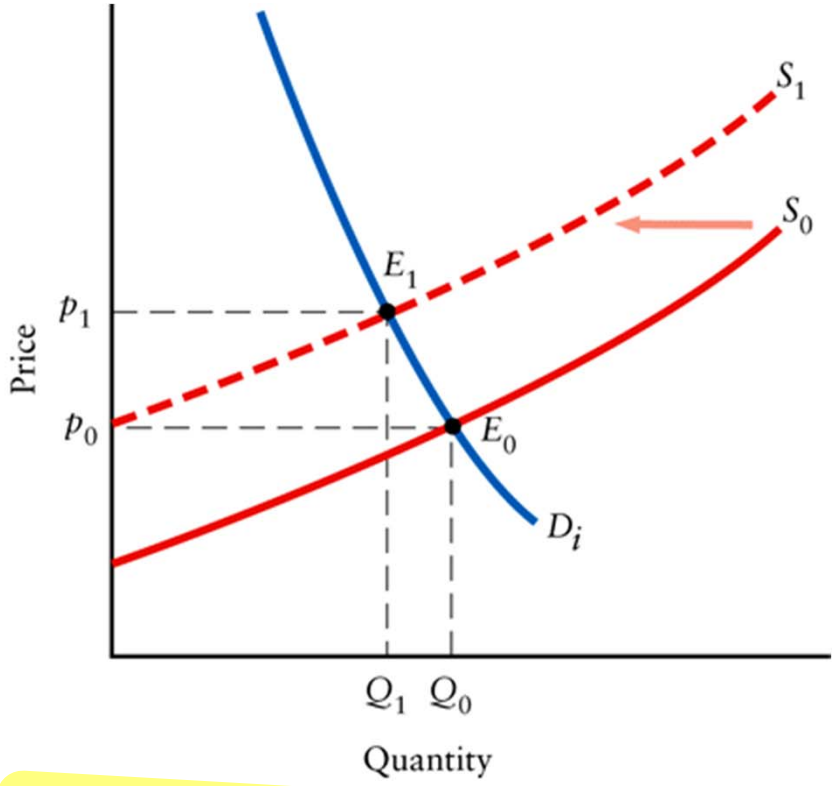
We will drop the minus sign and report all price elasticities as positive numbers.



The Effects of a Supply Shift with Two Different Demand Curves



(i) Relatively elastic demand



(ii) Relatively inelastic demand

- Both curves are drawn on the same scale
- The initial equilibrium prices and quantities were the same
- If the initial prices and quantities are the same in both cases, the larger absolute change is also the larger percentage change
- However, when we wish to deal with different initial price quantity equilibria, we need to decide whether we are interested in absolute or percentage changes

2nd Approach:

An alternative way to calculate elasticities:

the Midpoint Method

The Midpoint Method

The **midpoint method** is a technique for calculating the percent change. In this approach, we calculate changes in a variable compared with the average, or midpoint, of the starting and final values.

Example

Suppose you were trying to estimate the price elasticity of demand for gasoline by comparing gasoline prices and consumption in different countries

Because of high taxes , gasoline usually costs about three times as much per gallon in Europe as it does in the United States

A good way to avoid computing different elasticities for rising and falling prices is to use the midpoint method

$$\%\ \text{change in } X = \frac{\text{Change in } X}{\text{Average value of } X} \times 100$$

$$\text{Average value of } X = \frac{\text{Starting value of } X + \text{final value of } X}{2}$$

$$\text{Price elasticity of demand} = \frac{\dfrac{Q_2 - Q_1}{(Q_1 + Q_2)/2}}{\dfrac{P_2 - P_1}{(P_1 + P_2)/2}}$$

Using the Midpoint Method to Calculate Elasticities

	Price	Quantity demanded
Situation A	\$0.90	1,100
Situation B	\$1.10	900

$$\%\text{ change in quantity demanded} = \frac{-200}{(1{,}100 + 900)/2} \times 100 = \frac{-200}{1{,}000} \times 100 = -20\%$$

$$\%\text{ change in price} = \frac{\$0.20}{(\$0.90 + \$1.10)/2} \times 100 = \frac{\$0.20}{\$1.00} \times 100 = 20\%$$

$$\text{Price elasticity of demand} = \frac{\%\text{ change in quantity demanded}}{\%\text{ change in price}} = \frac{20\%}{20\%} = 1$$

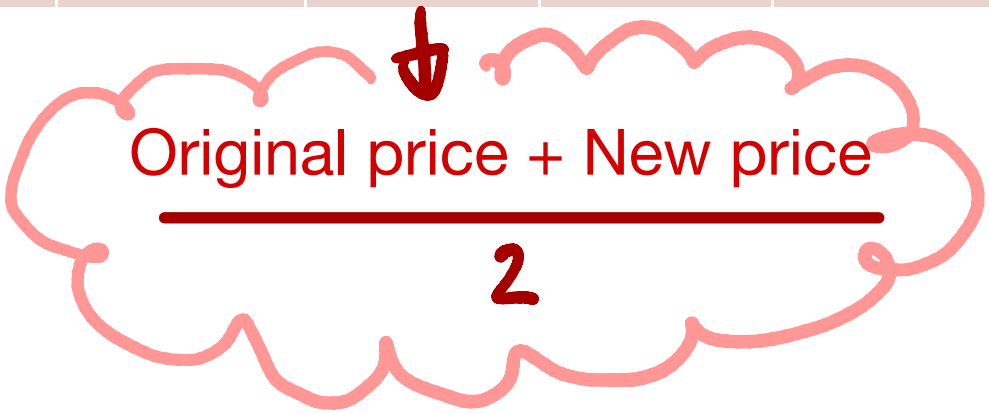
Example

Price reductions and corresponding increases in quantity demanded for three products

Commodity	Reduction in price	Increase in Quantity demanded (per month)
Cheese	$2 per pound	7,500 pounds
T-Shirts	$2 per shirt	25,000 shirts
CD players	$2 per CD player	500 CD players

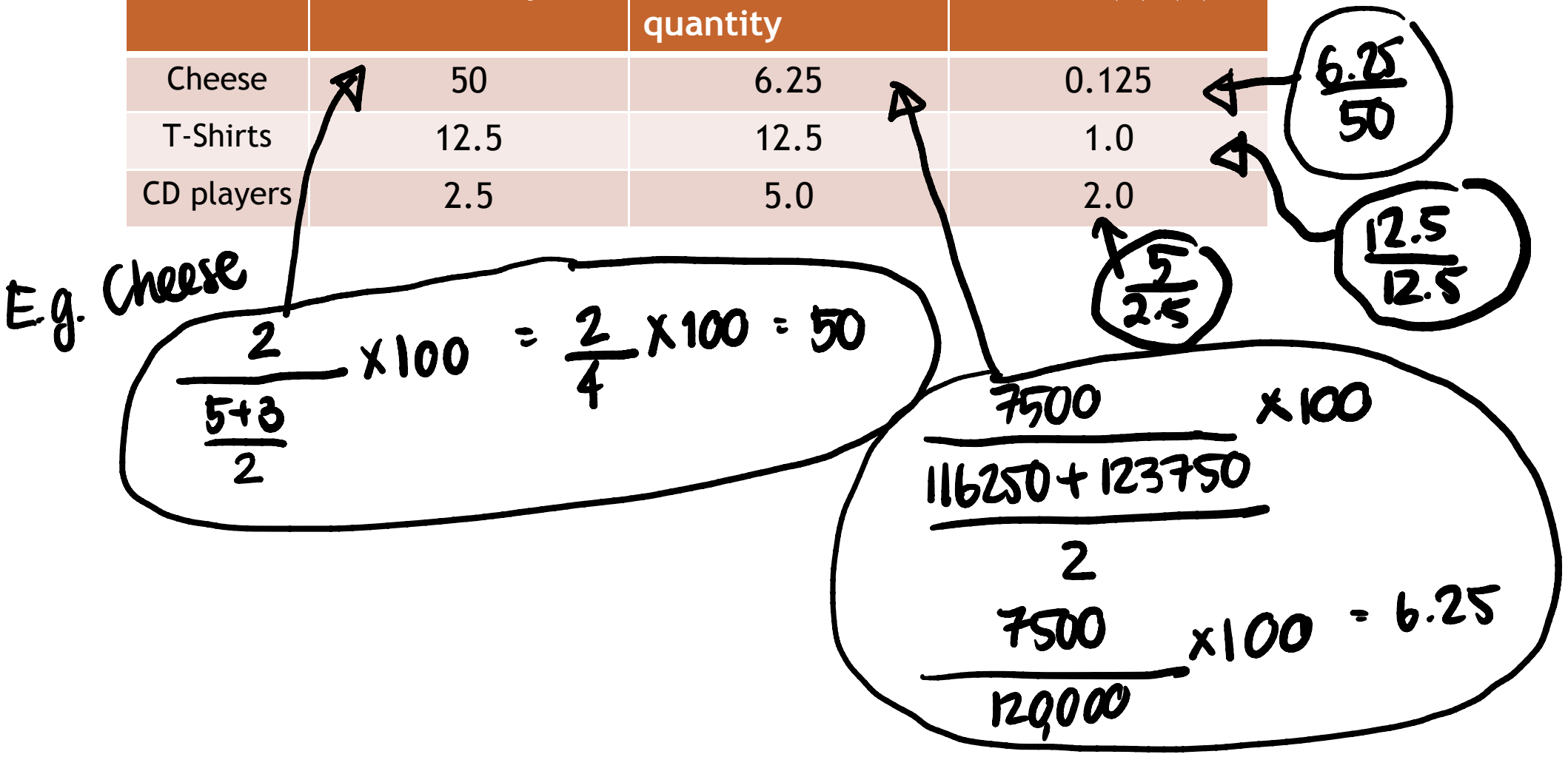
Price and Quantity information

Product	Unit	Original price($)	New price ($)	Average price ($)	Original quantity	New quantity	Average quantity
Cheese	Pound	5	3	4	116,250	123,750	120,000
T-Shirts	Shirt	17	15	16	187,500	212,500	200,000
CD players	player	81	79	80	9,750	10,250	10,000



Calculation of demand elasticities

Product	(1) Percentage decrease in price	(2) Percentage increase in quantity	(3) Elasticity of demand (2)/(1)
Cheese	50	6.25	0.125
T-Shirts	12.5	12.5	1.0
CD players	2.5	5.0	2.0



Hint: $\frac{\Delta P}{(P_1+P_2)/2} \times 100$; $\frac{\Delta Q^d}{(Q_1+Q_2)/2} \times 100$

Active Learning 1: Calculate an Elasticity

Use the following information to calculate the price elasticity of demand for iPhones:

- $P = \$400,\ Q_d = 10{,}600$ original price
- $P = \$600,\ Q_d = 8{,}400$ new price

A. Use the **midpoint method** to calculate percentage change in price

B. Use the **midpoint method** to calculate percentage change in quantity

C. Calculate **the price elasticity of demand** = Percentage change in Q^d / Percentage change in P

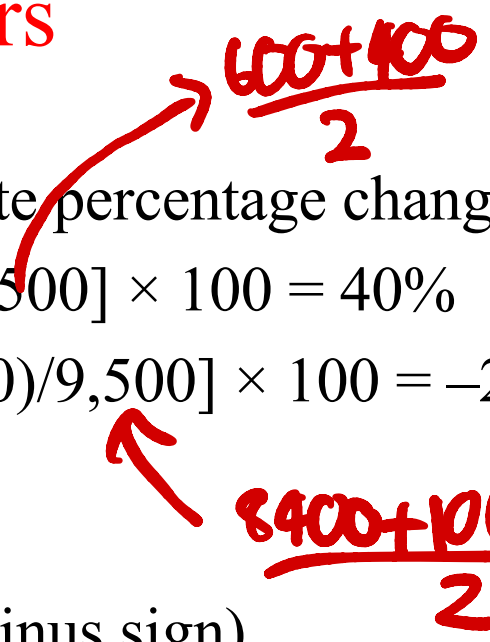
Active Learning 1: Answers

Using the midpoint method to calculate percentage changes:

A. % change in P = [(\$600 – \$400)/\$500] × 100 = 40%

B. % change in Q_d = [(8,400 – 10,600)/9,500] × 100 = –23.16%

C. Price elasticity of demand
   = % change in Q_d / % change in P
   = 23.16/40 = 0.58 (ignoring the minus sign)



Price Elasticity of Demand

Price Elasticity of Demand

Demand is elastic when quantity demanded is relatively responsive to a change in the product's own price.

Demand is inelastic if quantity demanded is relatively unresponsive to changes in price.

Elasticity is related to the slope of the demand curve, but it is not exactly the same.

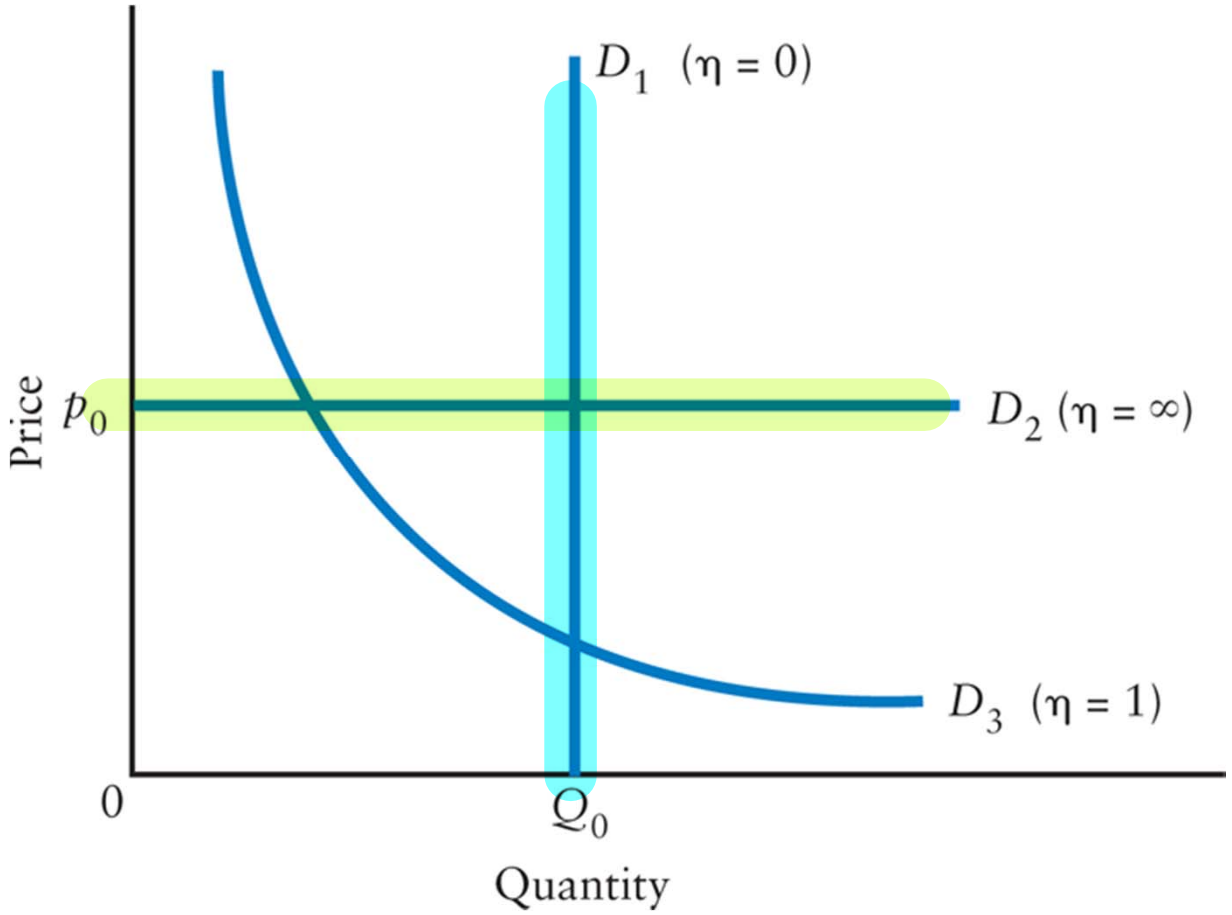
Interpreting Numerical Elasticities

Inelastic Demand (<1):
A given % change in p results in a smaller % change in Q^D.

Elastic Demand (>1):
A given % change in p results in a larger % change in Q^D.

Unit elastic Demand (=1):
A given % change in p results in the same % change in Q^D.

Three Demand Curves with Constant Elasticity



Two Extreme Cases of Price Elasticity of Demand

Demand is **perfectly inelastic** when the quantity demanded does not respond at all to changes in the price. When demand is perfectly inelastic, the demand curve is a vertical line.

Demand is **perfectly elastic** when any price increase will cause the quantity demanded to drop to zero. When demand is perfectly elastic, the demand curve is a horizontal line.

Unit-Elastic Demand, Inelastic Demand, and Elastic Demand

Demand is **elastic** if the price elasticity of demand is greater than 1

Demand is **inelastic** if the price elasticity of demand is less than 1

Demand is **unit-elastic** if the price elasticity of demand is exactly 1.

"Perfectly inelastic demand" (one extreme case)

$$\text{Price elasticity of demand} = \frac{\%\text{ change in } Q}{\%\text{ change in } P} = \frac{0\%}{10\%} = 0$$

D curve:

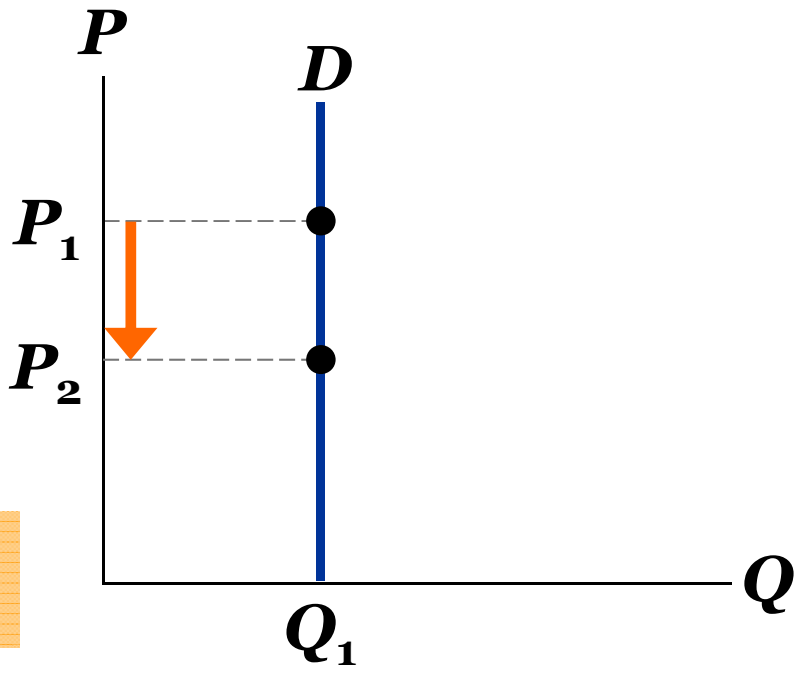
vertical

Consumers' price sensitivity:

none

Elasticity:

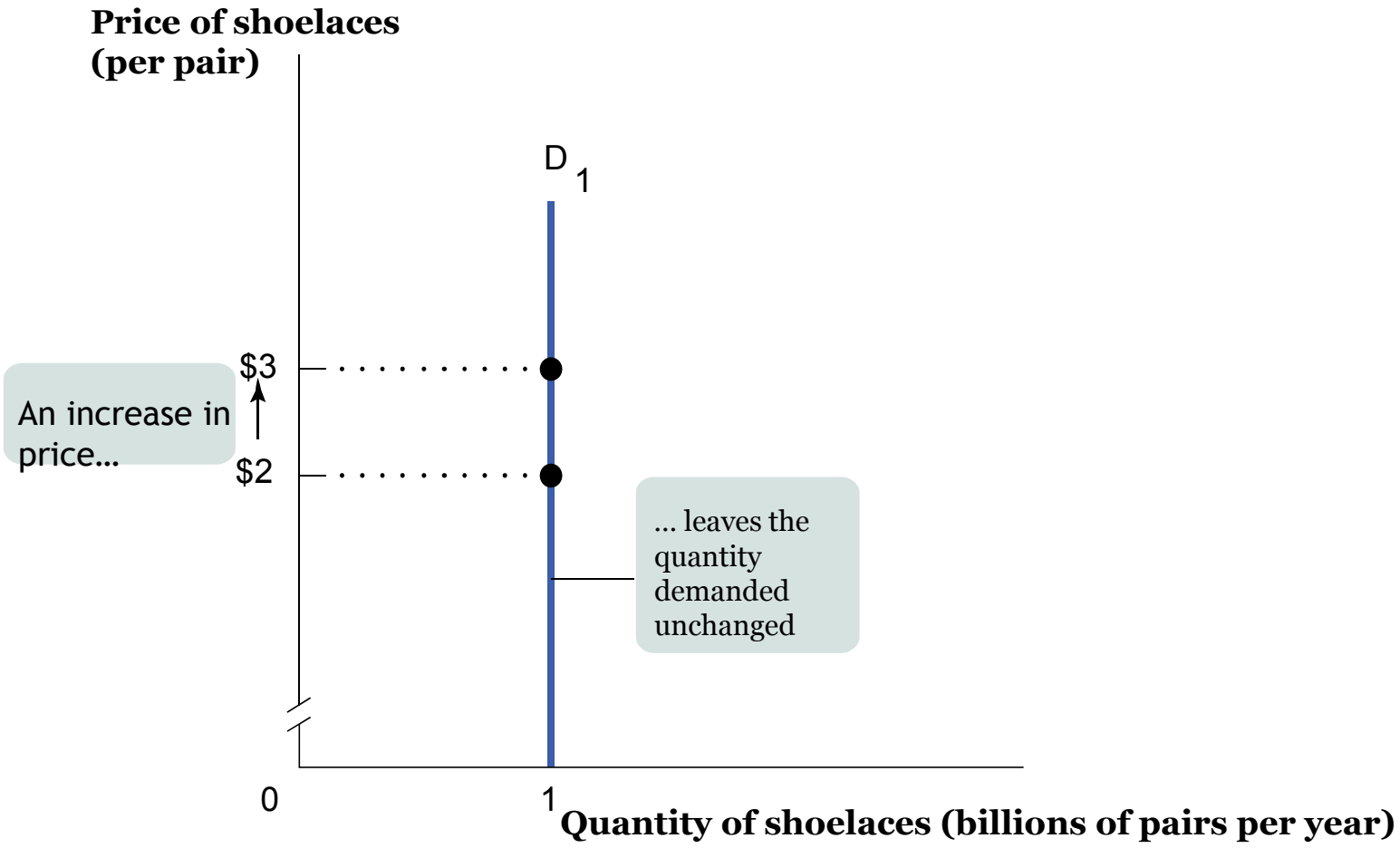
0



P falls by 10%

Q changes by 0%

Perfectly Inelastic Demand: Price Elasticity of Demand = 0



"Inelastic demand"

$$\text{Price elasticity of demand} = \frac{\%\text{ change in } Q}{\%\text{ change in } P} = \frac{< 10\%}{10\%} < 1$$

D curve:

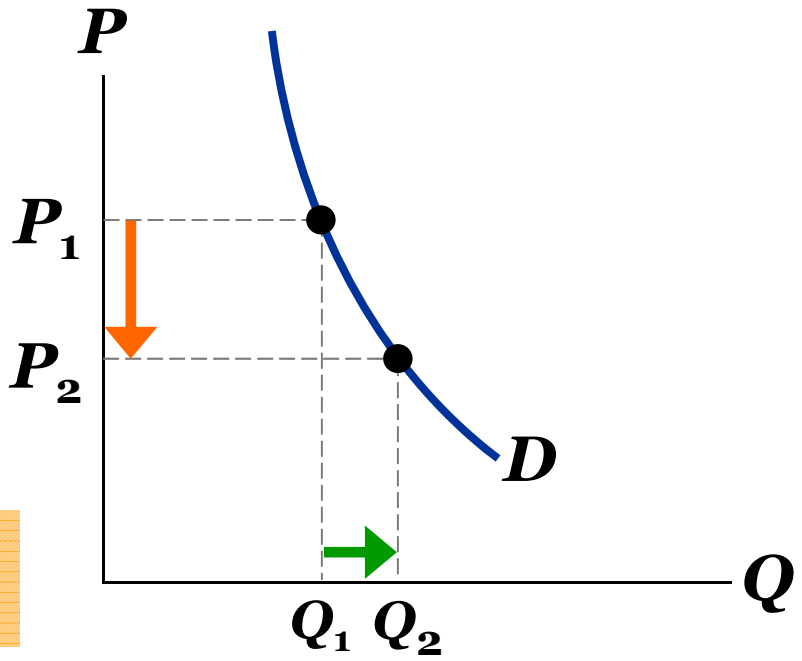
relatively steep

Consumers' price sensitivity:

relatively low

Elasticity:

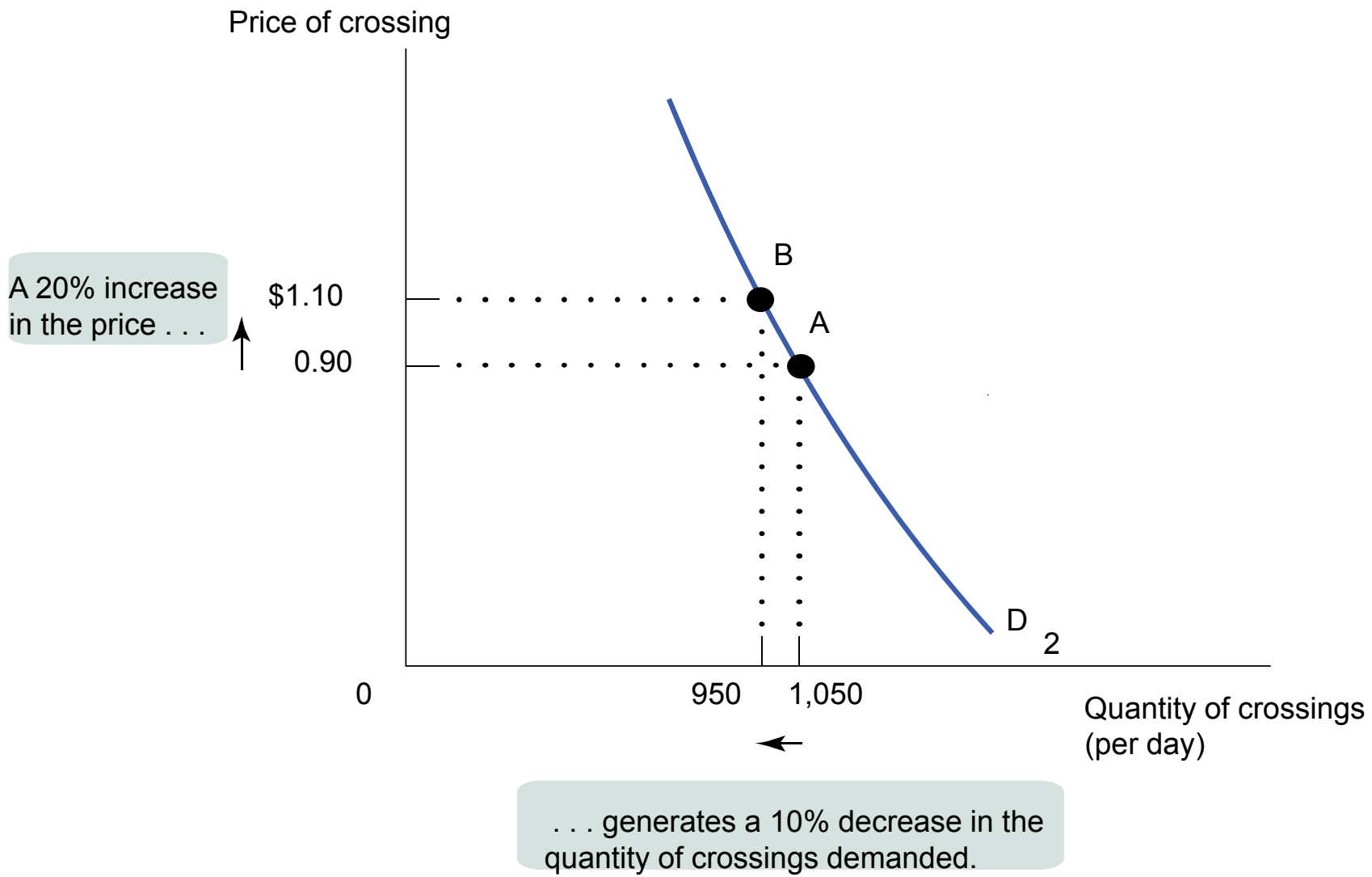
< 1



P falls by 10%

Q rises less than 10%

Inelastic Demand: Price Elasticity of Demand = 0.5



"Unit elastic demand"

$$\text{Price elasticity of demand} = \frac{\%\text{ change in } Q}{\%\text{ change in } P} = \frac{10\%}{10\%} = 1$$

D curve:

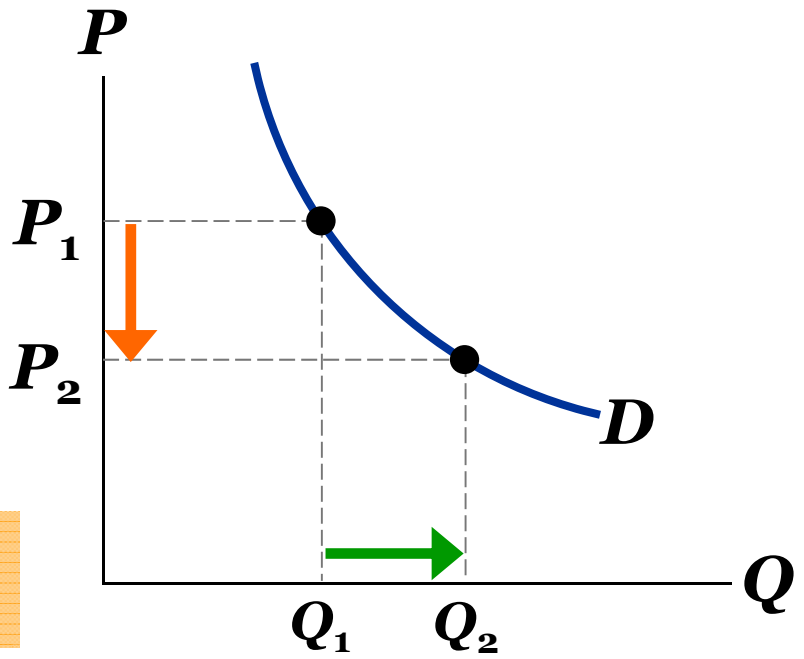
intermediate slope

Consumers' price sensitivity:

intermediate

Elasticity:

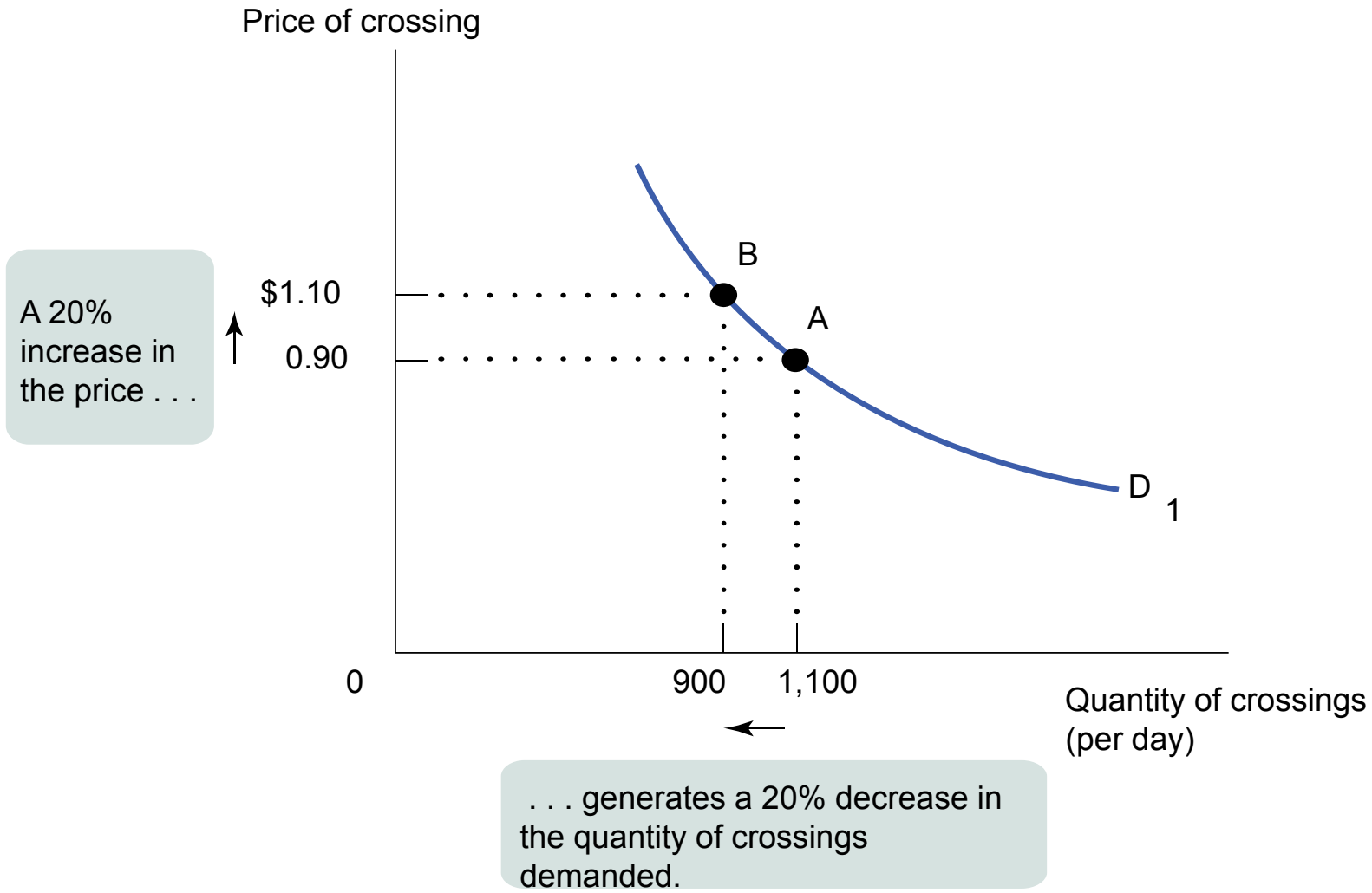
1



P falls by 10%

Q rises by 10%

Unit-Elastic Demand: Price Elasticity of Demand = 1



"Elastic demand"

$$\text{Price elasticity of demand} = \frac{\%\ \text{change in } Q}{\%\ \text{change in } P} = \frac{> 10\%}{10\%} \quad > 1$$

D curve:

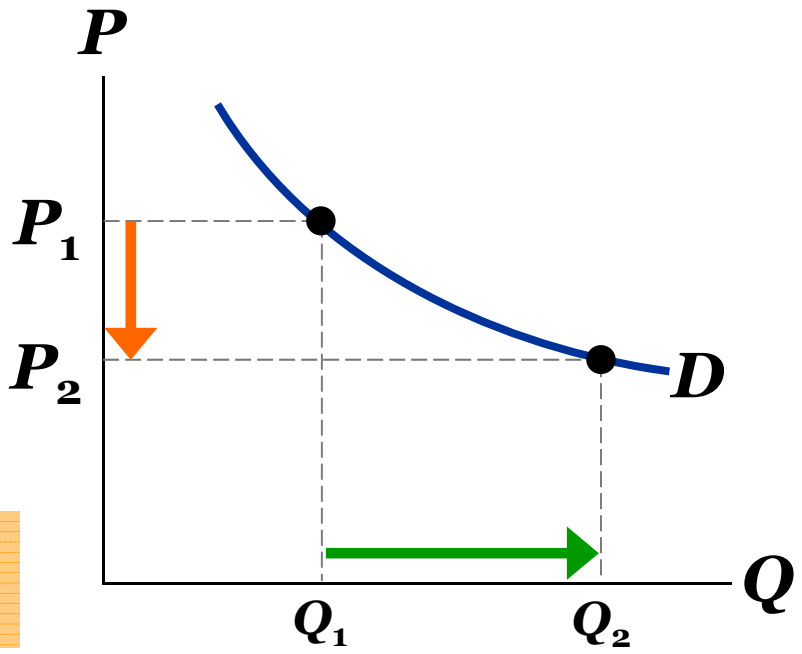
relatively flat

Consumers' price sensitivity:

relatively high

Elasticity:

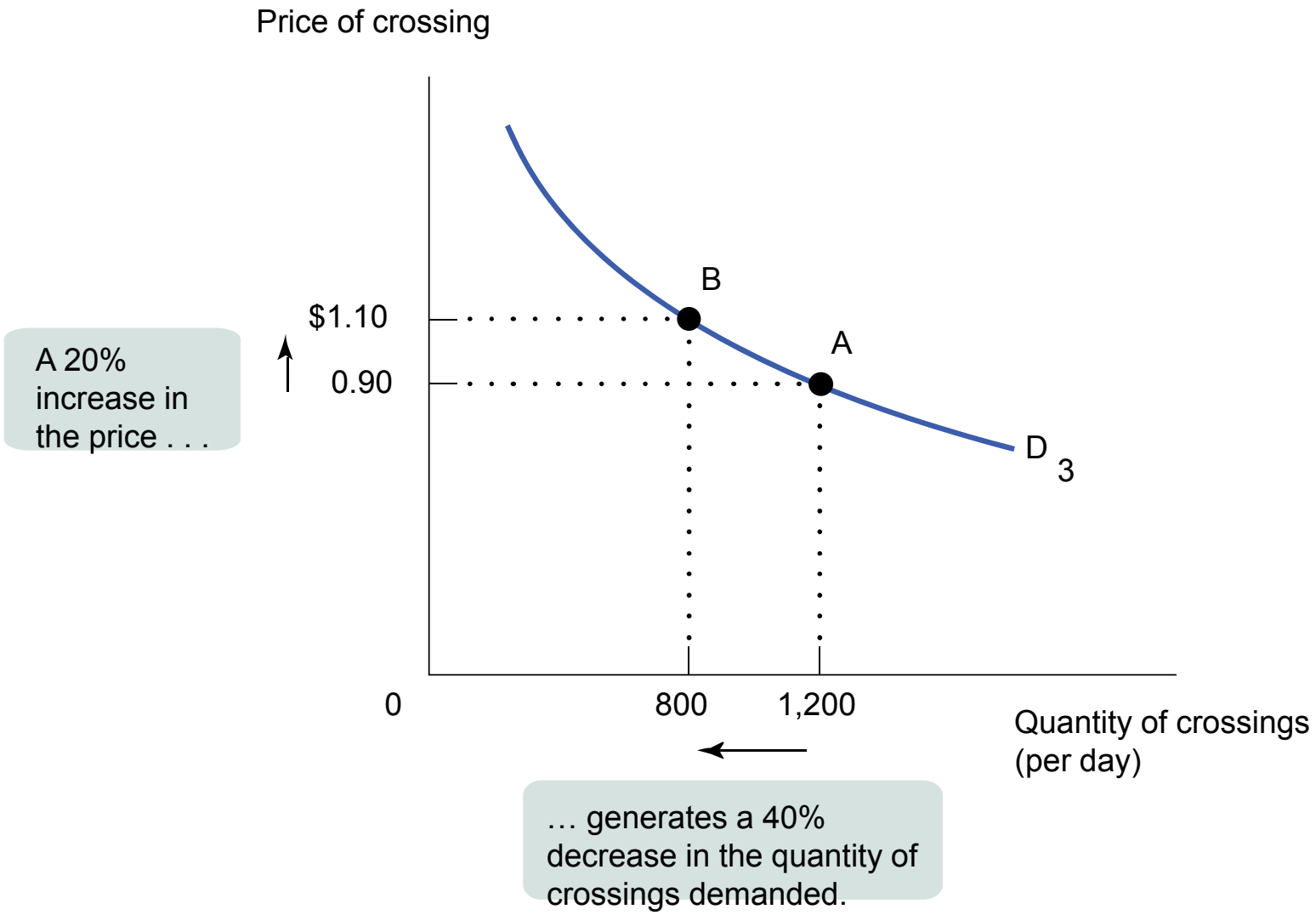
> 1



P falls by 10%

Q rises more than 10%

Elastic Demand: Price Elasticity of Demand = 2



"Perfectly elastic demand" (the other extreme)

$$\text{Price elasticity of demand} = \frac{\%\ \text{change in } Q}{\%\ \text{change in } P} = \frac{\text{any } \%}{0\%} = \text{infinity}$$

D curve:

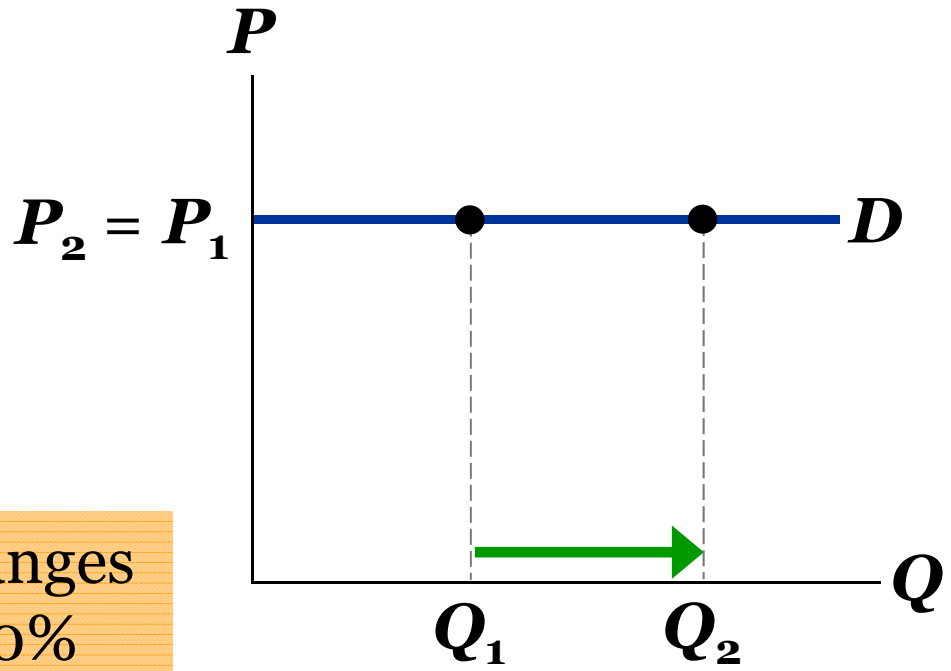
horizontal

Consumers' price sensitivity:

extreme

Elasticity:

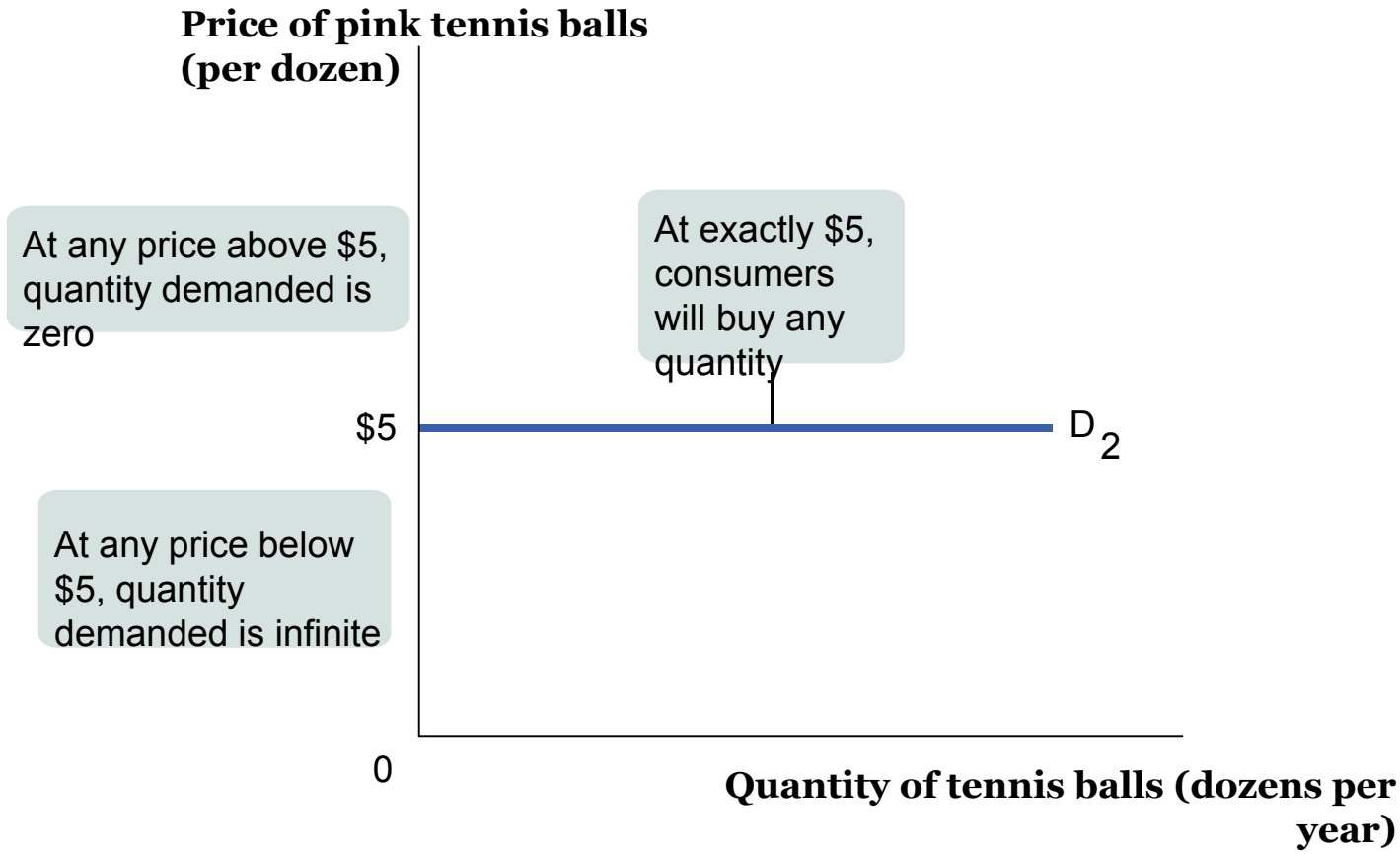
infinity



P changes by 0%

Q changes by any %

Price Elastic Demand: Price Elasticity of Demand = ∞



Some Estimated Price Elasticities of Demand

Good	Price elasticity
Inelastic demand	
• Eggs	0.1
• Beef	0.4
• Stationery	0.5
• Gasoline	0.5
Elastic demand	
• Housing	1.2
• Restaurant meals	2.3
• Airline travel	
• Foreign travel	4.1

Price elasticity of demand<1

Price elasticity of demand>1

EXAMPLE 1:
Breakfast Cereal vs. Sunscreen

- The prices of both of these goods rise by 20%. For which good does Q^d drop the most? Why?
  - Breakfast cereal has close substitutes (*e.g.*, pancakes, Eggo waffles, leftover pizza), so buyers can easily switch if the price rises.
  - Sunscreen has no close substitutes, so consumers would probably not buy much less if its price rises.
- Lesson: ***Price elasticity is higher when close substitutes are available.***

EXAMPLE 2:
Insulin vs. Caribbean Cruises

- The prices of both of these goods rise by 20%.
  For which good does Q^d drop the most? Why?
  - To millions of diabetics, insulin is a necessity.
    A rise in its price would cause little or no decrease in demand.
  - A cruise is a luxury. If the price rises, some people will forego it.
- Lesson: ***Price elasticity is higher for luxuries than for necessities.***

EXAMPLE 3:
Gasoline in the Short Run vs. Gasoline in the Long Run

- The price of gasoline rises 20%. Does Q^d drop more in the short run or the long run? Why?
  - There's not much people can do in the short run, other than ride the bus or carpool.
  - In the long run, people can buy smaller cars or live closer to where they work.
- Lesson: ***Price elasticity is higher in the long run than the short run.***

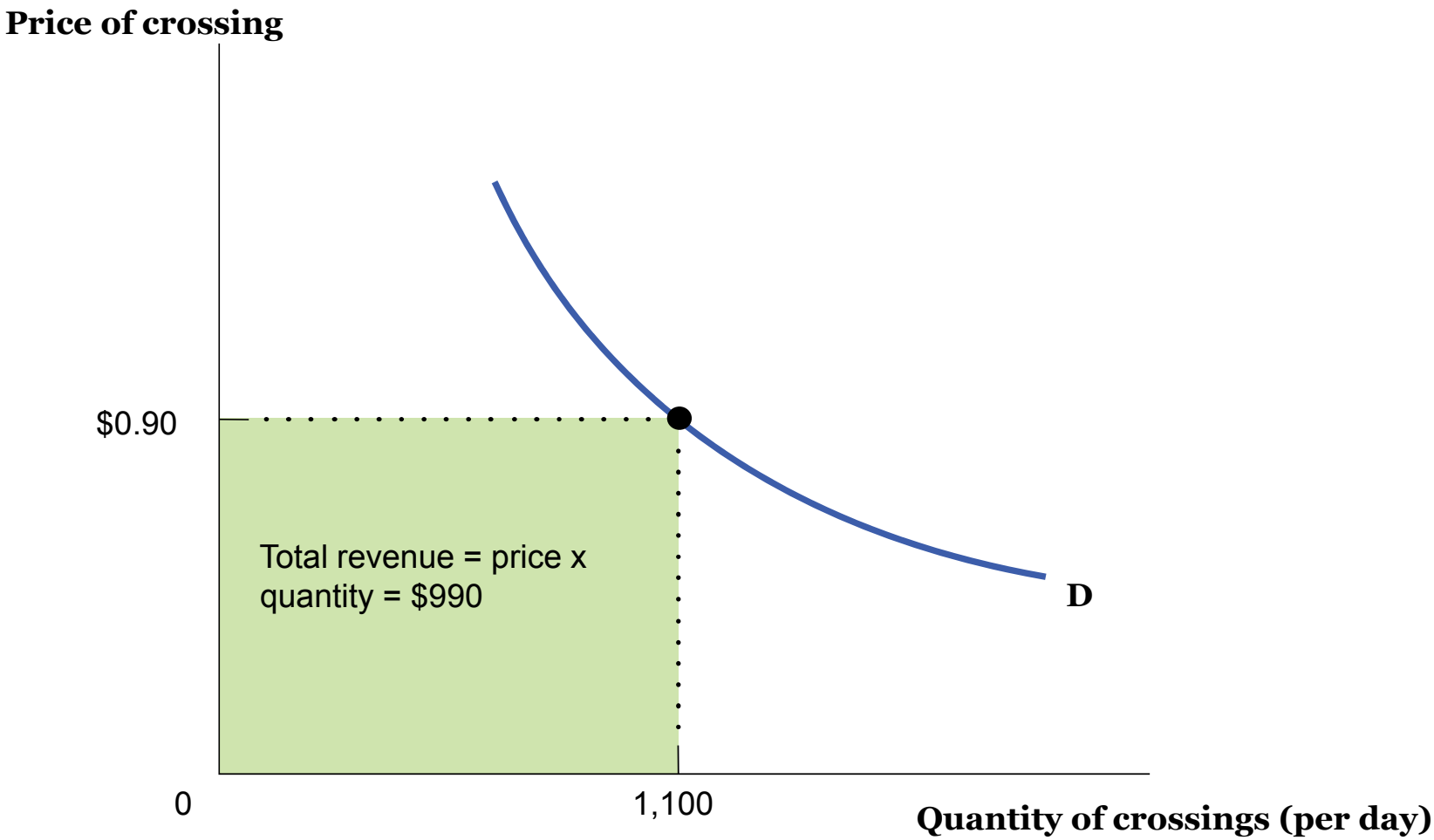
Why does it matter whether demand is unit-elastic, inelastic, or elastic?

- Because this classification predicts how changes in the price of a good will affect the *total revenue* earned by producers from the sale of that good.

- The **total revenue** is defined as the total value of sales of a good or service, i.e.

- Total Revenue = Price × Quantity Sold

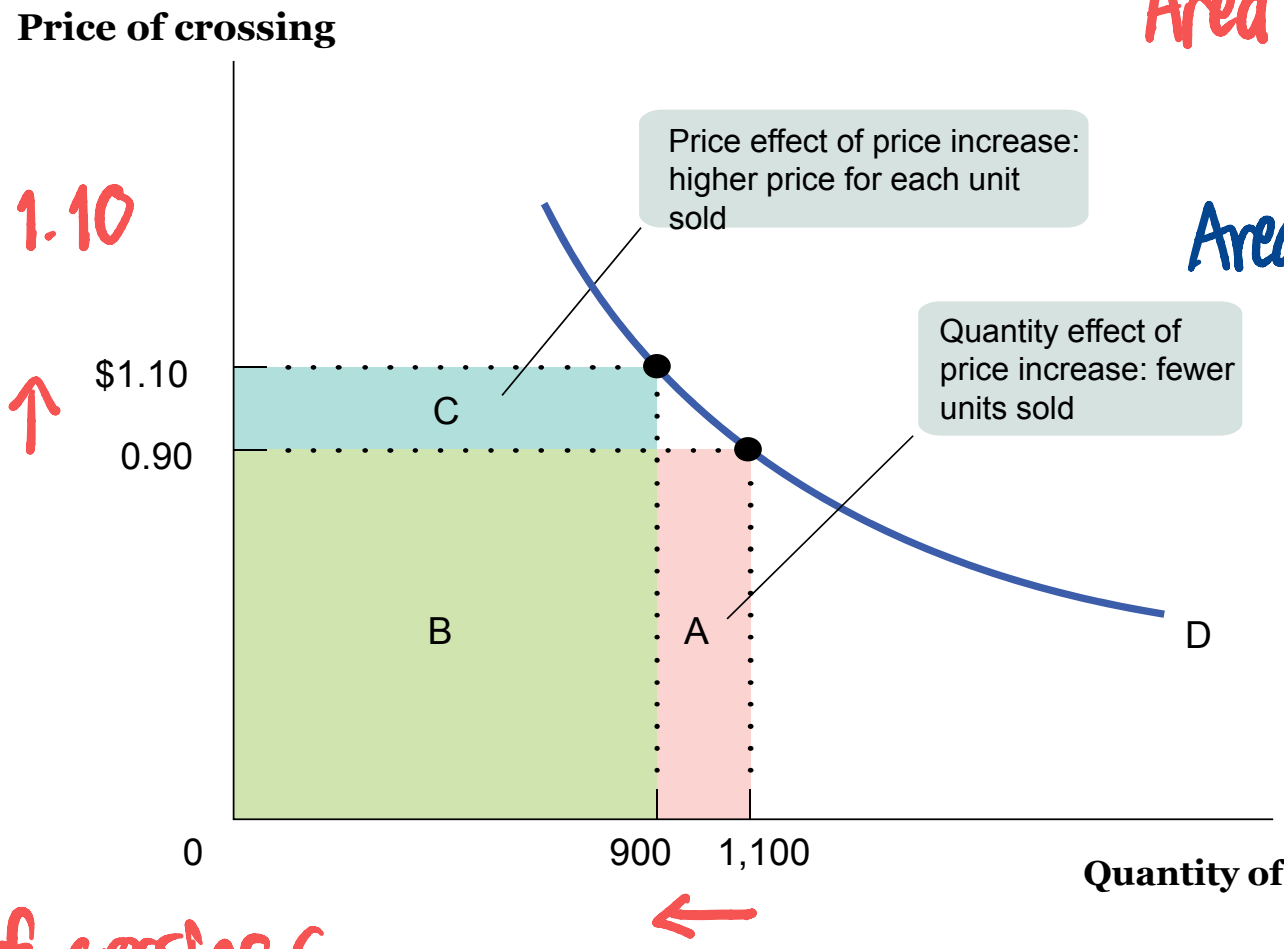
Total Revenue by Area



Elasticity and Total Revenue

- When a seller raises the price of a good, there are two countervailing effects in action (except in the rare case of a good with perfectly elastic or perfectly inelastic demand):
  - ***A price effect:*** After a price increase, each unit sold sells at a higher price, which tends to raise revenue.
  - ***A quantity effect:*** After a price increase, fewer units are sold, which tends to lower revenue.

Effect of a Price Increase on Total Revenue



Price
$0.90 → $1.10

Area C = $0.20 x 900
= $180

Area B = $0.90 x 900
= $810

Quantity of crossings
1100 → 900

Area A = 200 x 0.90 = $180

Price Elasticity and Total Revenue

- Continuing our scenario, if you raise your price from $200 to $250, would your revenue rise or fall?

  Revenue = ***P*** x ***Q***

- A price increase has two effects on revenue:
  - Higher ***P*** means more revenue on each unit you sell.
  - But you sell fewer units (lower ***Q***), due to law of demand.
- Which of these two effects is bigger?
  It depends on the price elasticity of demand.

- If demand for a good is ***elastic*** (the price elasticity of demand is greater than 1), an increase in price reduces total revenue. In this case, the quantity effect is stronger than the price effect.

- If demand for a good is ***inelastic*** (the price elasticity of demand is less than 1), a higher price increases total revenue. In this case, the price effect is stronger than the quantity effect.

- If demand for a good is ***unit-elastic*** (the price elasticity of demand is 1), an increase in price does not change total revenue. In this case, the sales effect and the price effect exactly offset each other.

- When demand is unit elastic, the two effect exactly balance; so a fall in price has no effect on total revenue

- When demand is inelastic, the price effect dominates the quantity effect; so a fall in price reduces total revenue

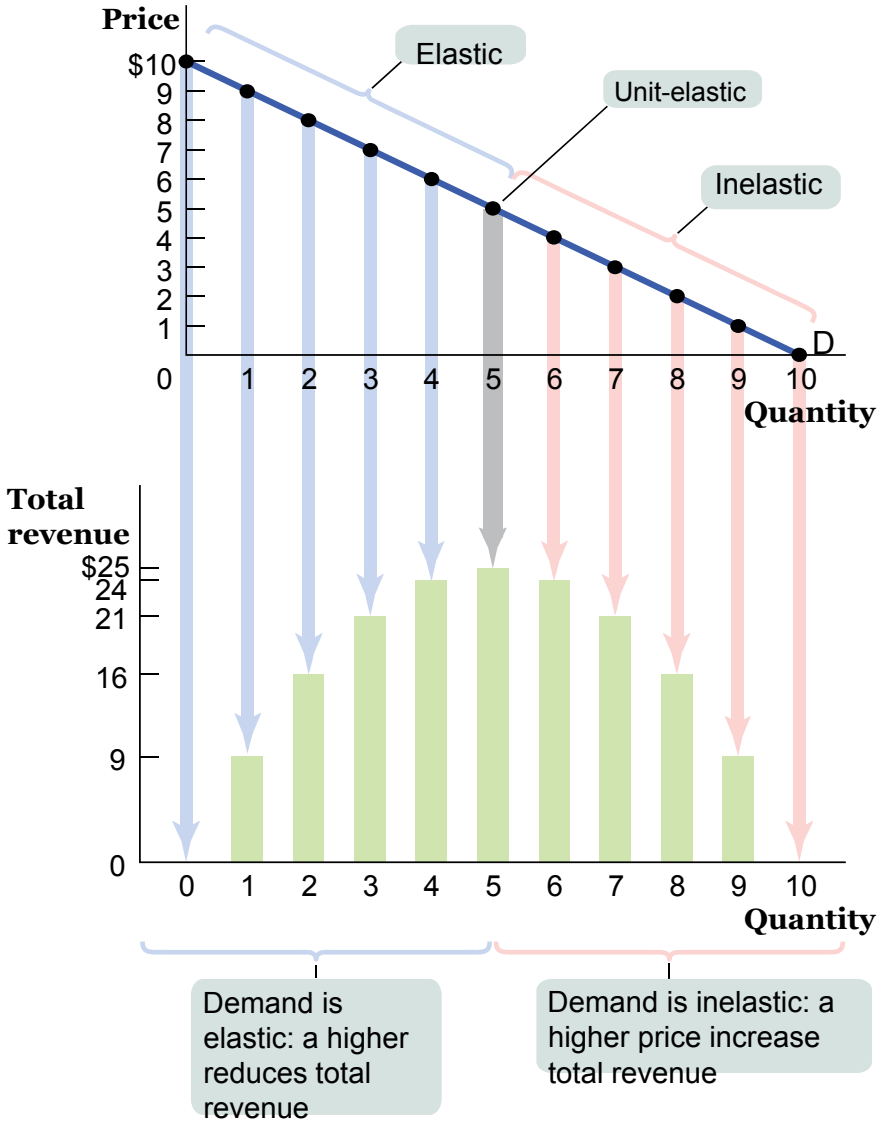
- When demand is elastic, the quantity effect dominates the price effect; so a fall in price increases total revenue

Price Elasticity of Demand and Total Revenue

	Price of crossing = $0.90	Price of crossing = $1.10
Unit-elastic demand (price elasticity of demand = 1)		
Quantity demanded	1,100	900
Total revenue	$990	$990
Inelastic demand (price elasticity of demand = 0.5)		
Quantity demanded	1,050	950
Total revenue	$945	$1,045
Elastic demand (price elasticity of demand = 2)		
Quantity demanded	1,200	800
Total revenue	$1,080	$880

1100 x 0.90 → 900 x 1.1 →
1050 x 0.90 → 950 x 1.1 →
1200 x 0.90 → 800 x 1.1 →

Demand Schedule and Total Revenue

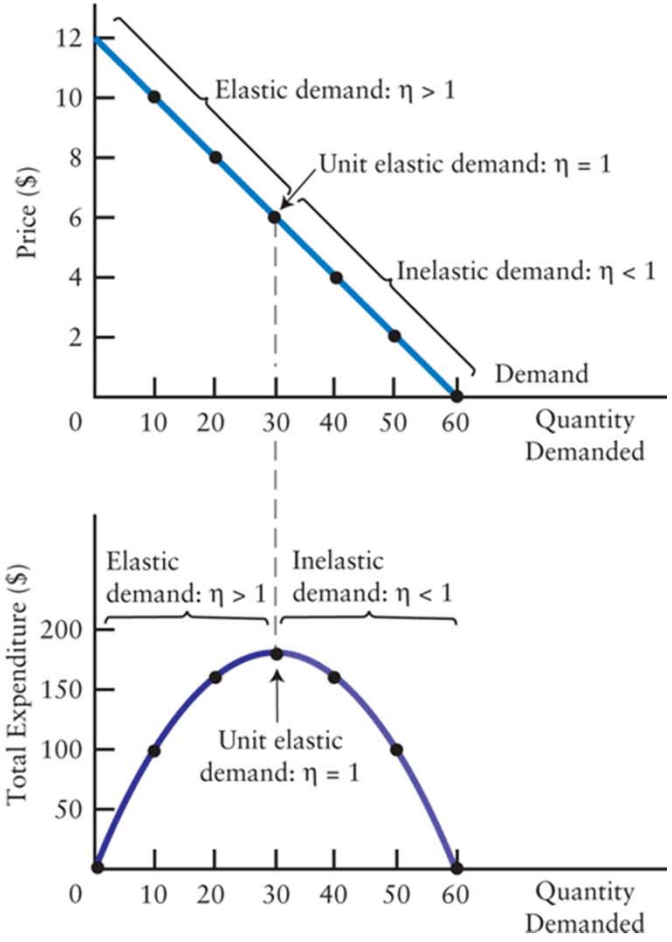


Demand Schedule and Total Revenue for a Linear Demand Curve		
Price	**Quantity demanded**	**Total Revenue**
$0	10	$0
1	9	9
2	8	16
3	7	21
4	6	24
5	5	25
6	4	24
7	3	21
8	2	16
9	1	9
10	0	0

The price elasticity of demand changes along the demand curve

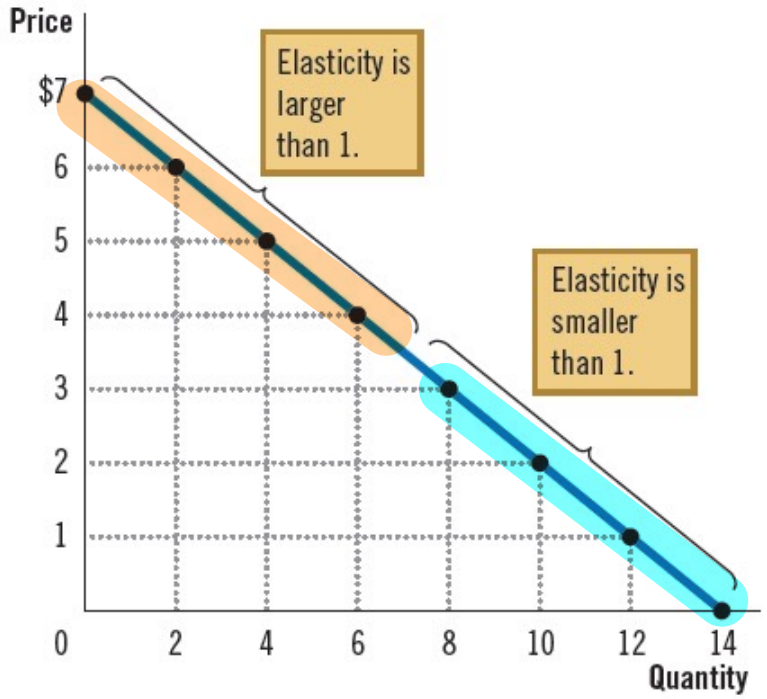
Total Expenditure and Quantity Demanded

Price ($)	Quantity Demanded	Expenditure ($)
12	0	0
10	10	100
8	20	160
6	30	180
4	40	160
2	50	100
0	60	0



Elasticity along a Linear Demand Curve

- The slope of a linear demand curve is constant, but its elasticity is not.
- The price elasticity of demand is calculated using the demand schedule and the midpoint method.
- At points with a low price and high quantity, the demand curve is inelastic.
- At points with a high price and low quantity, it is elastic.



Elasticity along a Linear Demand Curve

Price	Quantity	Total Revenue (Price × Quantity)	Percentage Change in Price	Percentage Change in Quantity	Elasticity	Description
$7	0	$0				
6	2	12	15	200	13.0	Elastic
5	4	20	18	67	3.7	Elastic
4	6	24	22	40	1.8	Elastic
3	8	24	29	29	1.0	Unit elastic
2	10	20	40	22	0.6	Inelastic
1	12	12	67	18	0.3	Inelastic
0	14	0	200	15	0.1	Inelastic

$$\%\ \text{change in } X = \frac{\text{Change in } X}{\text{Average value of } X} \times 100$$

$$\text{Average value of } X = \frac{\text{Starting value of } X + \text{final value of } X}{2}$$

$$\text{Price elasticity of demand} = \frac{\dfrac{Q_2 - Q_1}{(Q_1 + Q_2)/2}}{\dfrac{P_2 - P_1}{(P_1 + P_2)/2}}$$

Price Elasticity and Total Revenue

$$\text{Price elasticity of demand} = \frac{\text{Percentage change in } Q}{\text{Percentage change in } P}$$

$$\text{Revenue} = P \times Q$$

- If demand is elastic, then
  price elasticity of demand > 1
  % change in Q > % change in P
- The fall in revenue from lower Q is greater than the increase in revenue from higher P, so revenue falls.

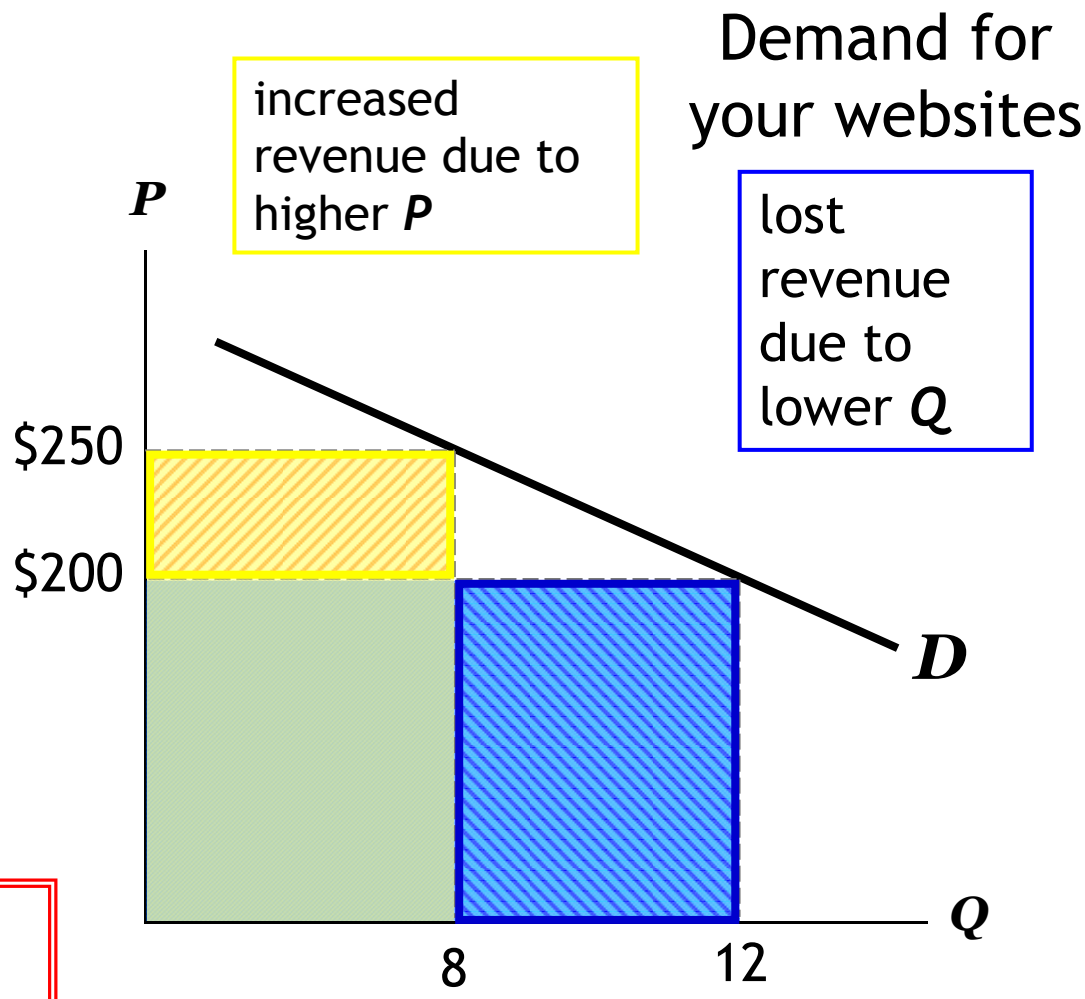
Price Elasticity and Total Revenue

Elastic demand
(elasticity = 1.8)

If ***P*** = \$200,
Q = 12 and revenue = \$2400.

If ***P*** = \$250,
Q = 8 and
revenue = \$2000.

When ***D*** is elastic,
a price increase
causes revenue to fall.



Price Elasticity and Total Revenue

$$\text{Price elasticity of demand} = \frac{\text{Percentage change in } \boldsymbol{Q}}{\text{Percentage change in } \boldsymbol{P}}$$

Revenue = $\boldsymbol{P}$ x $\boldsymbol{Q}$

- If demand is inelastic, then
  price elasticity of demand < 1
  % change in $\boldsymbol{Q}$ < % change in $\boldsymbol{P}$
- The fall in revenue from lower $\boldsymbol{Q}$ is smaller than the increase in revenue from higher $\boldsymbol{P}$, so revenue rises.
- In our example, suppose that $\boldsymbol{Q}$ only falls to 10 (instead of 8) when you raise your price to $250.

Price Elasticity and Total Revenue

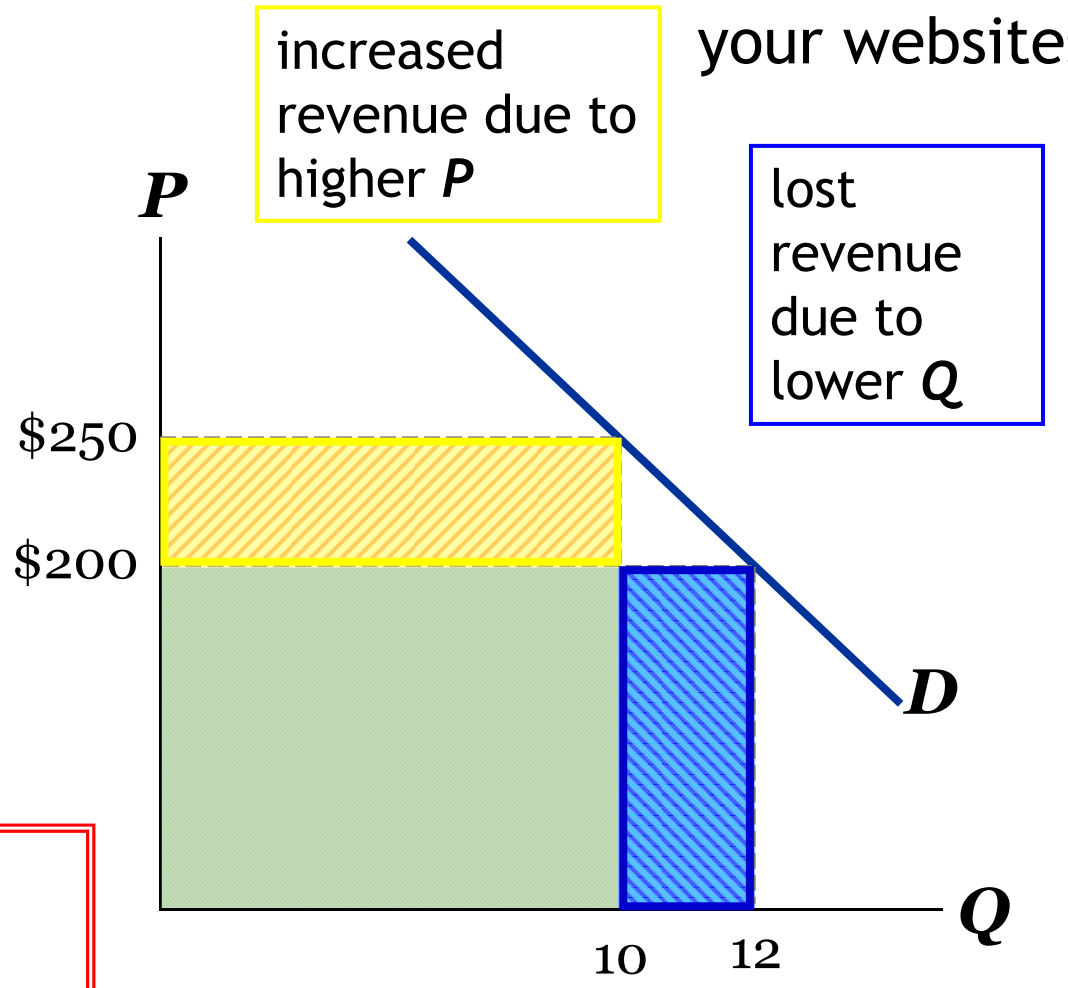
Now, demand is inelastic:
elasticity = 0.82

If ***P*** = \$200,
Q = 12 and revenue
= \$2400.

If ***P*** = \$250,
Q = 10 and
revenue = \$2500.

When ***D*** is inelastic,
a price increase
causes revenue to rise.

Demand for your websites



What Factors Determine the Price Elasticity of Demand?

The price elasticity of demand tends to be low if there are no close substitutes

- Whether Close Substitutes Are Available
- Whether the Good Is a Necessity or a Luxury
- Share of Income spent on the Good or proportion of consumer expenditure
- Time

The long run price elasticity of demand is often higher than short run elasticity

The price elasticity of demand tends to be high if the good is a luxury - something you can easily live without.

The price elasticity of demand tends to be low if a good is something you must have.

Share of Income spent on the Good or proportion of consumer expenditure

- The smaller the proportion of total expenditure that a product accounts for, the more price inelastic it is likely to be

- Any change in price will be less noticeable and so will be more easily absorbed

Example

Assume that a particular consumer takes a very short bus ride to the local village once a week. A return ticket costs £1.50

The consumer also uses the railways to travel to the nearest city once a week, a return ticket costing £ 50.

The consumer spends £200 every week in total

If both the bus and train tickets increase in price by 50 percent, the former will now cost £2.25 and the latter £75

As a consequence of the train ticket accounting for a much greater proportion of the total weekly expenditure, the consumer is more likely to decide to cut back on the number of trips to the city and to simply absorb the extra £0.75 spent on bus fares

The quantity demanded of train tickets is much more responsive to a change in price, and so is more price elastic

APPLICATION: Does Drug Interdiction Increase or Decrease Drug-Related Crime?

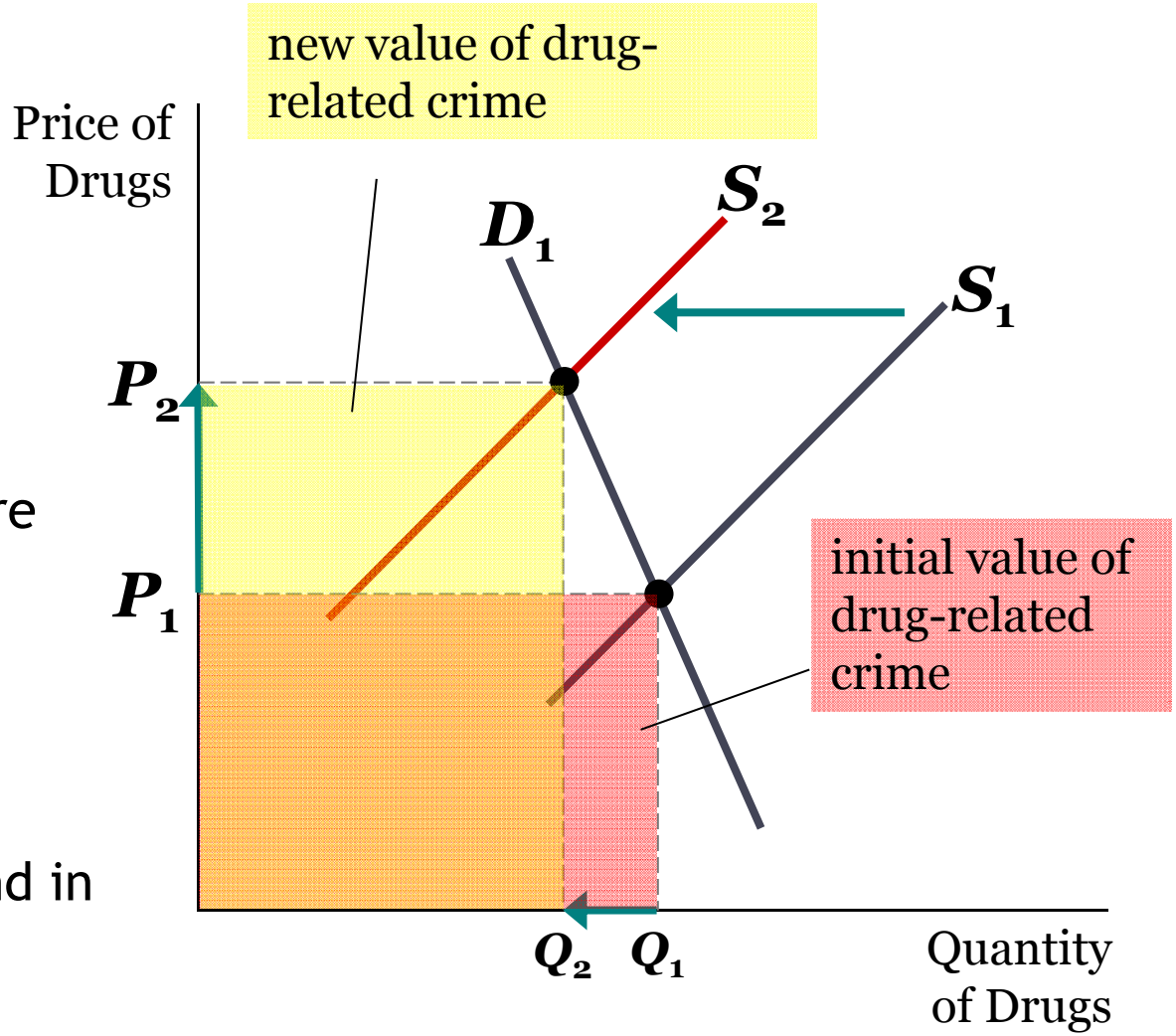
- One side effect of illegal drug use is crime: Users often turn to crime to finance their habit.
- We examine two policies designed to reduce illegal drug use and see what effects they have on drug-related crime.
- For simplicity, we assume the total dollar value of drug-related crime equals total expenditure on drugs.
- Demand for illegal drugs is inelastic, due to addiction issues.

Policy 1: Interdiction

Interdiction reduces the supply of drugs.

Since demand for drugs is inelastic,
P rises proportionally more than *Q* falls.

Result: an increase in total spending on drugs, and in drug-related crime

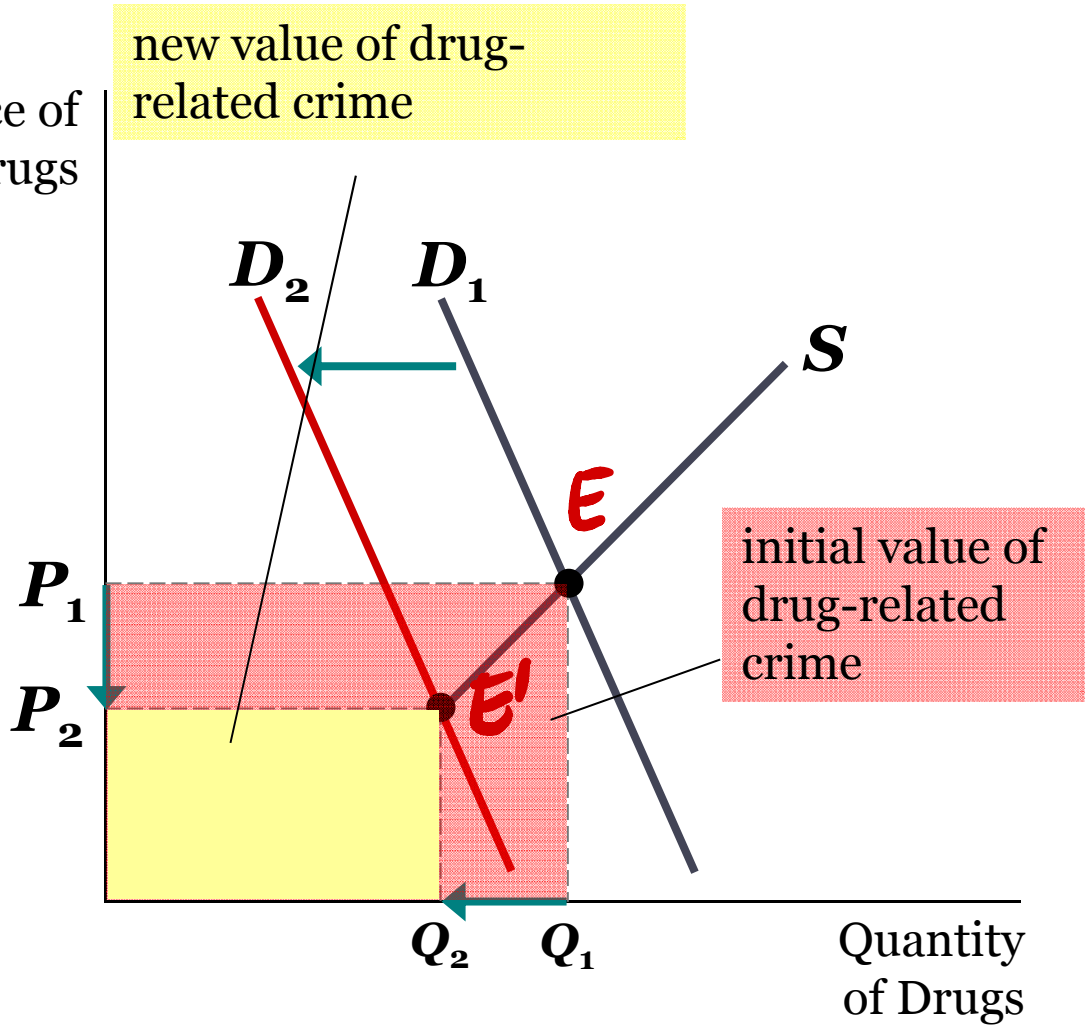


Policy 2: Education

Education reduces the demand for drugs.

P and ***Q*** fall.

Result:
A decrease in total spending on drugs, and in drug-related crime.



Class activity

Active Learning 2: Elasticity and Total Revenue

A. Pharmacies raise the price of insulin by 10%. Does total expenditure on insulin rise or fall?

A. As a result of a fare war, the price of a luxury cruise falls 20%. Does luxury cruise companies' total revenue rise or fall?

Active Learning 2: Answers

A. Expenditure = Total Revenue = $P \times Q$

- Insulin is a necessity
- Since demand for insulin is inelastic, Q will fall less than 10%, so expenditure rises

B. Revenue = $P \times Q$

- The fall in P reduces revenue, but Q increases, which increases revenue
- Since demand is elastic, Q will increase more than 20%, so revenue rises

Cross Price Elasticity

Other Demand Elasticities: Cross-Price Elasticity

- The **cross-price elasticity of demand** between two goods measures the effect of the change in one good's price on the quantity demanded of the other good. It is equal to the percent change in the quantity demanded of one good divided by the percent change in the other good's price.

The Cross-Price Elasticity of Demand Between Goods A and B:

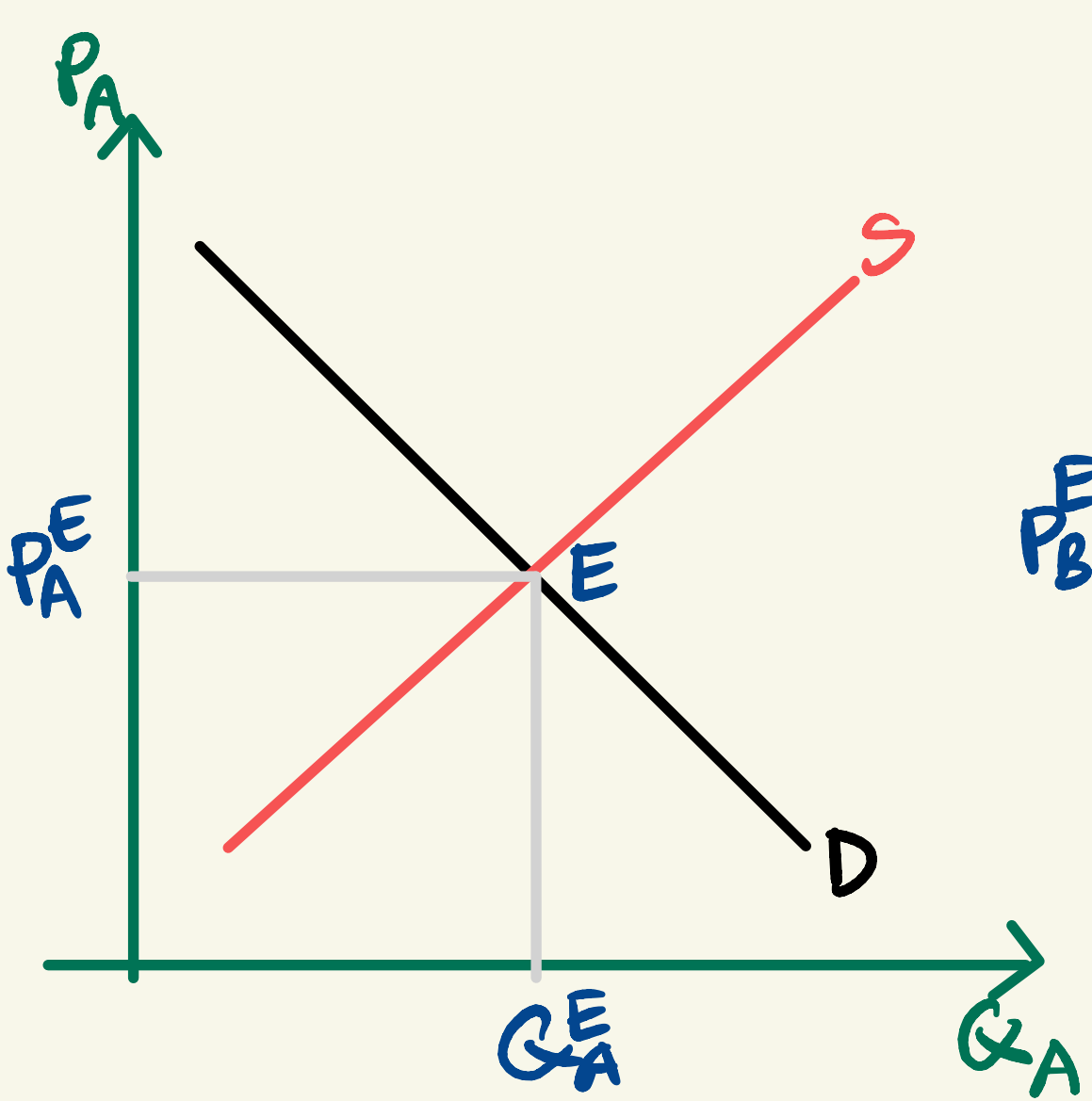
$$= \frac{\%\text{ change in quantity of A demanded}}{\%\text{ change in price of B}}$$

$$\eta_{XY} = \frac{\textit{percentage change in quantity demanded of good X}}{\textit{percentage change in price of good Y}}$$

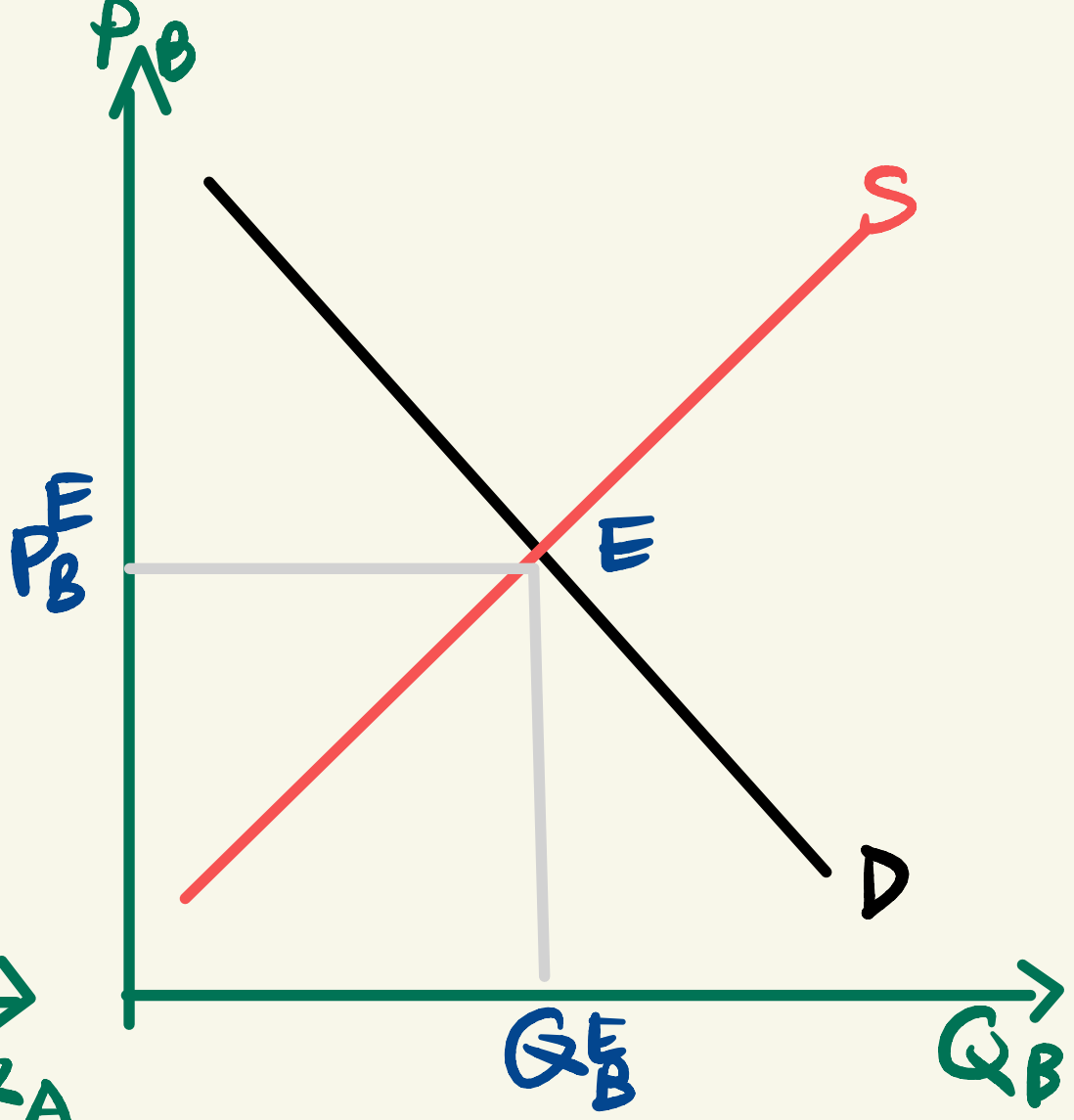
If $\eta_{XY} > 0$, then *X* and *Y* are substitutes.

If $\eta_{XY} < 0$, then *X* and *Y* are complements.

Note that in the case of the cross-price elasticity of demand, the sign (plus or minus) is very important: it tells us whether the two goods are complements or substitutes. So we cannot drop the minus sign as we did for the price elasticity of demand.

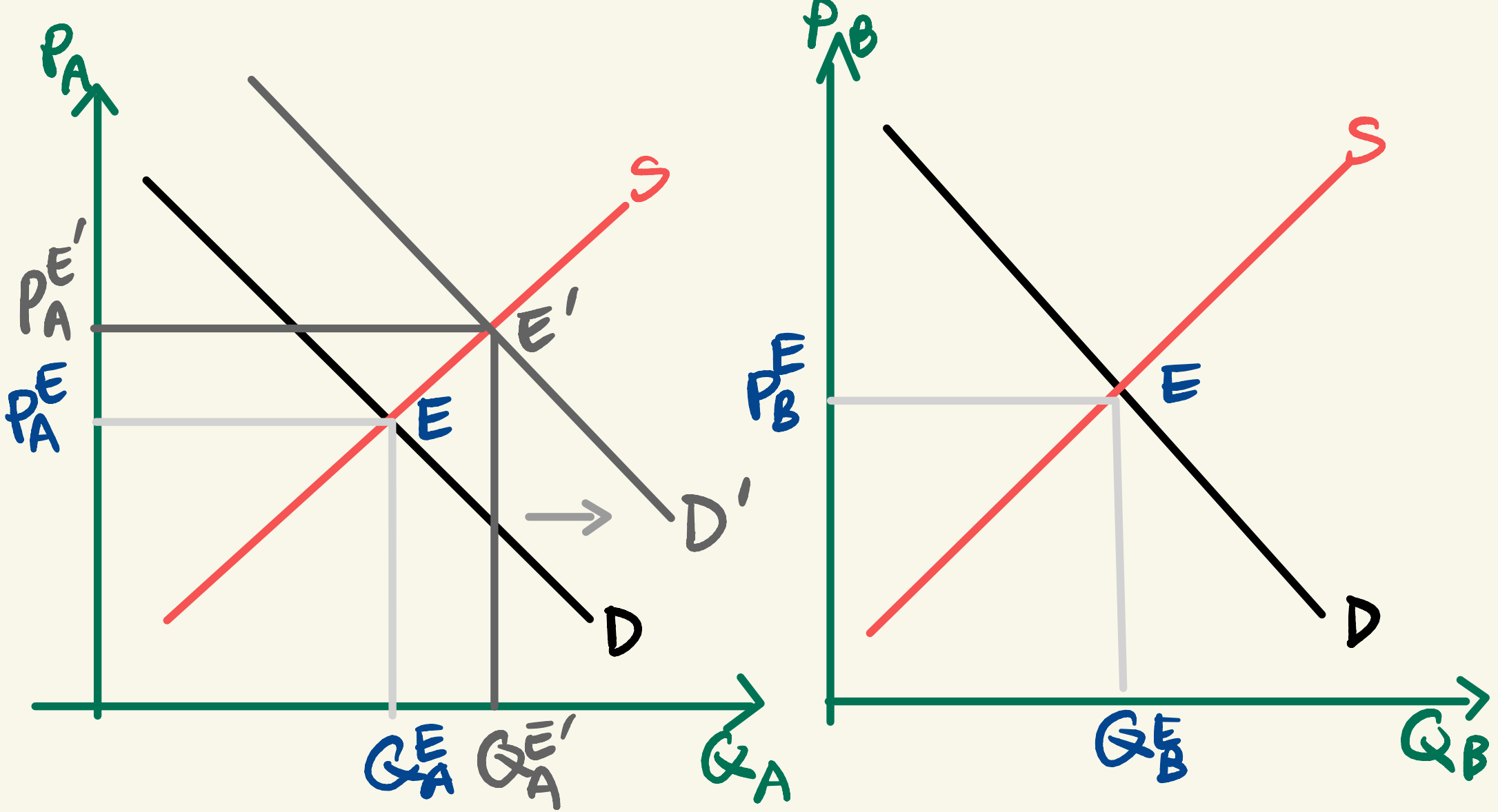


Mkt for good A



Mkt for good B

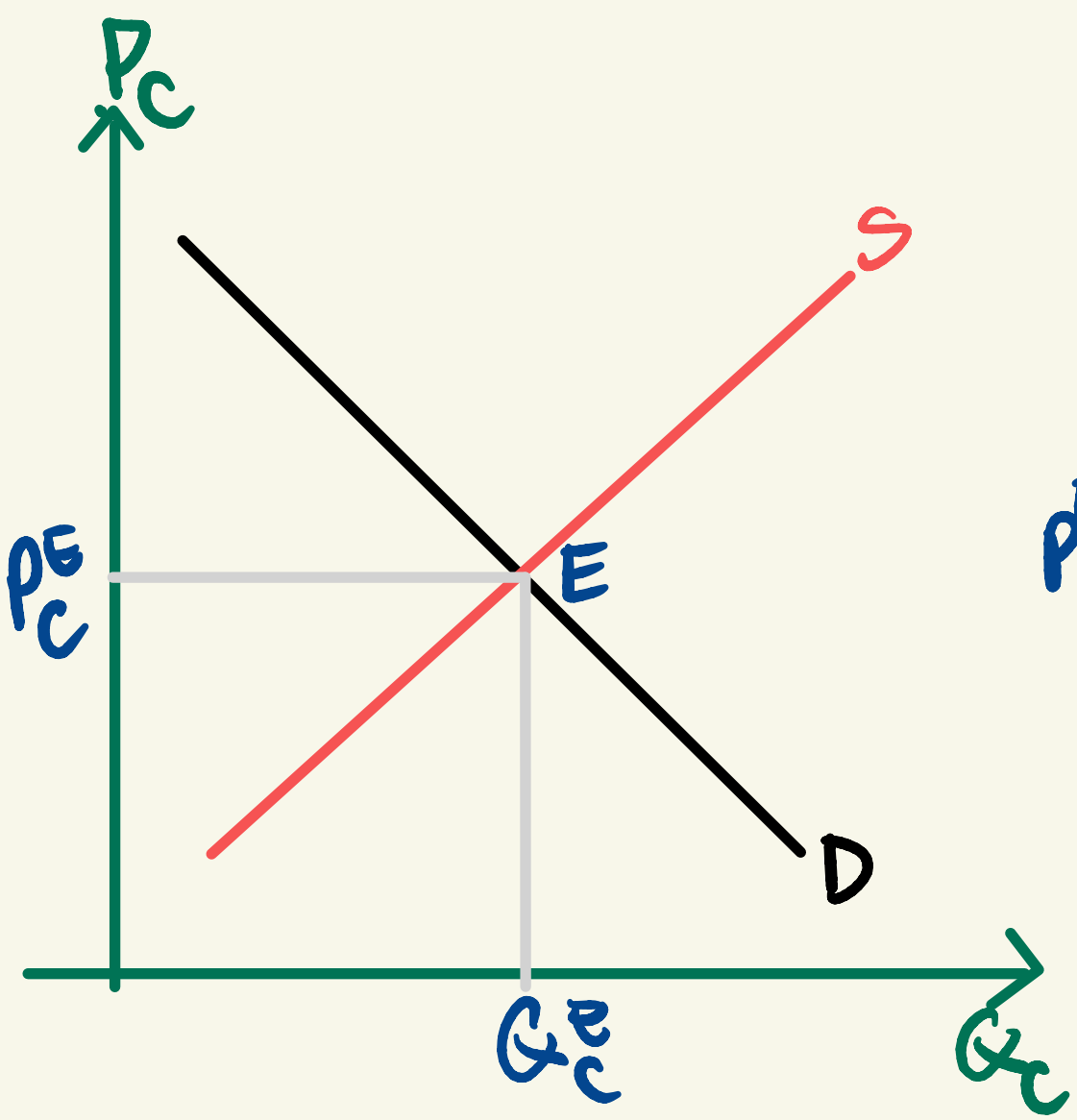
Substitute goods



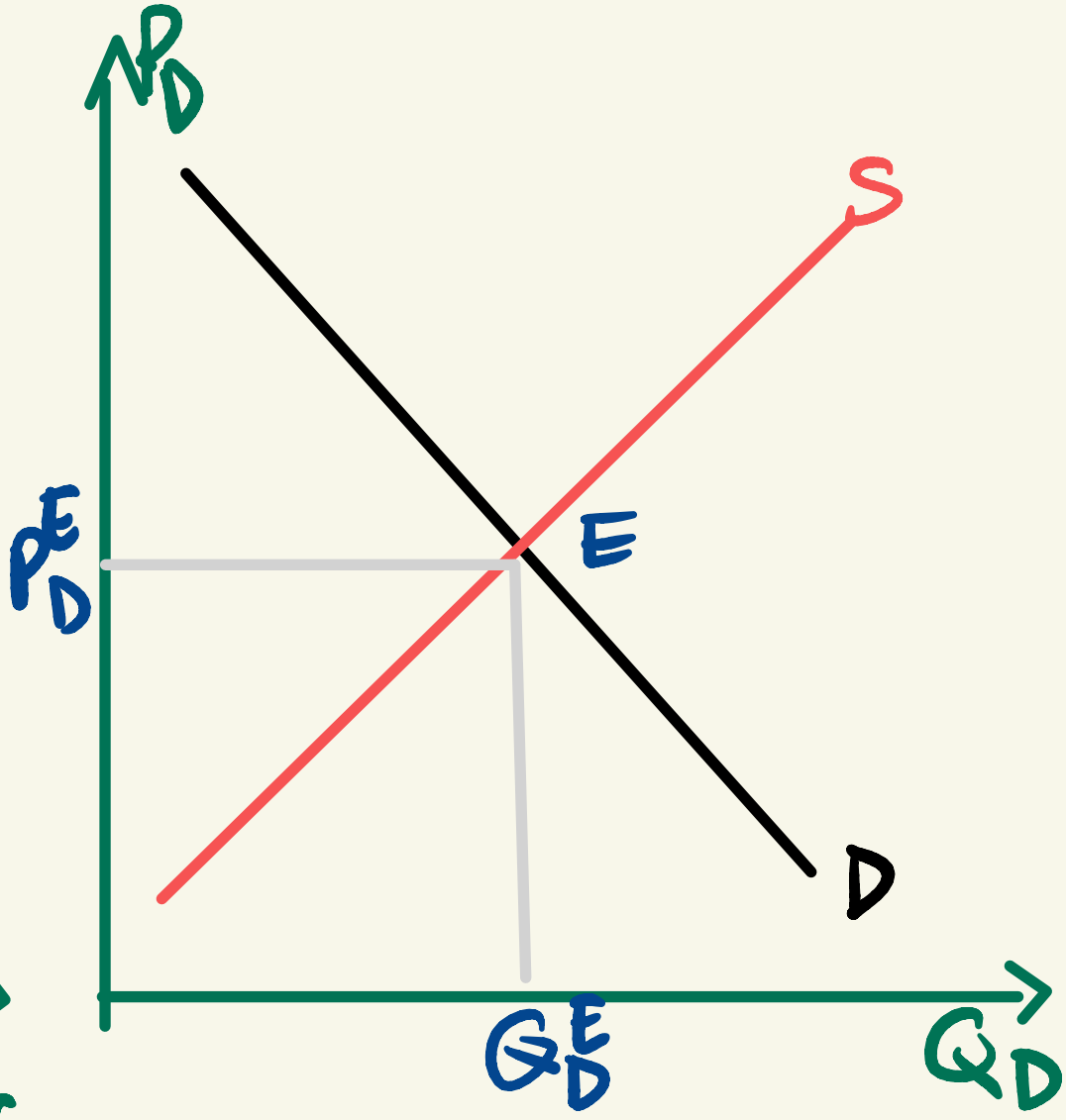
Mkt for good A

Mkt for good B

$P_B \uparrow$

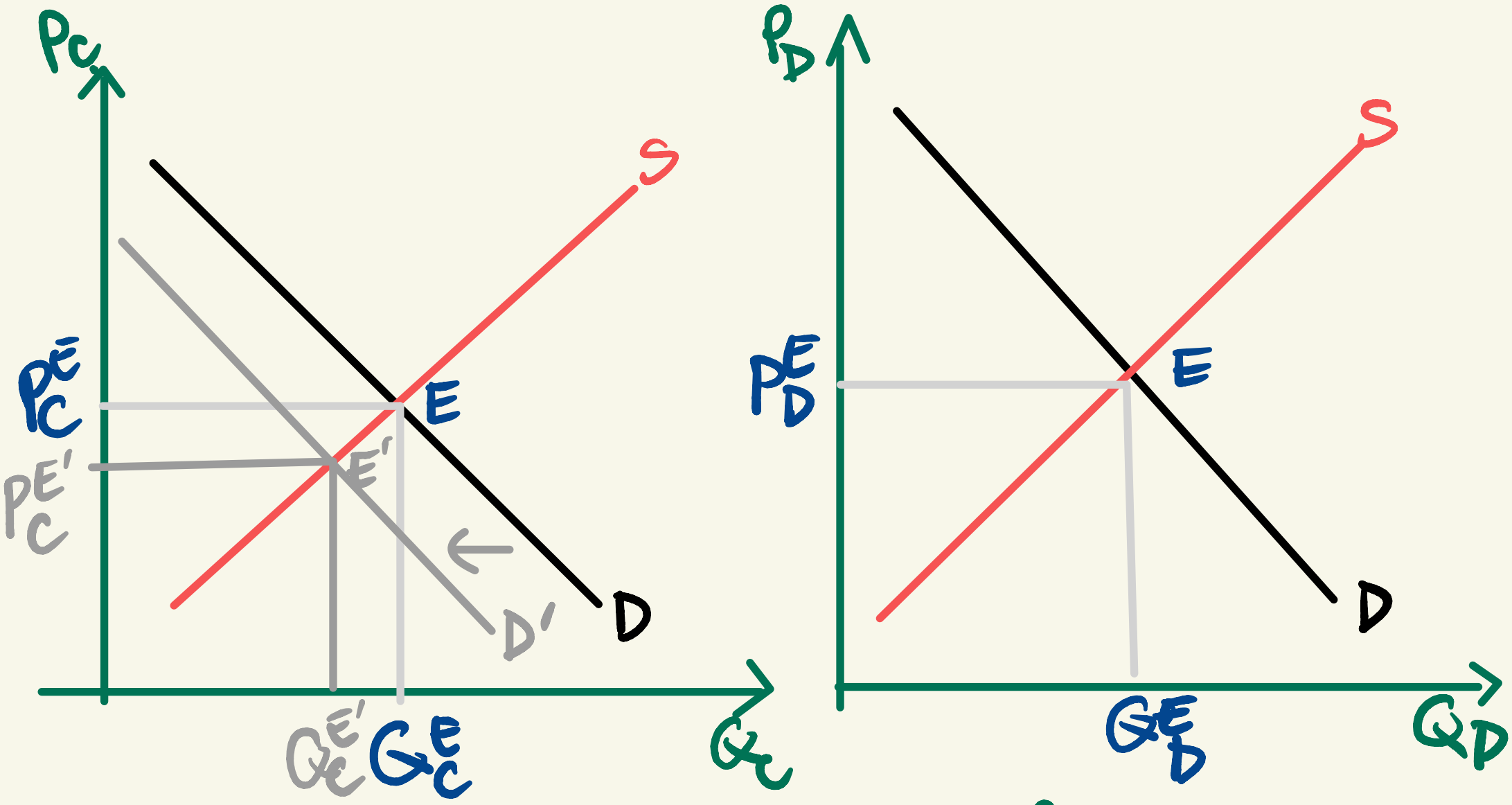


Mkt for good C



Mkt for good D

Complement goods



Mkt for good C

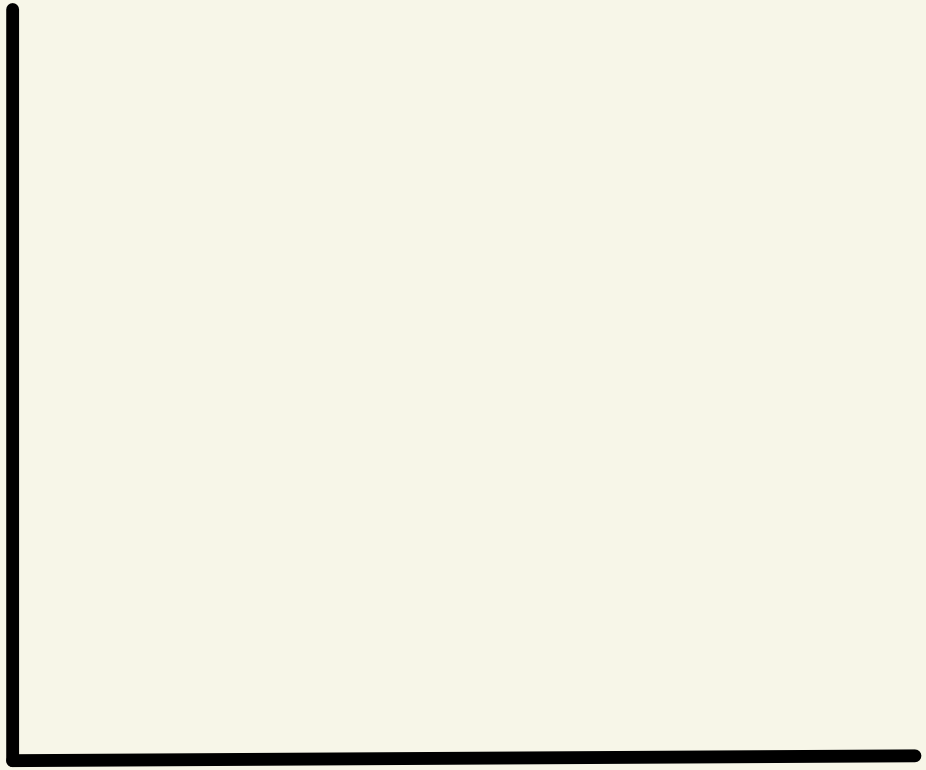
Mkt for good D

Complement goods $P_D \uparrow$

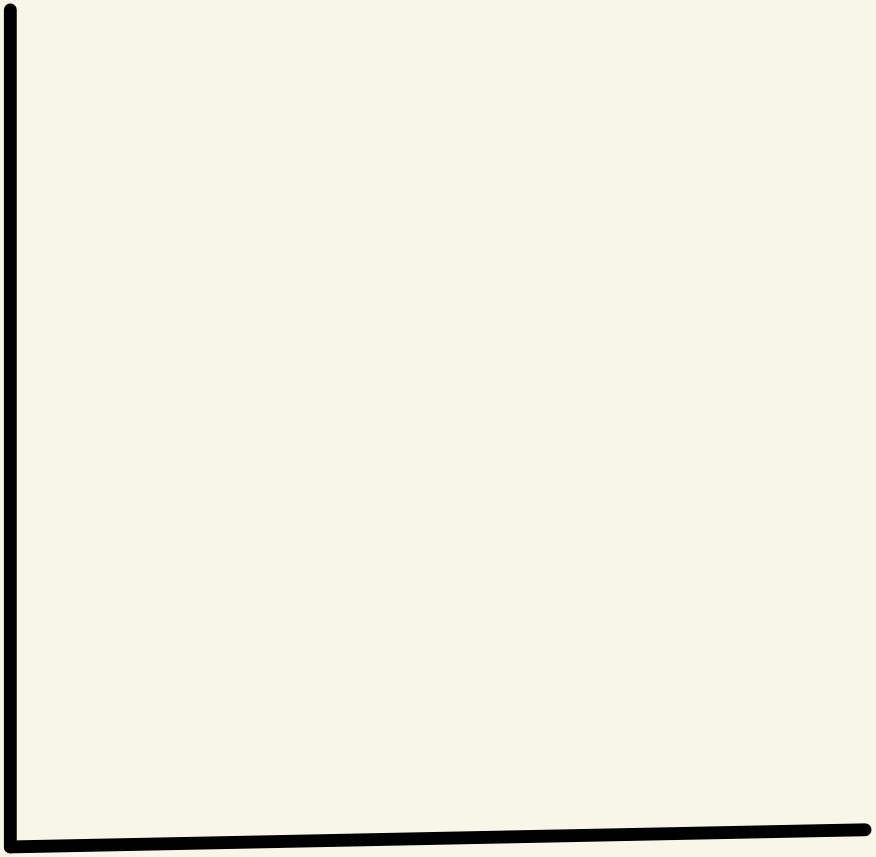
Cross-Price Elasticity

- Goods are **substitutes** when the *cross-price elasticity of demand* is positive.

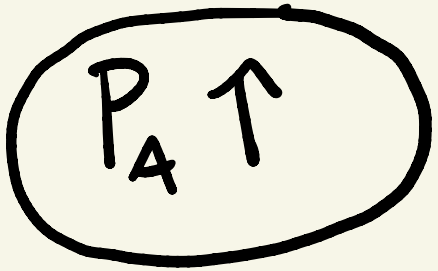
- Goods are **complements** when the cross-price elasticity of demand is negative.



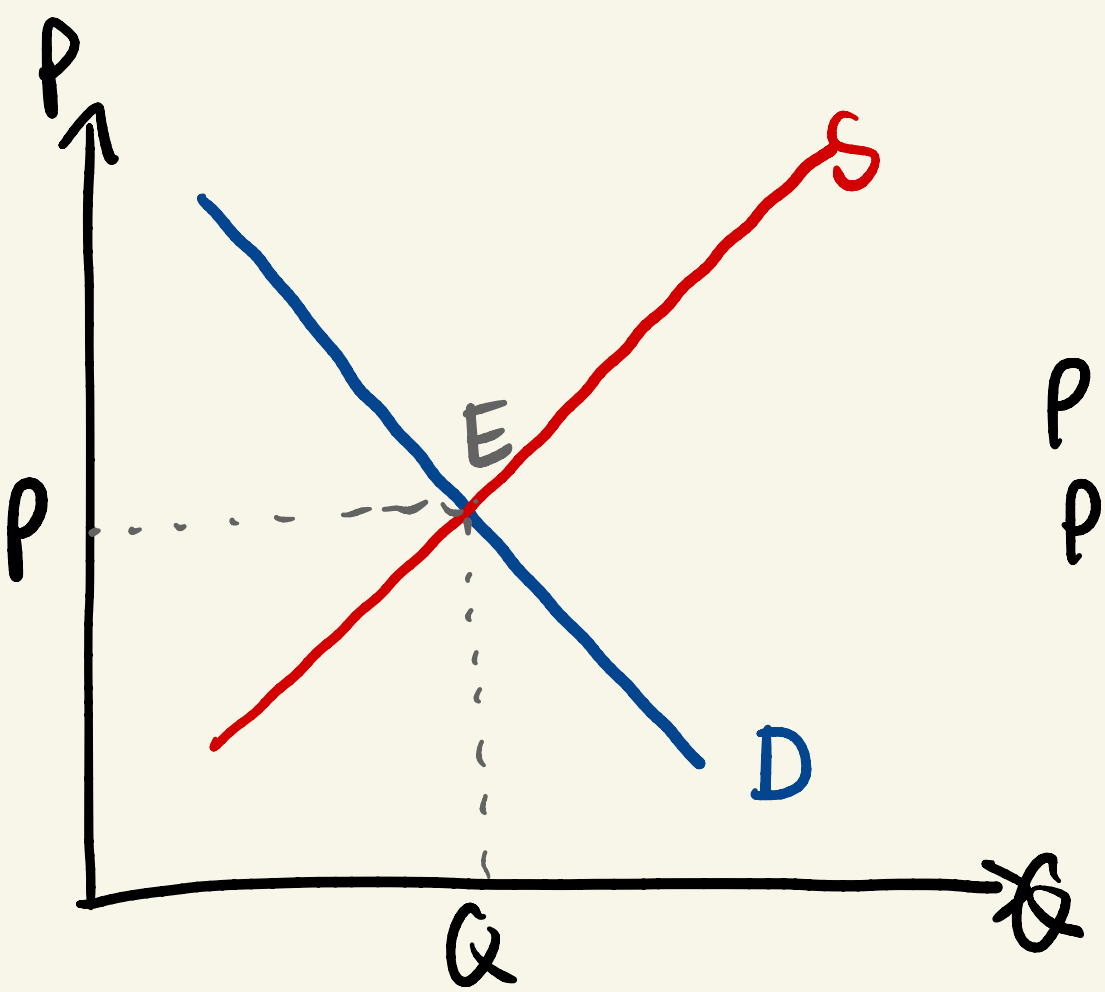
Good A



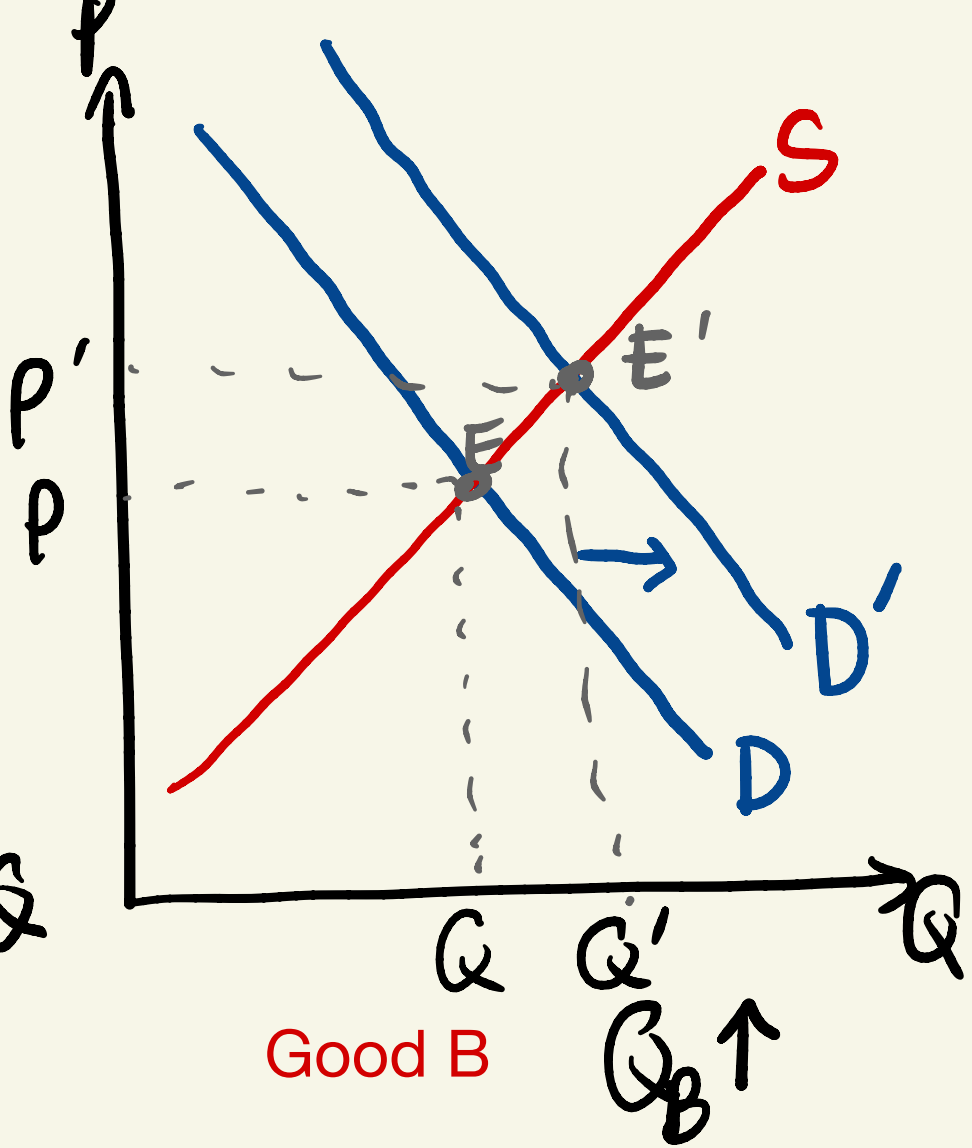
Good B



Goods are Substitutes.



Good A

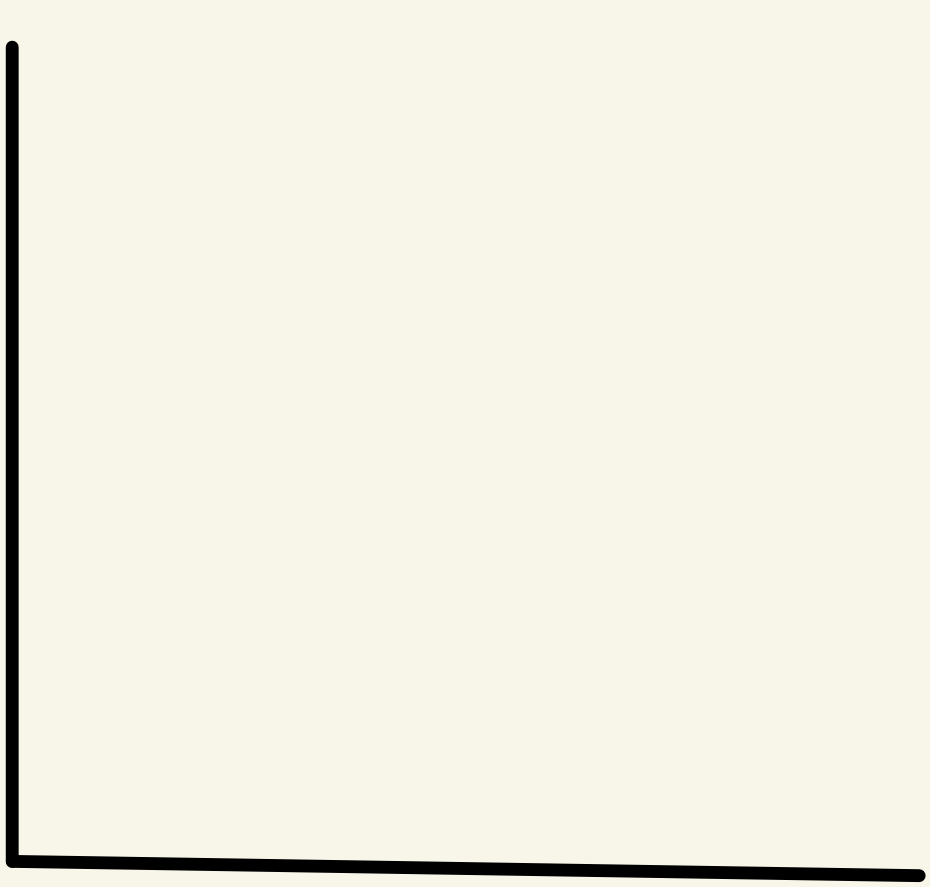


Good B

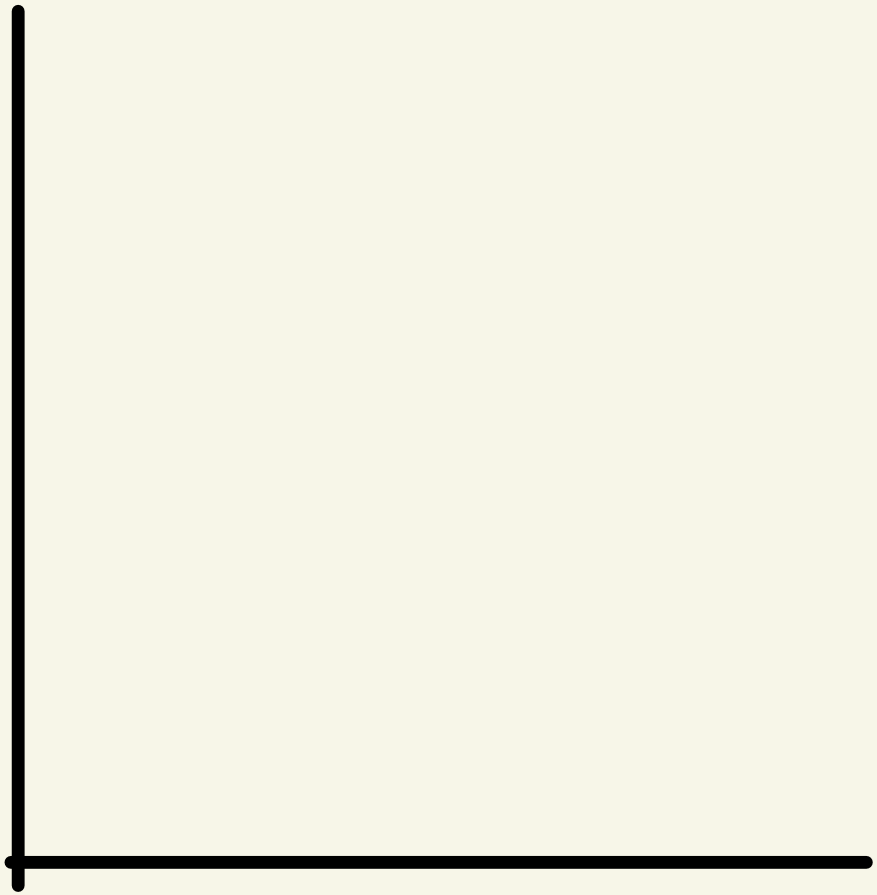
$Q_B \uparrow$

$P_A \uparrow$

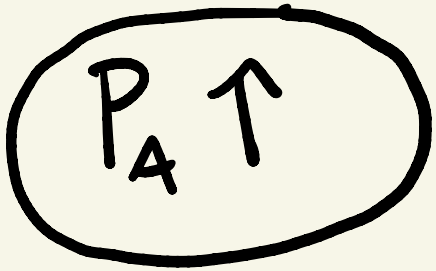
Goods are Substitutes.



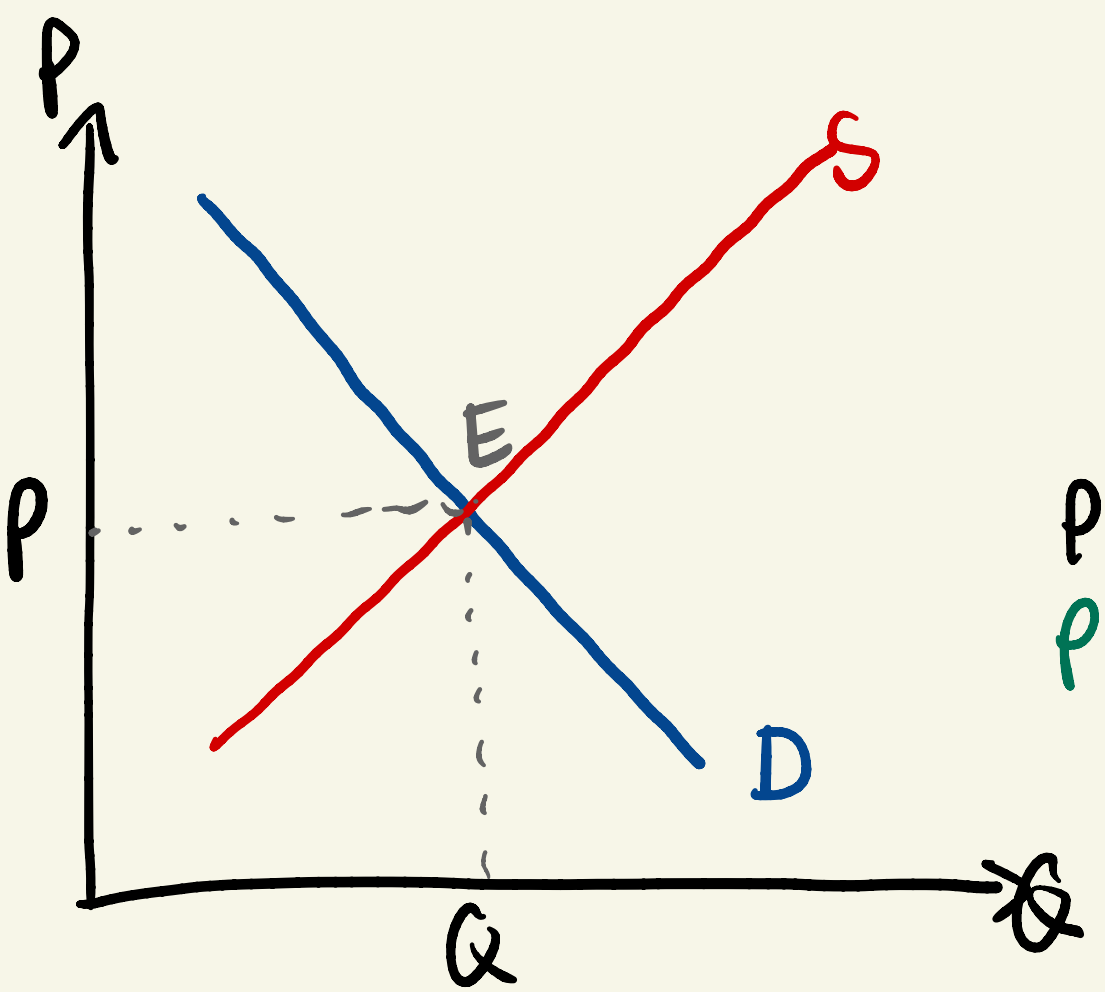
Good A



Good B

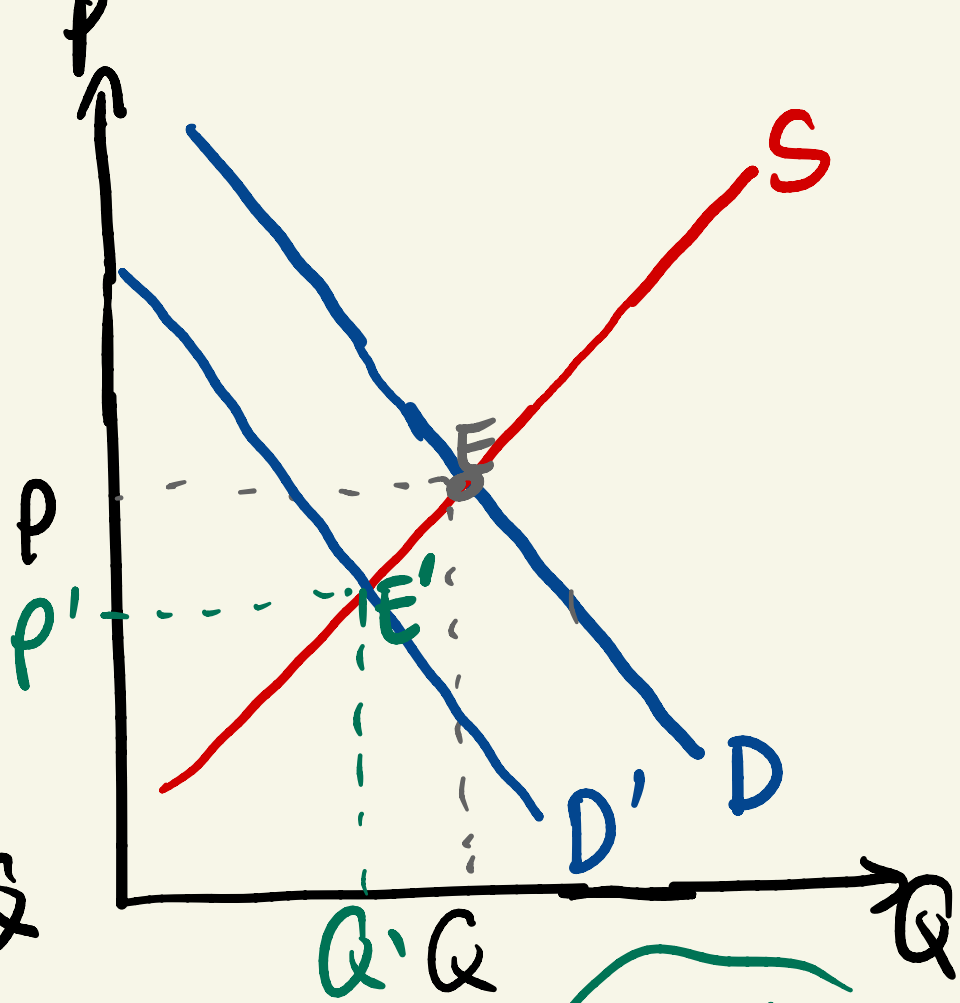


Goods are complements.



Good A

$P_A \uparrow$



Good B

$Q_B \downarrow$

Goods are complements.

- For substitutes, cross-price elasticity > 0
  (*e.g.*, an increase in price of beef causes an increase in demand for chicken)

- For complements, cross-price elasticity < 0
  (*e.g.*, an increase in price of computers causes decrease in demand for software)

The Income Elasticity of Demand

is the percent change in the quantity of a good demanded when a consumer's income changes divided by the percent change in the consumer's income.

$$\text{Income elasticity of demand} = \frac{\%\text{ change in quantity demanded}}{\%\text{ change in income}}$$

Income Elasticity of Demand

$$\eta_Y = \frac{\textit{percentage change in quantity demanded}}{\textit{percentage change in income}}$$

If $\eta_Y > 0$, the good is said to be normal.

If $\eta_Y < 0$, the good is said to be inferior.

These definitions relate directly to the sign of the income elasticity of demand

Normal Goods and Inferior Goods

- When the income elasticity of demand is positive, the good is a ***normal good*** - that is, the quantity demanded at any given price increases as income increases.

- When the income elasticity of demand is negative, the good is an ***inferior good*** - that is, the quantity demanded at any given price decreases as income increases.

Normal goods are

→ income-elastic - if the income elasticity of demand for that good is greater than 1

When income rises, the demand for income elastic good rises faster than income.

Luxury goods such as second homes and international travel tend to be income-elastic

→ income-inelastic - if the income elasticity of demand for that good is positive but less than 1

When income rises, the demand for income-inelastic goods rises, but more slowly than income.

Necessities such as food and clothing tend to be income-inelastic.

Measuring the Price Elasticity of Supply

is a measure of the responsiveness of the quantity of a good supplied to the price of that good. It is the ratio of the percent change in the quantity supplied to the percent change in the price as we move along the supply curve.

$$\text{Price elasticity of supply} = \frac{\%\text{ change in quantity supplied}}{\%\text{ change in price}}$$

Price Elasticity of Supply

Price elasticity of supply measures the responsiveness of the quantity supplied to a change in the product's own price.

It is denoted by η_s and is defined as:

$$\eta_S = \frac{\textit{percentage change in quantity supplied}}{\textit{percentage change in price}}$$

$$\eta_S = \frac{\Delta Q^S / \bar{Q}^S}{\Delta p / \bar{p}}$$

Price Elasticity of Supply

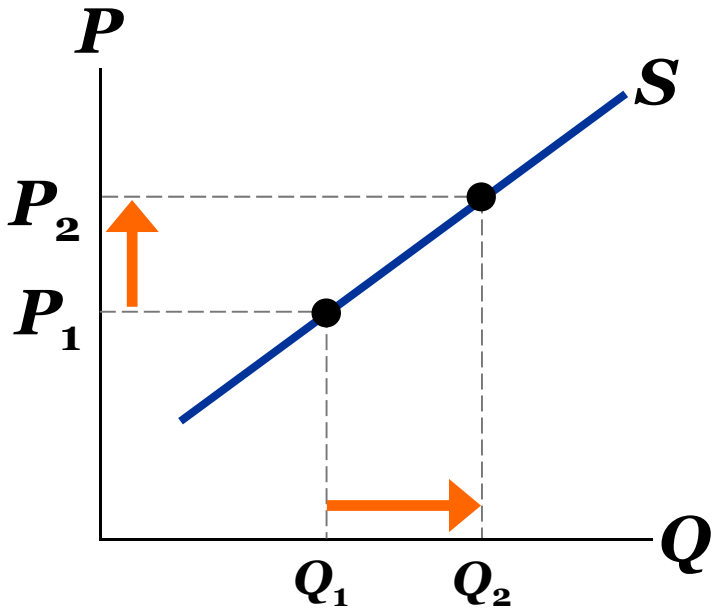
$$\text{Price elasticity of supply} = \frac{\text{Percentage change in } Q^s}{\text{Percentage change in } P}$$

Example:

Price elasticity of supply equals

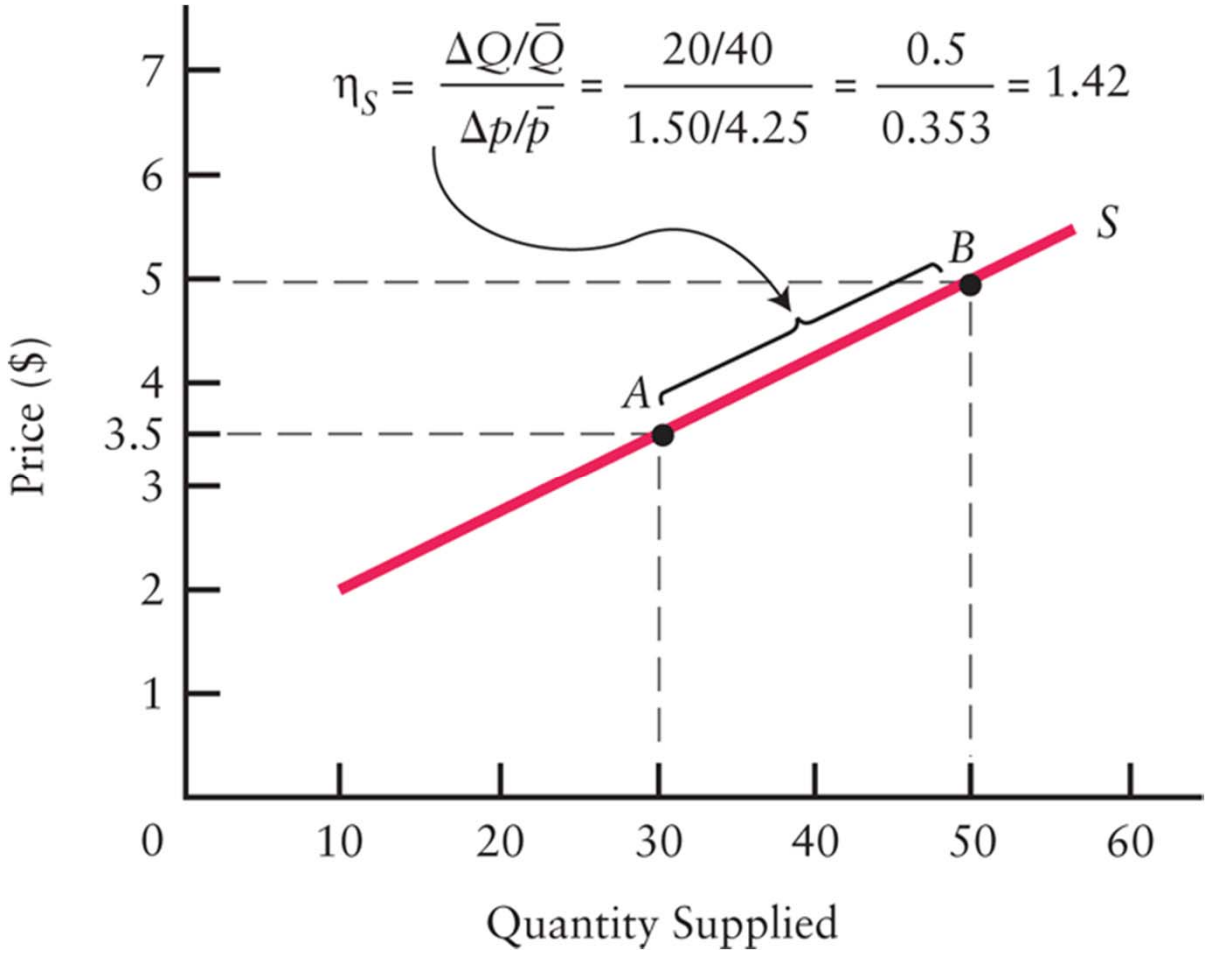
$$\frac{16\%}{8\%} = 2.0$$

P rises by 8%

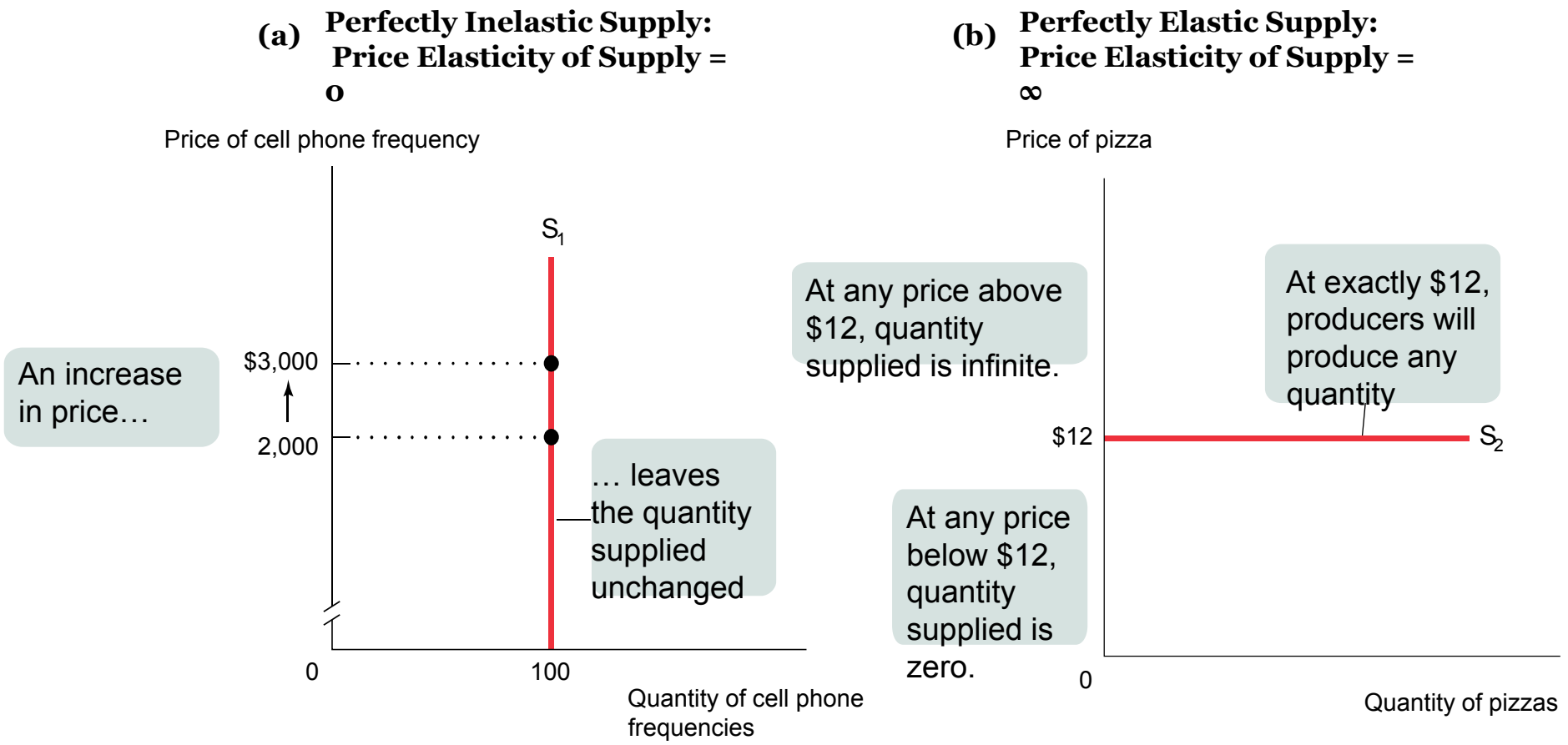


Q rises by 16%

Computing Price Elasticity of Supply



Two Extreme Cases of Price Elasticity of Supply



Two Extreme Cases of Price Elasticity of Supply

- There is **perfectly inelastic supply** when the price elasticity of supply is zero, so that changes in the price of the good have no effect on the quantity supplied. A perfectly inelastic supply curve is a vertical line.

- There is **perfectly elastic supply** when even a tiny increase or reduction in the price will lead to very large changes in the quantity supplied, so that the price elasticity of supply is infinite. A perfectly elastic supply curve is a horizontal line.

What Factors Determine the Price Elasticity of Supply?

- **The Availability of Inputs:** The price elasticity of supply tends to be large when inputs are readily available and can be shifted into and out of production at a relatively low cost. It tends to be small when inputs are difficult to obtain.

- **Time:** The price elasticity of supply tends to grow larger as producers have more time to respond to a price change. This means that the long-run price elasticity of supply is often higher than the short-run elasticity.

The Variety of Supply Curves

- The slope of the supply curve is closely related to price elasticity of supply.

- Rule of thumb:
  The flatter the curve, the bigger the elasticity.
  The steeper the curve, the smaller the elasticity.

"Perfectly inelastic" (one extreme)

$$\text{Price elasticity of supply} = \frac{\%\text{ change in } Q}{\%\text{ change in } P} = \frac{0\%}{10\%} = 0$$

S curve:

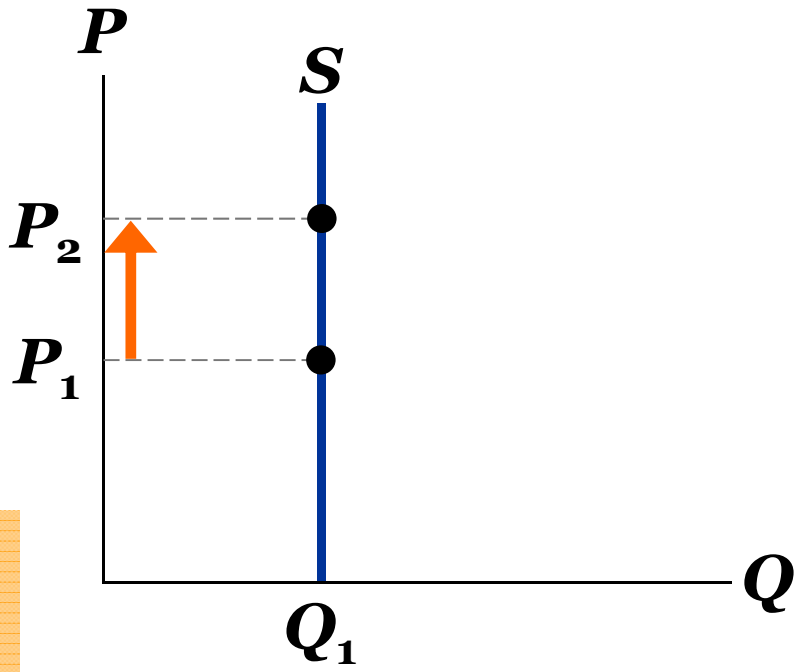
vertical

Sellers' price sensitivity:

none

Elasticity:

0



P rises by 10%

Q changes by 0%

"Inelastic"

$$\text{Price elasticity of supply} = \frac{\%\text{ change in } Q}{\%\text{ change in } P} = \frac{< 10\%}{10\%} \quad < 1$$

S curve:

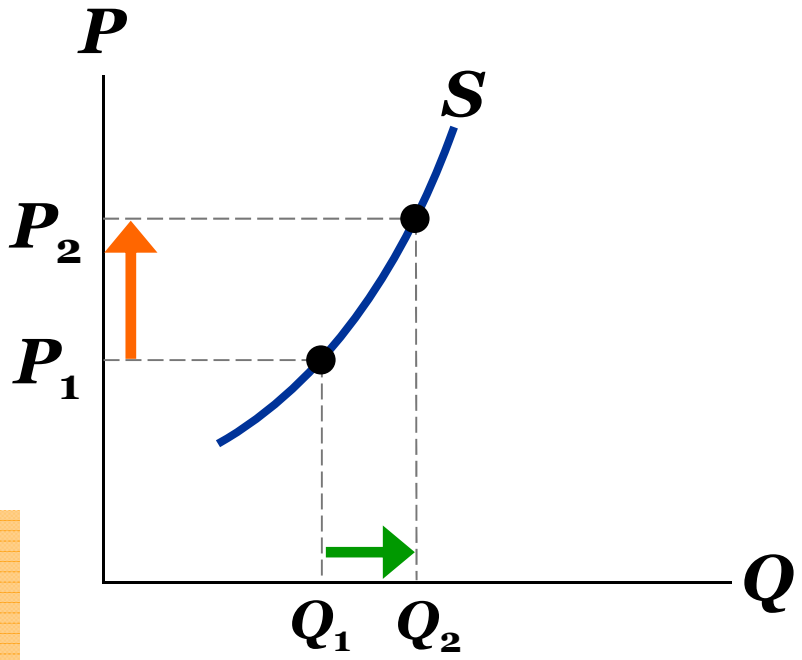
relatively steep

Sellers' price sensitivity:

relatively low

Elasticity:

< 1



P rises by 10%

Q rises less than 10%

"Unit elastic"

$$\text{Price elasticity of supply} = \frac{\%\text{ change in } Q}{\%\text{ change in } P} = \frac{10\%}{10\%} = 1$$

S curve:

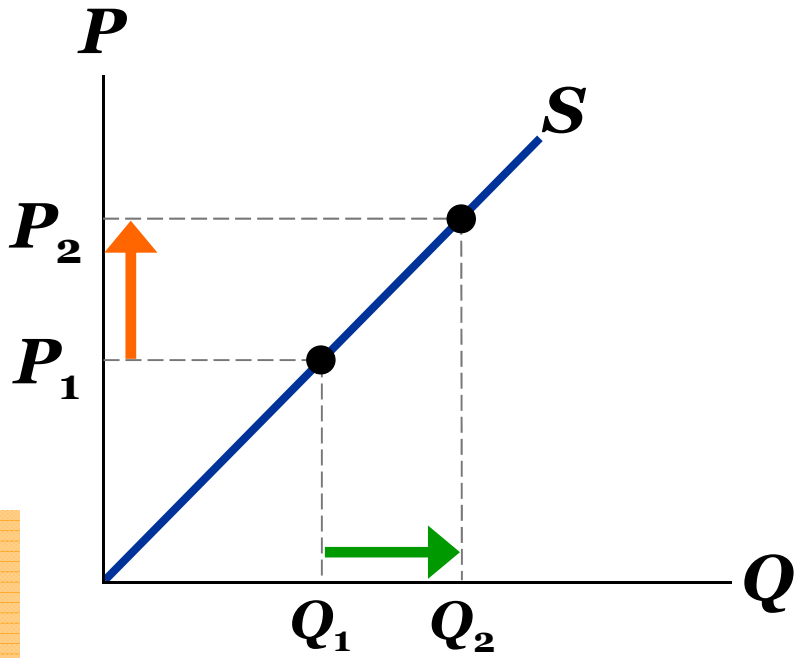
intermediate slope

Sellers' price sensitivity:

intermediate

Elasticity:

= 1



P rises by 10%

Q rises by 10%

"Elastic"

$$\text{Price elasticity of supply} = \frac{\%\text{ change in } Q}{\%\text{ change in } P} = \frac{> 10\%}{10\%} \quad > 1$$

S curve:

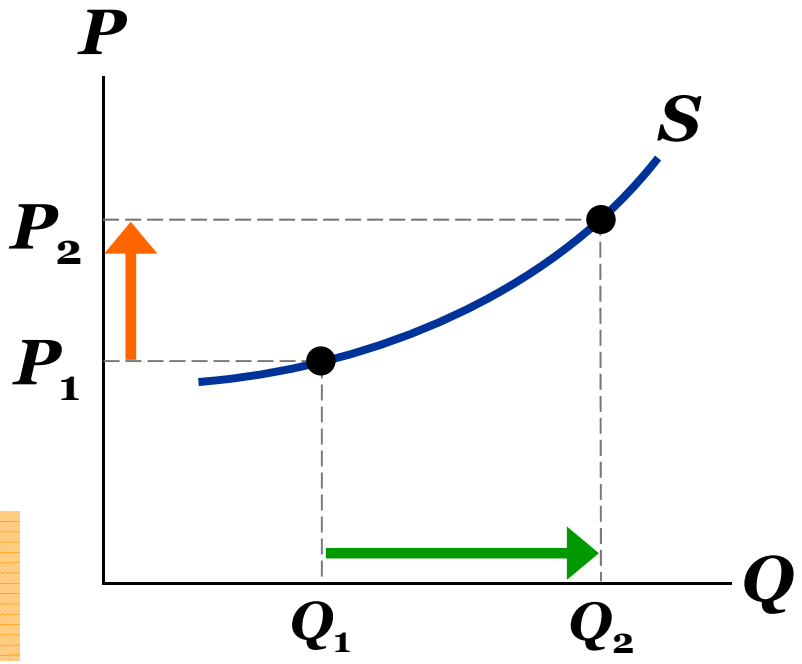
relatively flat

Sellers' price sensitivity:

relatively high

Elasticity:

> 1



P rises by 10%

Q rises more than 10%

"Perfectly elastic" (the other extreme)

$$\text{Price elasticity of supply} = \frac{\%\text{ change in } Q}{\%\text{ change in } P} = \frac{\text{any }\%}{0\%} = \text{infinity}$$

S curve:

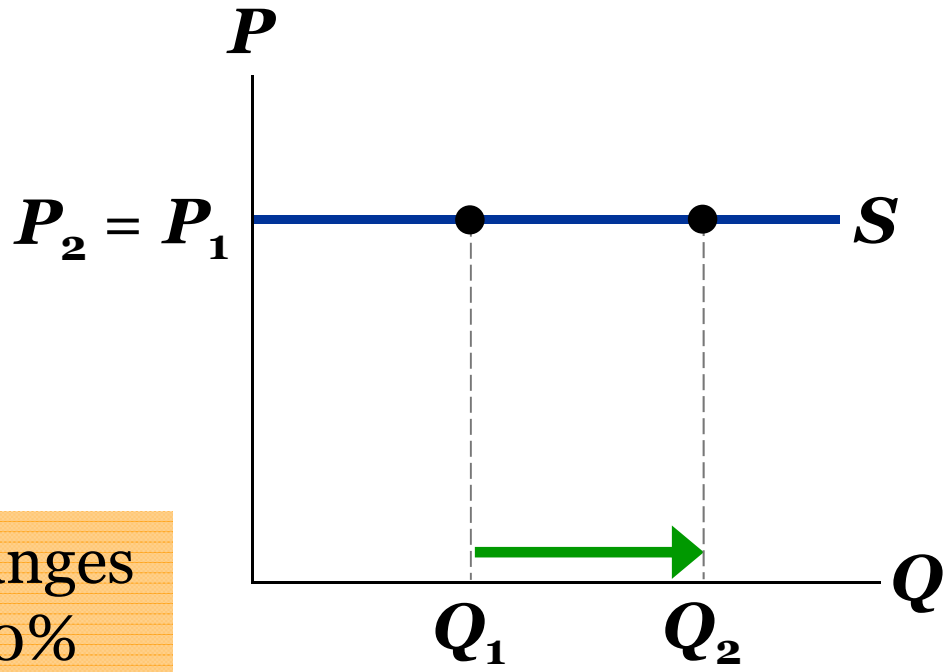
horizontal

Sellers' price sensitivity:

extreme

Elasticity:

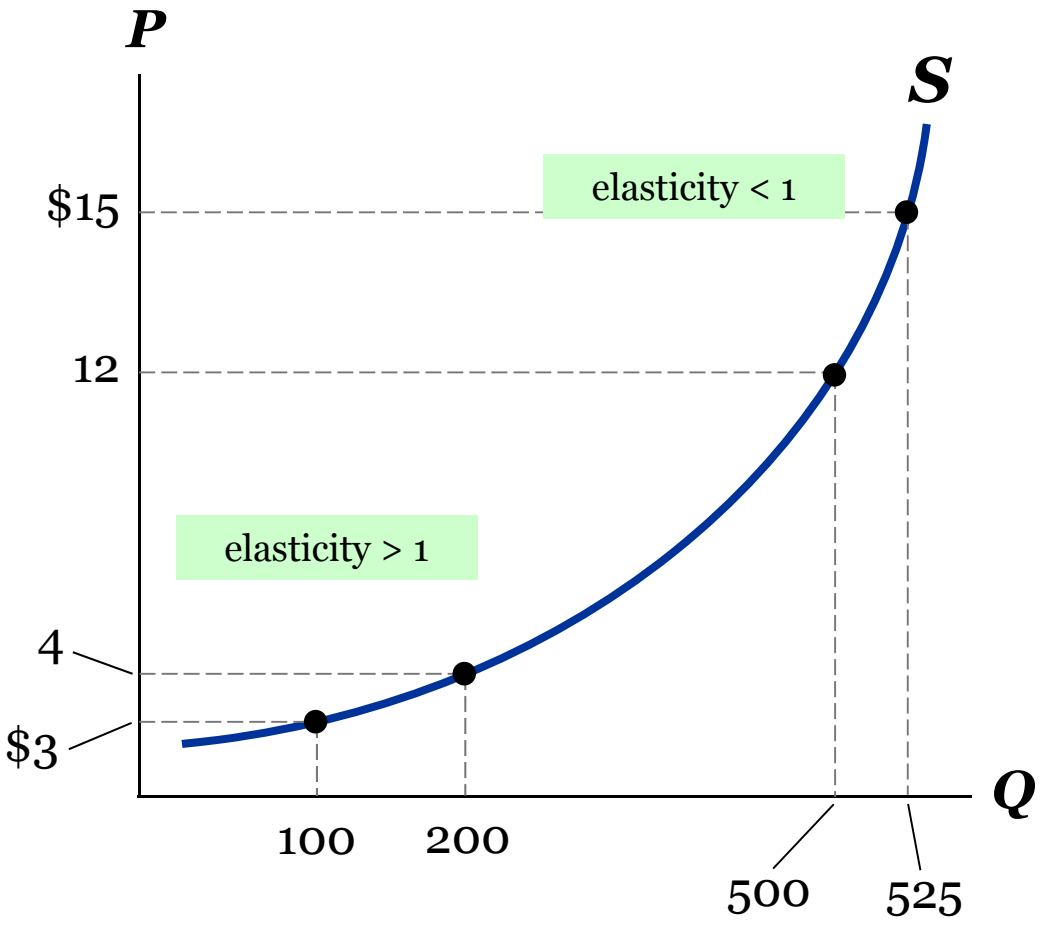
infinity



P changes by 0%

Q changes by any %

How the Price Elasticity of Supply Can Vary



Supply often becomes less elastic as *Q* rises, due to capacity limits.

Name	Possible values	Significance
Price elasticity of demand = $\frac{\%\text{ change in quantity demanded}}{\%\text{ change in price}}$ (dropping the minus sign)		
Perfectly inelastic demand	0	Price has no effect on quantity demanded (vertical demand curve).
Inelastic demand	Between 0 and 1	A rise in price increases total revenue.
Unit-elastic demand	Exactly 1	Changes in price have no effect on total revenue.
Elastic demand	Greater than 1, less than ∞	A rise in price reduces total revenue.
Perfectly elastic demand	∞	A rise in price causes quantity demanded to fall to 0. A fall in price leads to an infinite quantity demanded (horizontal demand curve).

Cross-price elasticity of demand = $\frac{\text{\% change in quantity } \textit{of one good} \text{ demanded}}{\text{\% change in price } \textit{of another good}}$		
Complements	Negative	Quantity demanded of one good falls when the price of another rises.
Substitutes	Positive	Quantity demanded of one good rises when the price of another rises.
Income elasticity of demand = $\frac{\text{\% change in quantity demanded}}{\text{\% change in income}}$		
Inferior good	Negative	Quantity demanded falls when income rises.
Normal good, income-inelastic	Positive, less than 1	Quantity demanded rises when income rises, but not as rapidly as income.
Normal good, income-elastic	Greater than 1	Quantity demanded rises when income rises, and more rapidly than income.
Price elasticity of supply = $\frac{\text{\% change in quantity supplied}}{\text{\% change in price}}$		
Perfectly inelastic supply	0	Price has no effect on quantity supplied (vertical supply curve).
	Greater than 0, less than ∞	Ordinary upward-sloping supply curve.
Perfectly elastic supply	∞	Any fall in price causes quantity supplied to fall to 0. Any rise in price elicits an infinite quantity supplied (horizontal supply curve).

Sources:

- Krugman, P. and Robin Wells (2008)
- Mankiw, N.G. (2012)
- Lipsey, Ragan, and Storer (2008)