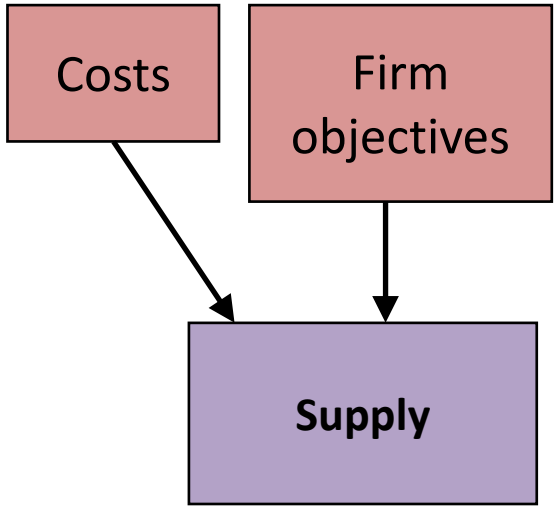
Lecture 4:
Market equilibrium and welfare. Elasticity

Reading: NW Ch. 9, 10

The story so far…



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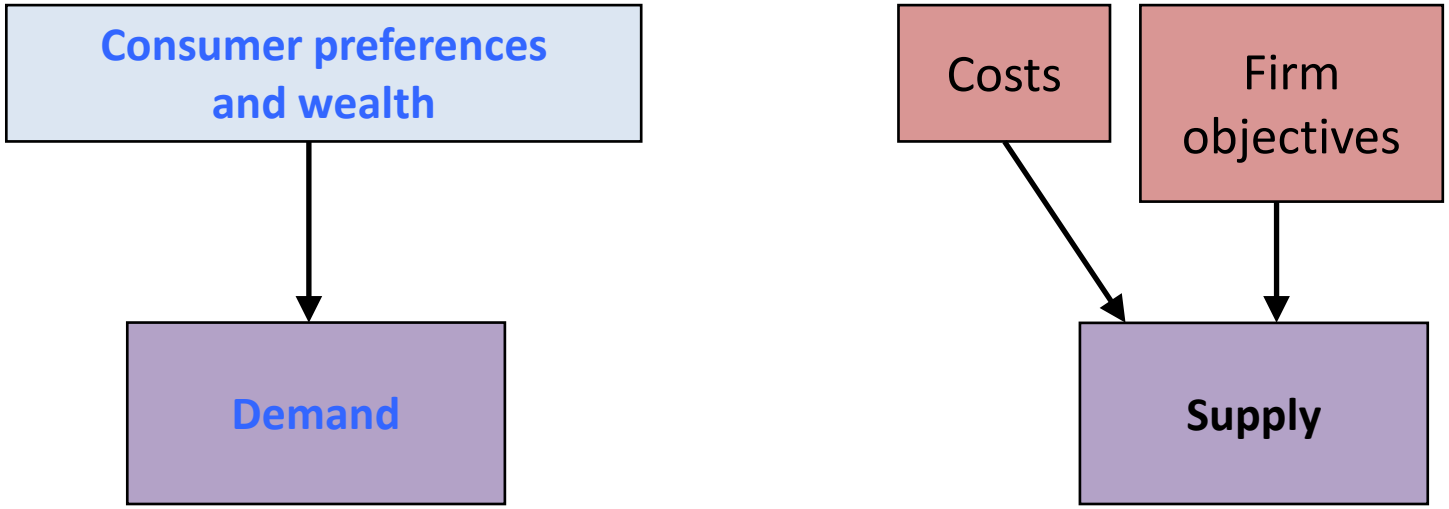

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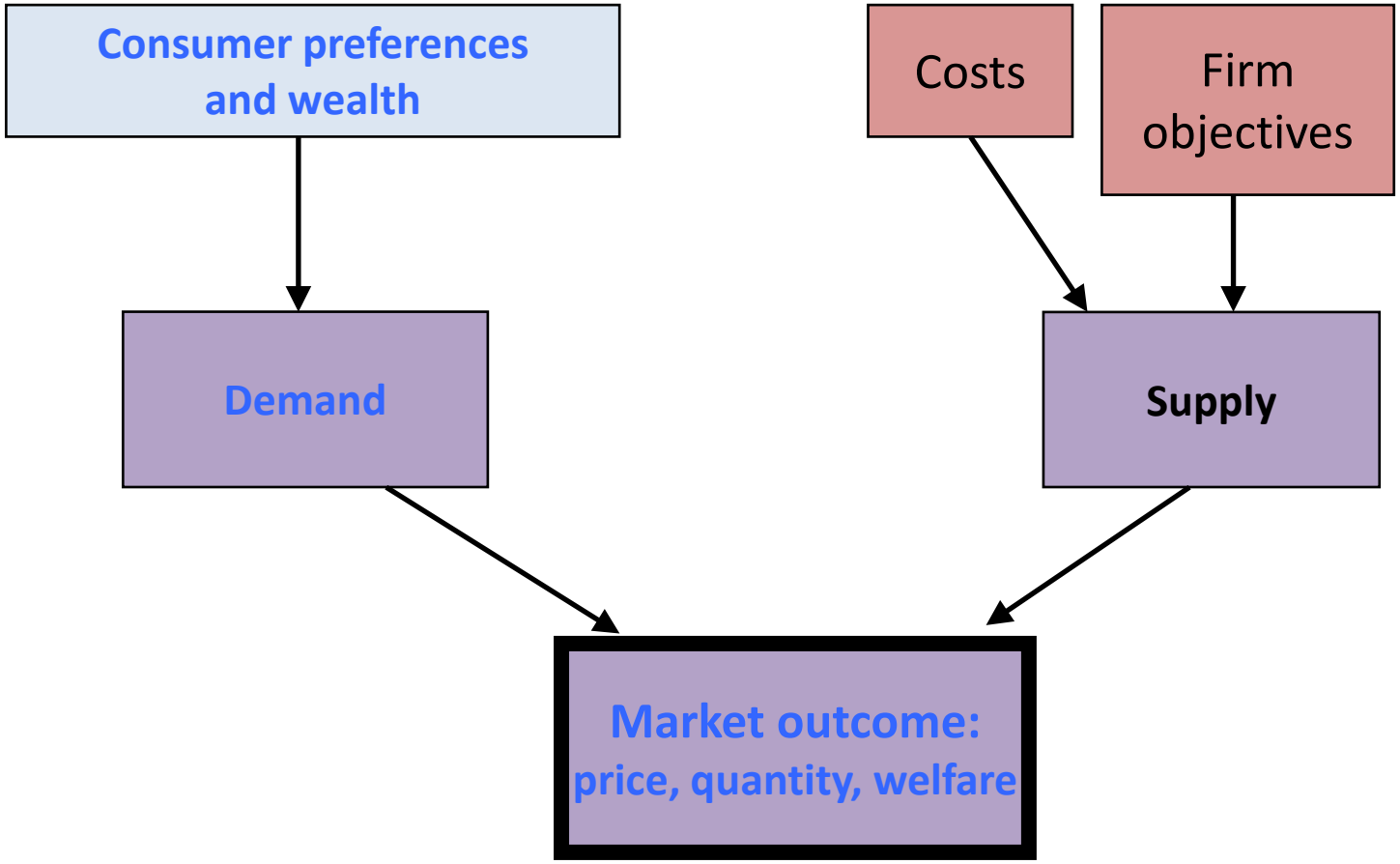


Outline

- Functioning of **MARKETS**:
  - Demand + Supply => equilibrium
  - Market equilibrium: price, quantity traded
  - Welfare analysis: surplus for consumers and firms

Market equilibrium and welfare analysis

NW Ch. 9

Introduction

- Together, demand and supply determine the **price and quantity traded** of a good or service in a market.
- These market outcomes are the focus of this part of the lecture.

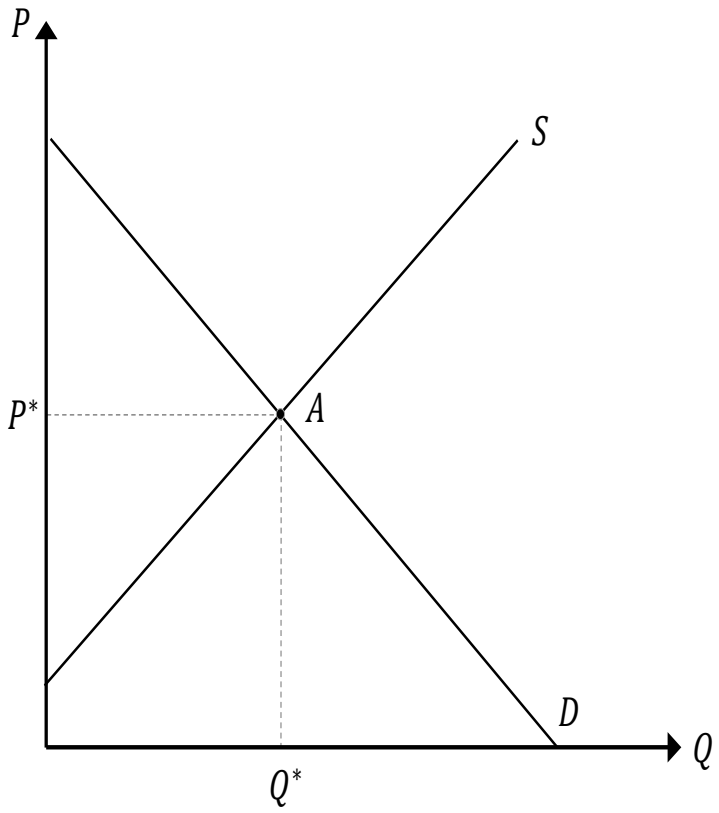
Market equilibrium

- A market is in **equilibrium** if, at the market price, the quantity demanded by consumers equals the quantity supplied by firms in the market.

- The price at which this occurs is called the **market-clearing price** (or 'equilibrium price').

- If a market is not in equilibrium, there will be pressure on price and quantity to move towards the equilibrium price and equilibrium quantity.

Market equilibrium



A market in equilibrium. The equilibrium price is P* and the equilibrium quantity traded is Q*

Market equilibrium

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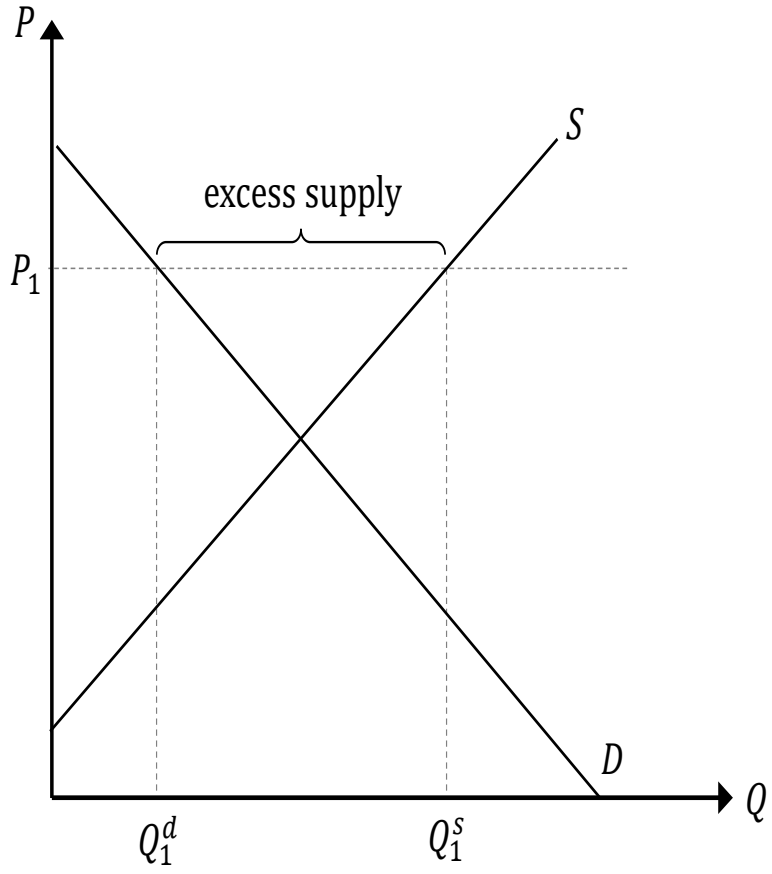
- The price at which this occurs is called the **market-clearing price** (or 'equilibrium price').

- If a market is **NOT** in equilibrium, there will be pressure on price and quantity to move towards the equilibrium price and equilibrium quantity.

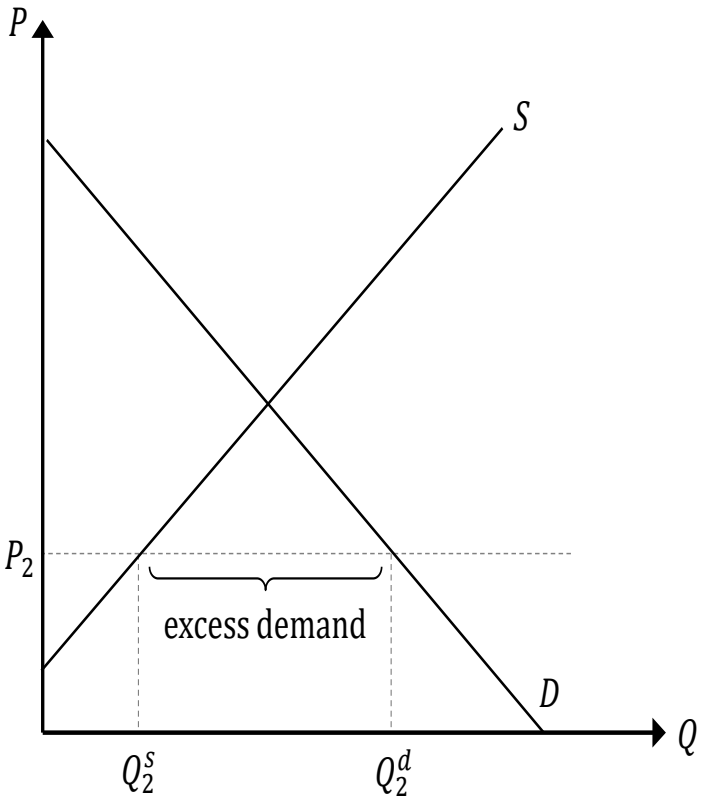
Excess supply – price above market clearing price



Excess supply

- If the market price is *above* the equilibrium price, the quantity supplied exceeds the quantity demanded.
  - This difference is called **excess supply**.
  - Sellers cannot find buyers for all units supplied to the market.
  - There will be downward pressure on prices
    - sellers try to bring more consumers into the market by lowering prices; at the same time, the quantity supplied will fall and quantity demanded will rise in response to the decrease in prices.
  - This downward pressure on prices will continue until the excess of supply is eliminated, moving the market towards equilibrium.

Excess demand



When market price is below the equilibrium price, there is an excess of demand in the market.

Excess demand

- If the market price is *below* the equilibrium price, there is **excess demand**.
  - The quantity demanded exceeds the quantity supplied
  - Sellers do not supply enough units to meet consumer demand.
  - There will be *upward pressure on prices*
    - buyers compete for limited units in the market; this increase in prices will increase the quantity supplied and also decrease quantity demanded.
  - This upward pressure on prices will continue until the excess of demand is eliminated, moving the market towards equilibrium.

Comparative static analysis

- Markets are affected by **a change or event** beyond the direct control of buyers or sellers in that market.

- In such cases, we may want to analyse how that change or event affects the **choices** of firms and/or consumers in the market, and how those choices affect **market outcomes**.

Comparative static analysis

- How do we deal with it?

1. Assume that the market in question is initially in equilibrium.

2. Ascertain whether the change or event will affect the demand curve or the supply curve of the market (or both).
   - That is, which curve will shift, and which way will it move.

3. Use the demand and supply diagram to compare prices and quantities traded in the market before and after the change.

Example: car market

Consider the market for cars when the price of steel increases.

Example: car market

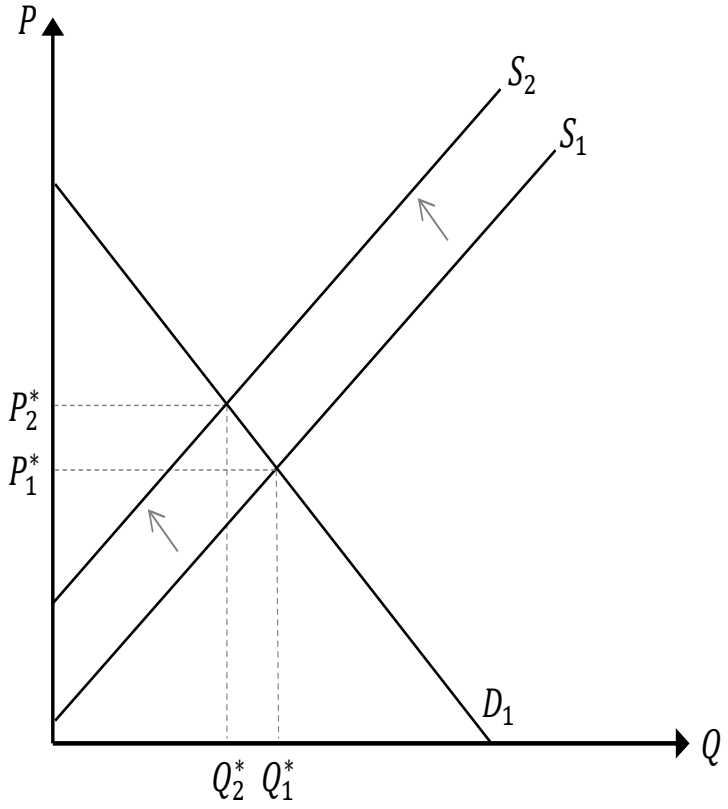
Consider the market for cars when the price of steel increases.

1. The market is initially in equilibrium at (Q*,P*).

2. Assuming that steel is an *input* in the production of cars, the MC of making each car will increase, causing the supply curve to shift up to S_2 (decrease in supply).

3. This will cause a decrease in the quantity demanded, as we move along the demand curve D_1 to the new equilibrium. At the new equilibrium (Q_2,P_2).
   - Price of cars is higher but quantity traded is lower than before the change in the price of steel.

Example: car market with an increase in the steel price



Question

- Consider the market for cars. Following a technological innovation in steel production overseas, car producers can import steel at a lower price than before. What happens in the car market?

A. Increase in supply
B. Market price for cars drops
C. Quantity of cars sold rises
D. All of the above
E. I have no idea

Answer

- Consider the market for cars. Following a technological innovation in steel production overseas, car producers can import steel at a lower price than before. What happens in the car market?

A. Increase in supply
B. Market price for cars drops
C. Quantity of cars sold rises
D. All of the above
E. I have no idea

Welfare – the benefit to market participants

- Markets are one of the main ways that goods and services are produced and distributed.
- Consumers and firms will only participate in markets if it is **beneficial** to them
  - they are at least as well off from trading than if they do not
- We can measure and observe changes in the benefits to these participants using **welfare analysis**.

Consumer surplus

- **Consumer surplus (CS)** is the welfare consumers receive from buying units of a good or service in the market.
- We can measure consumer surplus by evaluating the net value (**net benefit**) of a good or service to the consumer, as he or she perceives it.
- That is, consumer surplus is given by the consumer's willingness to pay, minus the price actually paid*, for each unit bought.*

Consumer surplus – intuition

- Hamish buys a chocolate bar. His willingness to pay (or marginal benefit) for the chocolate bar is $5.50, but the price is $2.
- He receives $5.50 benefits, minus the price actually paid of $2.
- Therefore, his surplus (or net benefit) from buying the chocolate bar is $3.50.
- Repeating this process for every unit purchased calculates the CS Hamish receives from all the chocolate bars he buys.

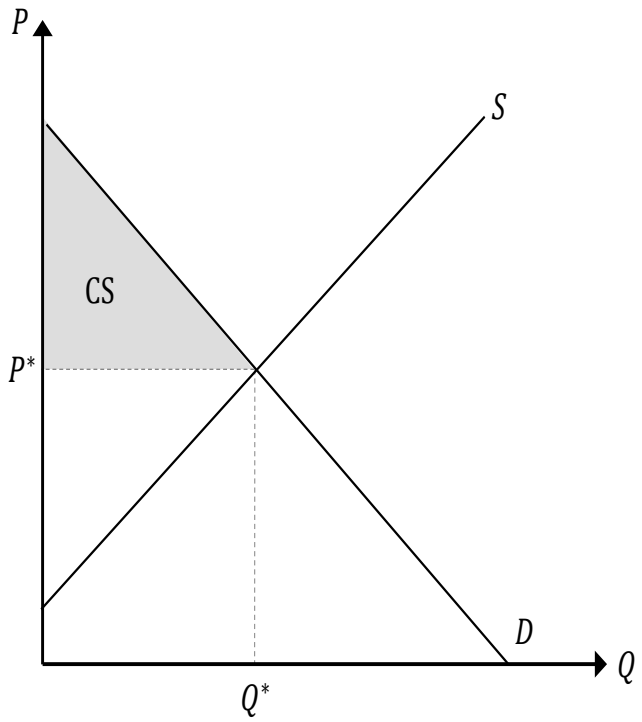
Consumer surplus and the demand curve

- Recall the individual demand curve traces out a consumer's marginal benefit or willingness to pay

- An **individual's CS** is by calculating the area between the individual demand curve and the price line.

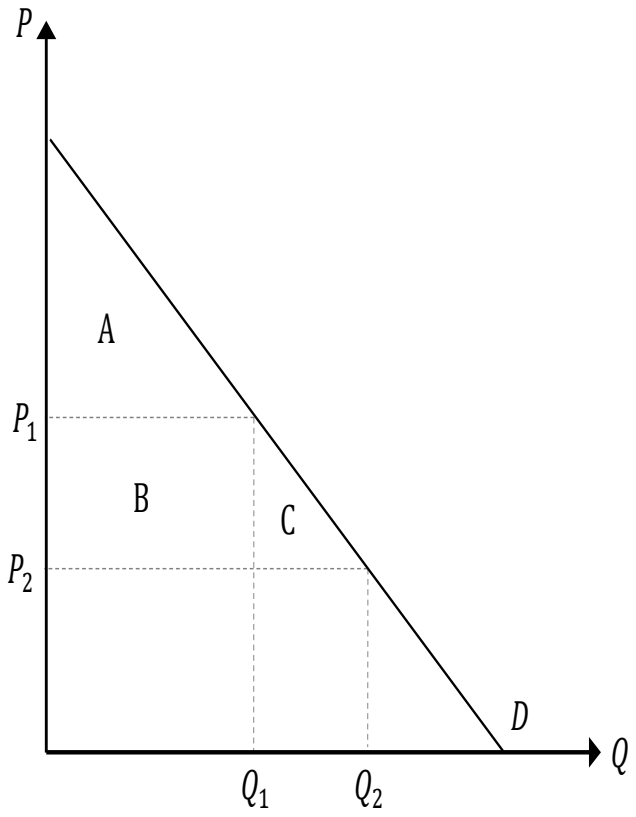
- Similarly, we can find the **CS of all consumers** in the market by calculating the area between the market demand curve and the price line.

Consumer surplus



The area of consumer surplus in this market is denoted by the grey-shaded area – the area under the demand curve above the price line.

Change in CS with a decrease in price



If price falls from P_1 to P_2, CS increases due to 2 reasons:

(1) on all the units previously consumed, the difference between MB and price is now larger, increasing the net benefit from consuming each of these units (area B); and

(2) the lower price now means that more units are purchased, generating an additional net benefit to consumers (area C).

Producer surplus

- **Producer surplus (PS)** is the welfare producers (firms) receive from selling units of a good or service in the market.

- Producer surplus can be measured by considering the **net benefit** of selling a good or service.

- That is, producer surplus is given by the price the producer receives, minus the cost of production, *for each unit of the good* or service bought.

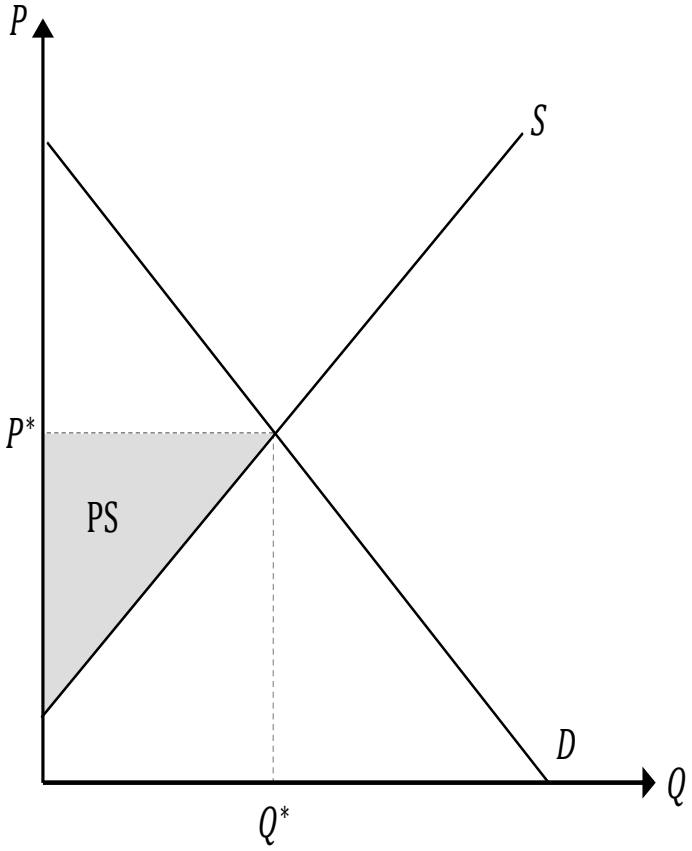
Producer surplus – intuition

- Adam sells chocolate bars. The price of chocolate bars is $2. The marginal cost to Adam of producing the chocolate bar is $0.50.
- If Adam sells the chocolate bar, his net benefit is the $2 received, minus $0.50 in extra production costs.
- Therefore, his PS from selling the chocolate bar is $1.50.
- If Adam sells multiple units, add up the surplus from each chocolate bar to get his PS from selling chocolate bars.

Producer surplus and the supply curve

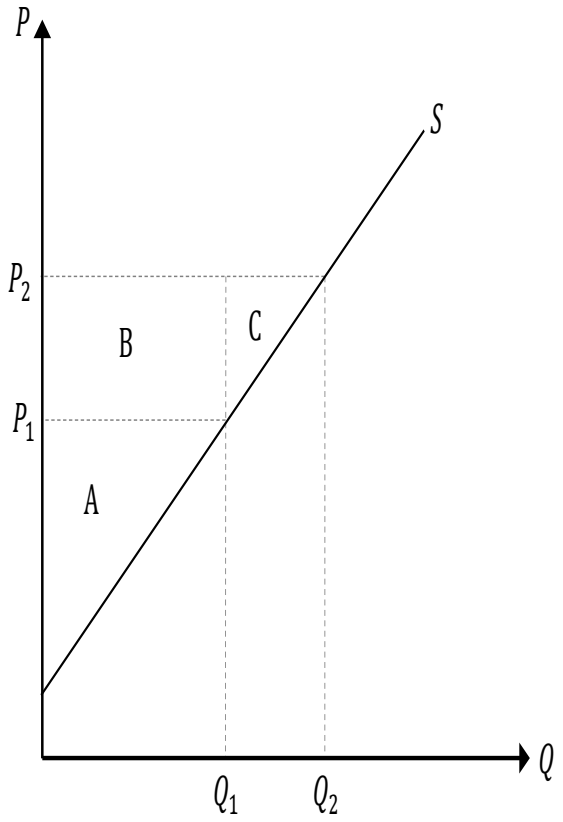
- A firm's supply curve is given by its MC curve.
- A **firm's PS** can be found by calculating the area between the price line and the firm's supply curve.
- Similarly, we can find the **PS of all producers** in the **market** by calculating the area between the price line and the market supply curve.

Producer surplus



The area of producer surplus in this market is denoted by the grey-shaded area.

Producer surplus with an increase in price



When the market price increases from P1 to P2, PS increases from A to A+B+C. The area B represents the increase in PS from an increase in the net benefit of selling units that would have been sold previously. The area C is the increase in PS from the sale of additional units.

Total surplus

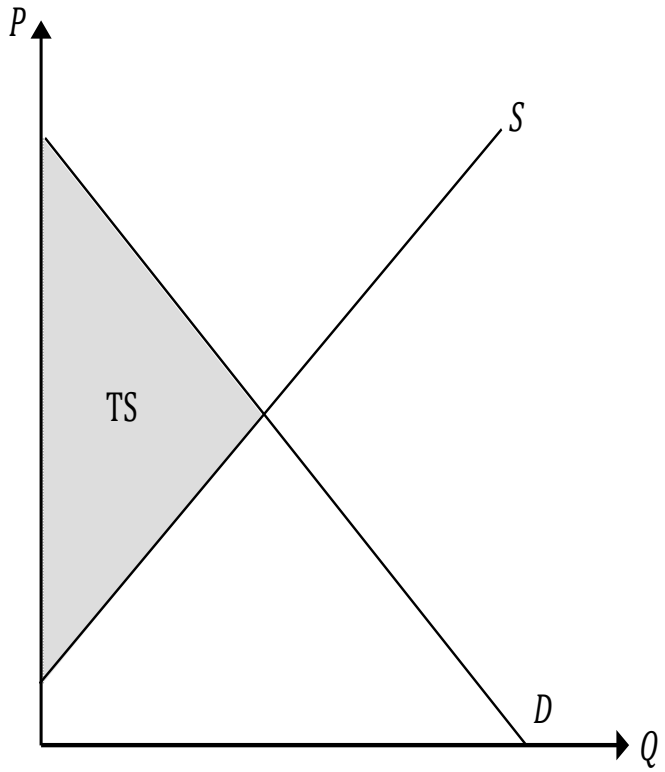
- We can also measure the **total welfare** of all participants in the market.
  - Here, there are only two types of participants: consumers and producers.
  - In later chapters, we will allow for other participants in the market (namely, the government).

- With only consumers and producers in the market, **total surplus (TS)** is the sum of consumer surplus and producer surplus in the market equilibrium:

$$TS = CS + PS$$

→ total gains from trade

Total surplus – sum of CS and PS

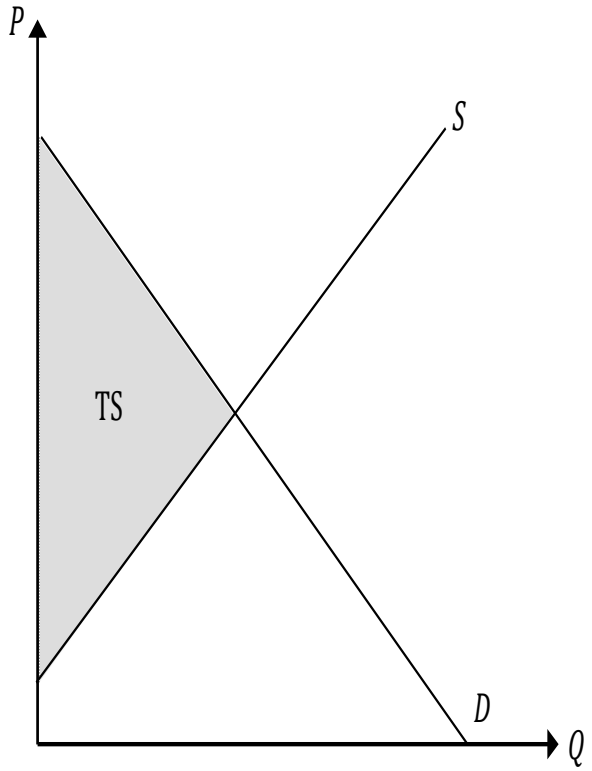


In this market, TS is the area between the demand and supply curves, up to the market equilibrium quantity q*. TS in this market is denoted by the grey-shaded area

Pareto efficiency

- To analyse welfare in a market further, we introduce the concept of **Pareto efficiency**.
- **Pareto efficient** if it is not possible to make someone better off without making someone else worse off.
  - Conversely, an outcome is *not Pareto efficient* if it is possible to reallocate resources (or do things differently in the market) and make someone better off without making someone else worse off.
- Another way of thinking about Pareto efficiency in this context is that the Pareto efficient outcome ***maximizes total surplus***.

Competitive market outcome and efficiency



The competitive market maximizes the total gains from trade, hence it is Pareto efficient. It is not possible to change the level of output (up or down) and make at least one person better off without making anyone worse off.

Competitive market outcome and efficiency

The outcome in a competitive market is Pareto efficient:

- For all the trades up to the competitive market equilibrium (Q*), MB ≥ MC.
- Hence, the consumer is willing to pay more than the extra cost required to make the item.
- Trading **all units up until Q*** increases total surplus (as it increases CS, PS or both).

Competitive market outcome and efficiency

- If **fewer** than Q* units are traded, this outcome is not Pareto efficient, because it is possible to increase the number of units traded in order to make the consumer and/or the producer better off, without making any one worse off.

- If **more** than Q* units are traded we know that MC > MB. All units traded beyond Q* make someone worse off: either the buyer paid more than his MB, the seller received a price less than her MC, or both. Therefore, this outcome is not Pareto efficient, because total surplus would rise if output were reduced (back to Q*).

Competitive market outcome and efficiency

- In the competitive-market equilibrium, **all the potential gains from trade are exhausted.**
  - There are no consumers left in the market with a willingness to pay higher than any seller's MC to provide an additional unit.
  - *Importantly*, the **price mechanism** ensures that the people with the **highest value** for the product (those that are willing to pay more than the price) end up with the goods, and that those firms with the **lowest cost** are the ones who make the goods (the firms who have a MC less than the market price).
  - **While these actions are completely decentralized**, in the sense that there is no one person coordinating the actions of the many parties in the market**, a competitive market manages to maximize total surplus** (that is, reach a Pareto efficient outcome).

Caveat regarding Pareto efficiency

- Pareto efficiency has a very strict and specialized definition.
- It does not imply either uniqueness or fairness/equity.
  - It is possible that there is more than one market outcome in an economy that is Pareto efficient.
    - Unclear which one is best
  - Further, an outcome that is Pareto efficient is not automatically the most fair or equitable, or even the most desirable.

Concluding comments – market equilibrium

- We defined consumer surplus, producer surplus and total surplus.
- A competitive market has the following characteristics:
  - (i) via the price mechanism, it allocates goods to consumers who **value** them **most highly**; and
  - (ii) via the price mechanism, it allocates demand for goods to sellers who can **produce** at the **least cost**.
  - (iii) a competitive market **maximizes total surplus** and, hence, is Pareto efficient. It follows that a person who can dictate the price and quantity of a good traded in the market (a '**social planner**') cannot achieve an outcome that is more efficient than the free (competitive) market.

Elasticity

Reading: NW Ch. 10

Outline

- **ELASTICITY**: responsiveness of one variable to a change in another variable
  - Examples: how does the equilibrium quantity traded respond to a change in the market price? How does demand respond to changes in consumer income? How does supply respond to a change in input prices?
  - How do we measure it?

- Elasticity concepts considered:
  - own price elasticity of demand
  - price elasticity of supply
  - cross-price elasticities of demand
  - Income elasticity of demand

Elasticity

- **We are often interested in measuring how a change in one variable affects another.**
  - For example, how does the equilibrium quantity traded respond to a change in the market price, or how demand responds to changes in consumer income?

- One issue with measuring quantitative changes is that different markets use **different units of measurement** (litres, kilograms, ounces), each market has its own price level (a few cents or millions of dollars).

- Elasticity is a way we can compare quantitative changes across different situations by looking at **proportional** (or percentage) changes.

Elasticity

- Elasticity measures how responsive one variable (y) is to changes in another variable (x).
  - That is, when we increase x by a certain amount, does y change by a small amount or by a large amount?
  - We can calculate elasticity (ϵ) by dividing the percentage change in y by the percentage change in x. Note: Δ simply means ‘change'.

$$\varepsilon = \frac{\%\Delta y}{\%\Delta x}$$

  - This says for 1% change in x there will be an ϵ% change in y.
  - Note the larger the absolute value of ϵ the more responsive y is to changes in x, and vice versa.

Elasticity – proportional change

- Generally, we can calculate the proportional change in a variable by dividing the change in the variable by the variable itself:

$$\varepsilon = \frac{\Delta y / y}{\Delta x / x}$$

- However, it is not always obvious how to determine the proportional change in a particular variable.
- Two classic methods are: the ***point method***, using the initial values; and the ***midpoint (arc) method***, that uses the averages of the initial and final points.

Point method

- At times we are interested in the elasticity around a particular outcome:
  - **For example, what is the elasticity on a demand curve around the point (Q_1, P_1)?**
  - In other words, how responsive is the quantity demanded to a change in the price, at (Q_1, P_1) ?

- In these cases, we can use the *point method* of calculating elasticity.

$$\varepsilon = \frac{\Delta y / y}{\Delta x / x} = \frac{\Delta y}{\Delta x} . \frac{x}{y} = \frac{dy}{dx} . \frac{x}{y}$$

Point elasticity: *example*

- Suppose the demand curve for forks is given by Q = 100 - 2P, and the price of forks is P = 30. What is elasticity at this point?

- From the demand equation, we know that when P = 30, Q = 40. The slope of this line is -2.
- Substituting these values into the point formula gives:

$$\varepsilon = -2.\frac{30}{40} = -1.5$$

- The interpretation is: at this price, if price of forks increases by 1%, the quantity demanded of forks falls by 1.5%.

Midpoint (or arc) method

- Sometimes we are interested in elasticity when moving from one point to another.
  - **For example, suppose the price of a good changes from P_1 to P_2, which causes the quantity demanded to change from Q_1 to Q_2.**

- It is unclear in this situation whether we should measure the change in price (resp. quantity) as a percentage of P_1 or of P_2 (resp. Q_1 or Q_2)?

- To resolve this ambiguity, sometimes we adopt the *midpoint (or arc) method*;
  - To calculate the proportional changes use the average (midpoint) of P and Q (or the variables of interest).

Midpoint (or arc) elasticity

- The formula for elasticity using the midpoint method is:

$$\varepsilon = \frac{\Delta y / y^m}{\Delta x / x^m} = \frac{\Delta y}{\Delta x} . \frac{x^m}{y^m}$$

where $y^m = \frac{y_1 + y_2}{2}$ and $x^m = \frac{x_1 + x_2}{2}$

Midpoint elasticity: *example*

- When the price of spoons is $10, the quantity demanded is 50 units. When the price increases to $20, the quantity demanded falls to 30 units.

- To calculate elasticity, we need to find the averages of price and quantity:
  - $P^M = 15$ and $Q^M = 40$.
  - Also, we need to know: $\Delta P = 20 - 10 = 10$ and $\Delta Q = 30 - 50 = -20$.
  - Substituting these values into the midpoint formula gives:

$$\varepsilon = \frac{-20}{10} . \frac{15}{40} = -0.75$$

  - If price of spoons increases by 1%, the quantity demanded of spoons falls by 0.75%.

Recap – the formulas for the **price** elasticity of demand

- Using formulas above, the price elasticity of demand for the **point method** is:

$$\varepsilon_d = \frac{\Delta q / q}{\Delta P / p} = \frac{dq}{dP} \cdot \frac{P}{q}$$

- Using the **midpoint method** price elasticity of demand for averages q^M and P^M is:

$$\varepsilon_d = \frac{\Delta q / q^m}{\Delta P / P^m} = \frac{\Delta q}{\Delta P} \cdot \frac{P^m}{q^m}$$

Interpretation of the **price elasticity of demand**

- The price elasticity of demand measures how sensitive the quantity demanded of a good (Q_d) is to changes in price (P).

- It is the proportional change in quantity demanded of a good, given a 1% change in its price.

Intermezzo: own price elasticity of demand

- Why is it useful to have an understanding of the responsiveness of quantity demanded to a change in price?
  - *Business* might be interested in the effect of a price change on quantity sold, revenue and profits
    - *For example, the price of milk*
  - *Governments* might want to know how (consumer or firm) behaviour changes when a specific policy is put in place
    - *For example, a carbon tax, a change in the price of a toll road, a change in the price of public transport, a change in minimum wage, a change in the tax on alcohol,...*

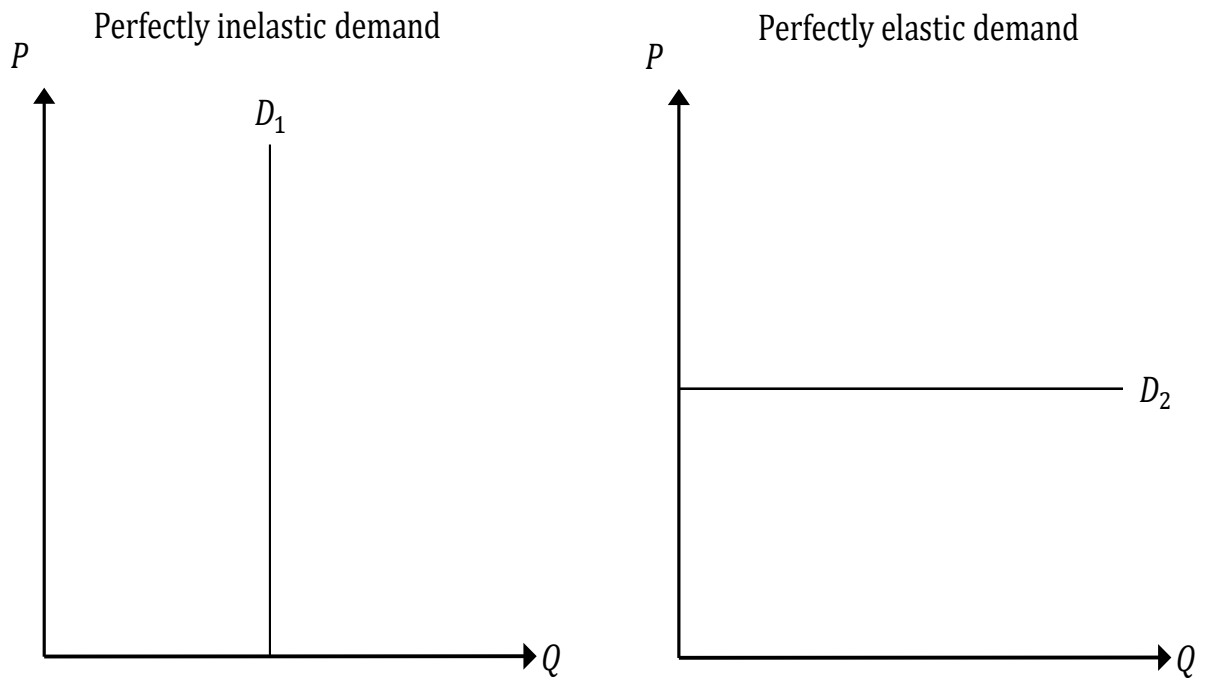
Interpretation of the elasticity of demand

- Given the law of demand, the elasticity of demand will normally be **negative** (or at least non-positive).
- For this reason, some authors find it convenient to drop the minus sign when reporting the elasticity of demand, treating the negative sign as implicit.
- We will not adopt that convention here, but it should be noted that either approach is fine, so long as it is consistently applied.

Interpretation of elasticity of demand

- If $\epsilon_d = 0$, demand is *perfectly inelastic*.
  - For a 1% change in price, there is no change in the quantity demanded.
  - Quantity demanded is not at all responsive to changes in price. The demand curve is vertical. Example?
- If $-1 < \epsilon_d < 0$, demand is *inelastic*.
  - For a 1% change in price, the resulting change in quantity demanded is less than 1%.
  - Quantity demanded is not very responsive to changes in price.
- If $\epsilon_d = -1$, demand is *unit elastic*.
  - For a 1% change in price, there is a 1% change in quantity demanded (a proportional change).
- $\epsilon_d < -1$, demand is *elastic*.
  - A 1% change in price results in a change in quantity demanded larger than 1%; quantity demanded is very responsive to price.
- If $\epsilon_d = -\infty$, demand is *perfectly elastic*.
  - For a small increase in price, quantity demanded will drop to zero.
  - If a firm raises its price at all, its customers will go elsewhere to buy the product. Demand is horizontal. Example?

Perfectly inelastic and elastic demand



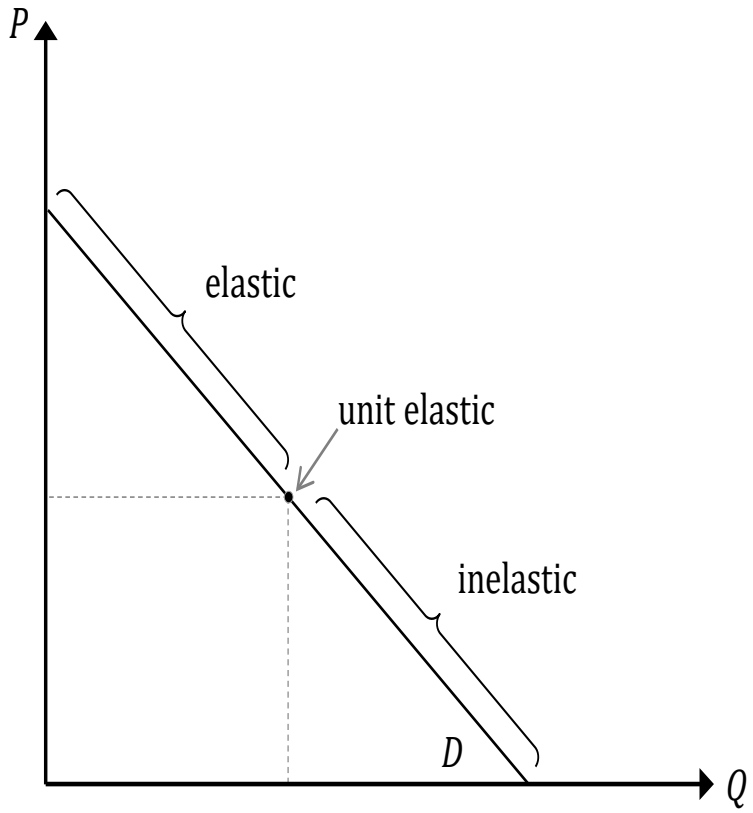
When demand is perfectly inelastic, the demand curve is vertical (as seen the left panel). When demand is perfectly elastic, the demand curve is horizontal (as seen the right panel).

Price elasticity of demand along a straight-line demand curve

- The price elasticity of demand depends on the **slope** of the line, but also the **reference point** on the curve used to calculate elasticity.

- Thus the price elasticity of demand changes along a linear (straight-line) demand curve.
  - ✓ Because the **slope** of the demand curve is **constant**, the elasticity varies because the proportional change in quantity (and price) varies depending on the size of quantity (or price) at a particular point.
  - ✓ For every linear demand curve, there is an **inelastic** section (when quantity is high and price is low); a point that is **unit elastic** (in the middle of the demand curve); and an **elastic** section (when quantity is relatively low and price relatively high).
    - The price elasticity of demand ranges from 0 (when it cuts the Q-axis) to - ∞ (at the P-axis).

Price elasticity on a linear demand curve



Price elasticity on a linear demand curve - Example

- Consider the following demand curve:

$$p = 80 - 2Q$$

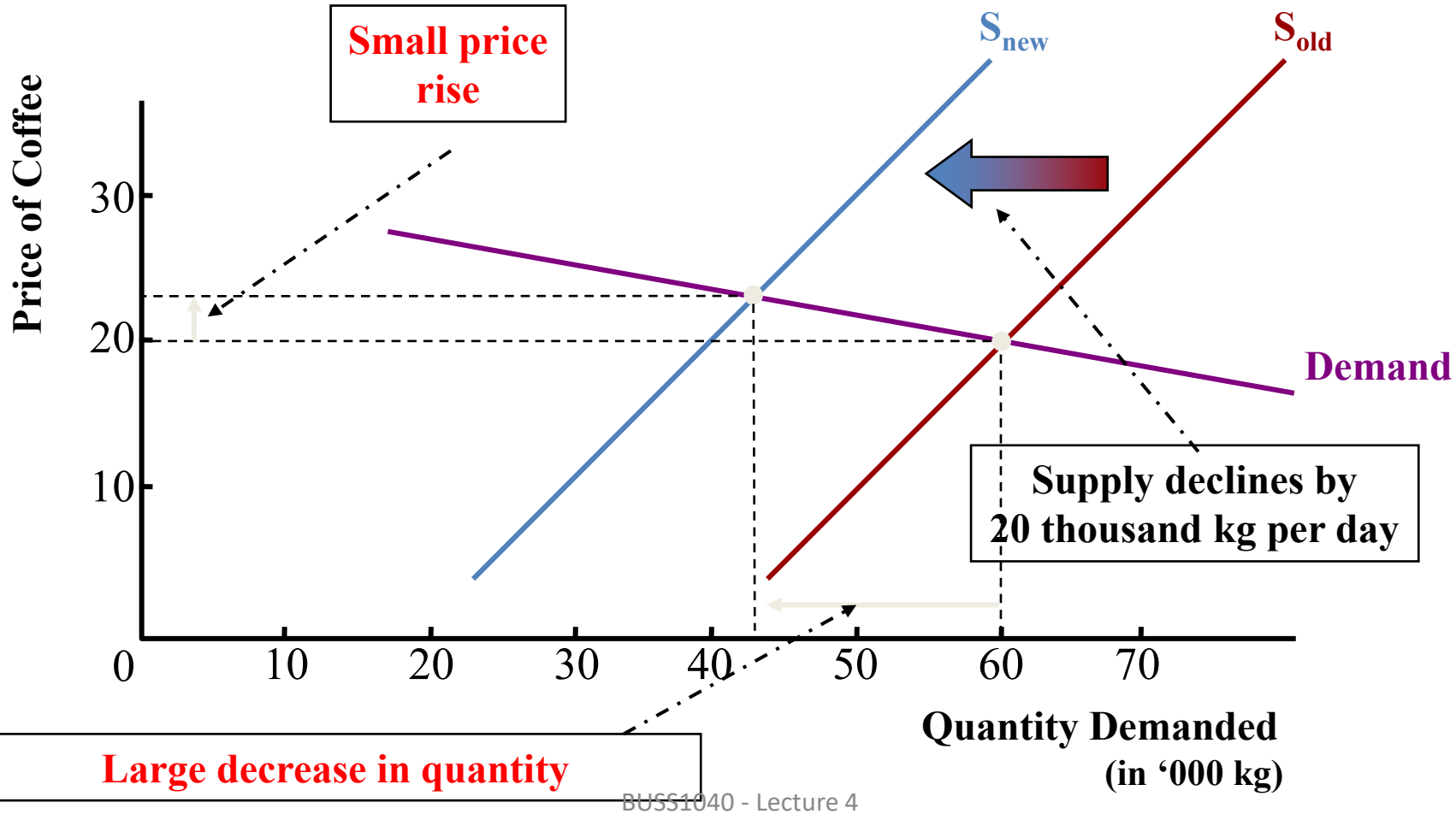
- Find the own price elasticity of demand when price is equal to \$20, \$40 and \$60.

- Using the point elasticity formula:
  - Rewriting the demand curve: Q = 40 – P/2
  - yields answers:
  - at P=\$20: ϵ_d = -1/3, at P=\$40: ϵ_d = -1 and at P=\$60: ϵ_d = -3

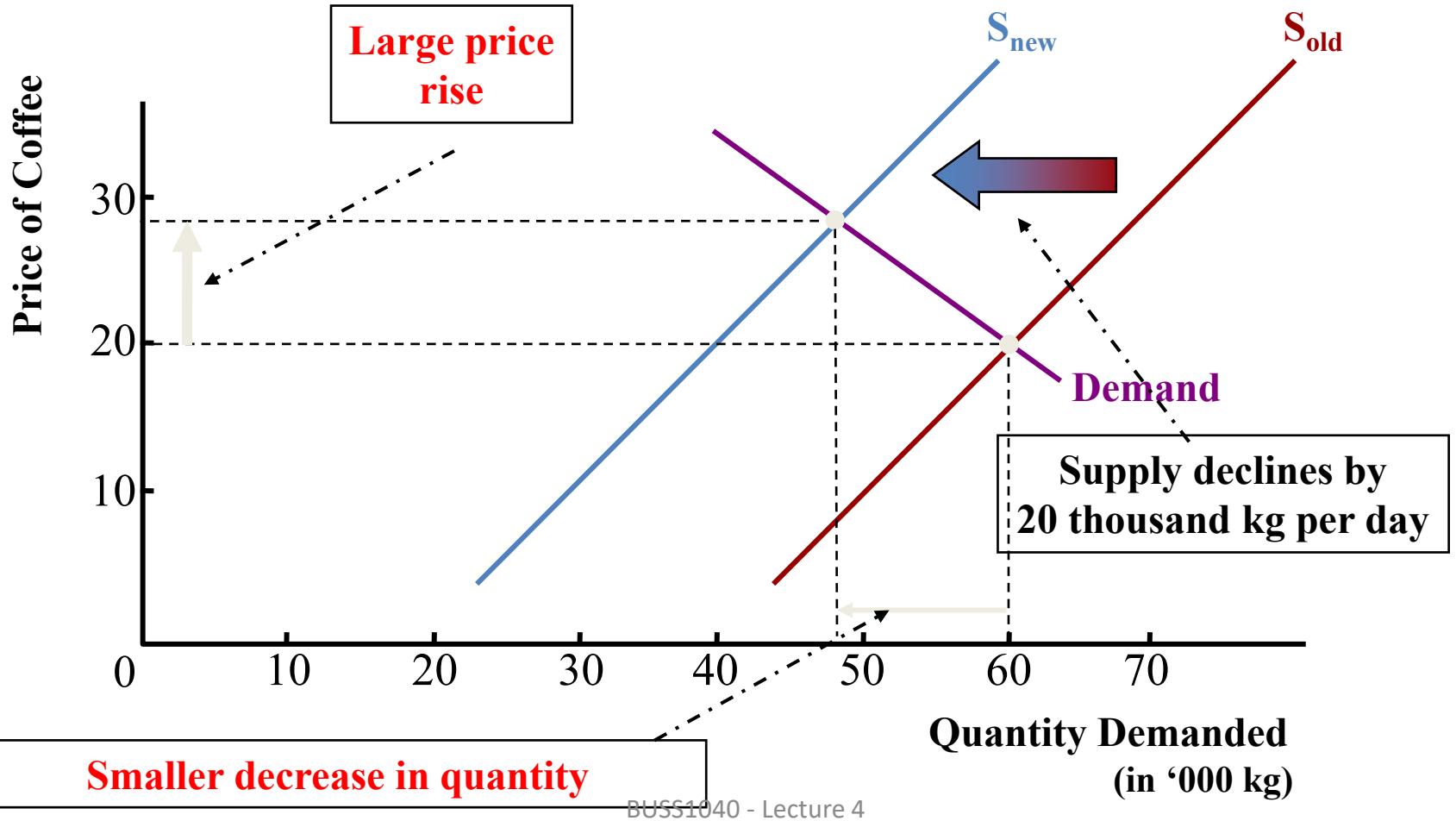
Importance of the Price Elasticity of Demand

- Remember comparative statics?
  - Using the price elasticity of demand we can evaluate the (expected) effect on price and quantity of a ***change in supply***.
  - Not only the *direction* of the effects, but also the *amount*…
  - and its effect on revenue.

Importance of the Price Elasticity of Demand…



… Importance of Price Elasticity of Demand

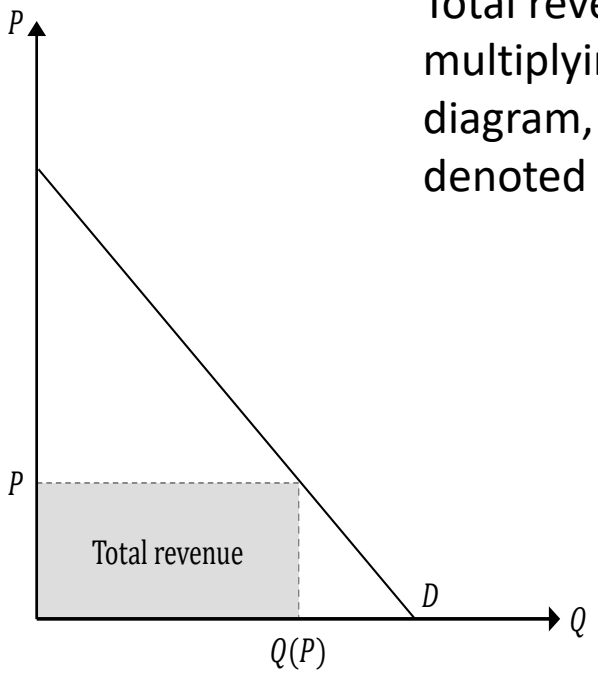


Elasticity and revenue

- We can determine from the elasticity of demand how total revenue in the market will change as price changes.
  - As we know from the *demand curve*, the quantity demanded in the market (q) depends upon the market price (P). This means that we can write the quantity demanded as a function of price: q(P).
  - Total revenue as a function of P is:

$$TR(P) = P.\ q(P)$$

Total revenue and elasticity



Total revenue can be calculated by multiplying price and quantity. In this diagram, the size of total revenue is denoted by the grey-shaded area

Changes in revenue and elasticity

- We can differentiate this equation with respect to P in order to determine how total revenue changes in response to a small increase in price:

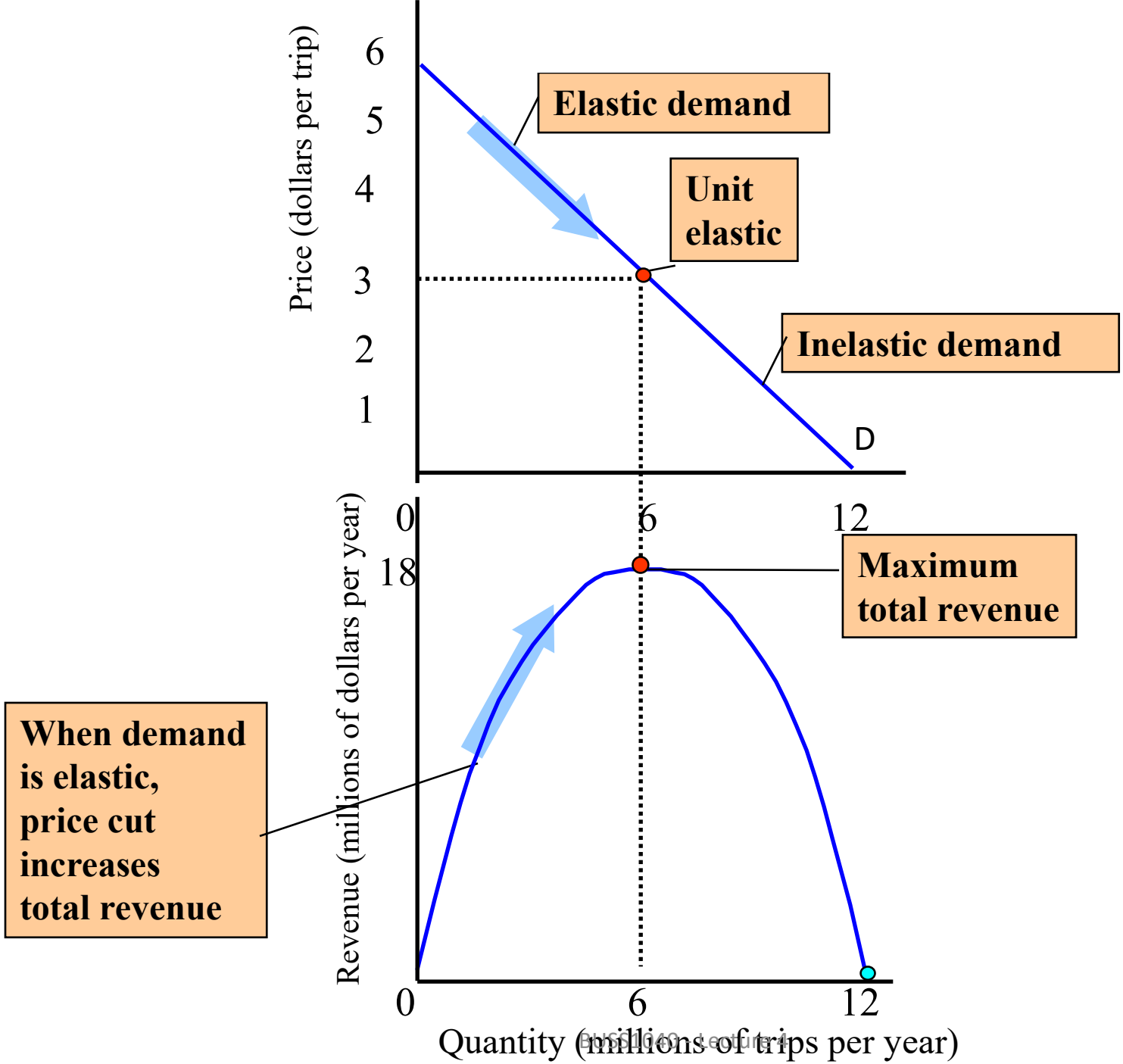
$$\frac{dTR}{dP} = q + P.\frac{dq}{dP}$$

- Rearranging gives:

$$\frac{dTR}{dP} = q\left(1 + \frac{P}{q}.\frac{dq}{dP}\right) = q\left(1 + \varepsilon_d\right)$$

Changes in revenue and elasticity

- This equation provides a **direct link** between the price elasticity of demand and the change in total revenue.
- In order for TR to increase with a price increase, the right-hand side of the equation must be positive.
  - This will be true if and only if $\epsilon_d > -1$; that is, if demand is inelastic.
  - On the other hand, if demand is elastic ($\epsilon_d < -1$), TR will fall when the market price rises.
- On the **elastic part** of the demand curve (the upper part) the price needs to be lowered in order to increase total revenue. On the **inelastic part** of the demand curve (the lower part) the price needs to be raised to increase revenue. The means that total revenue is maximized when demand is **unit-elastic**, in the middle of the demand curve.


Price (dollars per trip)
6
5
4
3
2
1
Elastic demand
Unit elastic
Inelastic demand
D
0
6
12
Revenue (millions of dollars per year)
18
Maximum total revenue
When demand is elastic, price cut increases total revenue
0
6
12
Quantity (millions of trips per year)

Changes in revenue and elasticity

- The **intuition** for the result is:
  - If demand is **elastic**, a 1% increase in price will cause a greater than 1% fall in the quantity demanded. This means that the increase in P is more than offset by the decrease in Q_d, causing **TR to fall** overall.
  - If demand is **inelastic**, a 1% increase in price will cause quantity demanded to fall but by less than 1%; the increase in P outweighs the decrease in Q_d causing **TR to increase** overall.

Elasticity of supply

- Elasticity can also be applied to supply.
- ***Elasticity of supply*** ϵ_s measures how sensitive the quantity supplied of a good (q_s) is to changes in price (P).
- That is, what is the proportional change in quantity supplied of a good, given a 1% change in its price.
- The midpoint (arc) method and the point method for calculating elasticity of supply are as follows:

$$\varepsilon_s = \frac{\Delta q / q_s^m}{\Delta P / P^m} = \frac{\Delta q}{\Delta P} . \frac{P^m}{q_s^m} \qquad \varepsilon_s = \frac{\Delta q_s / q_s}{\Delta P / p} = \frac{dq_s}{dP} . \frac{P}{q_s}$$

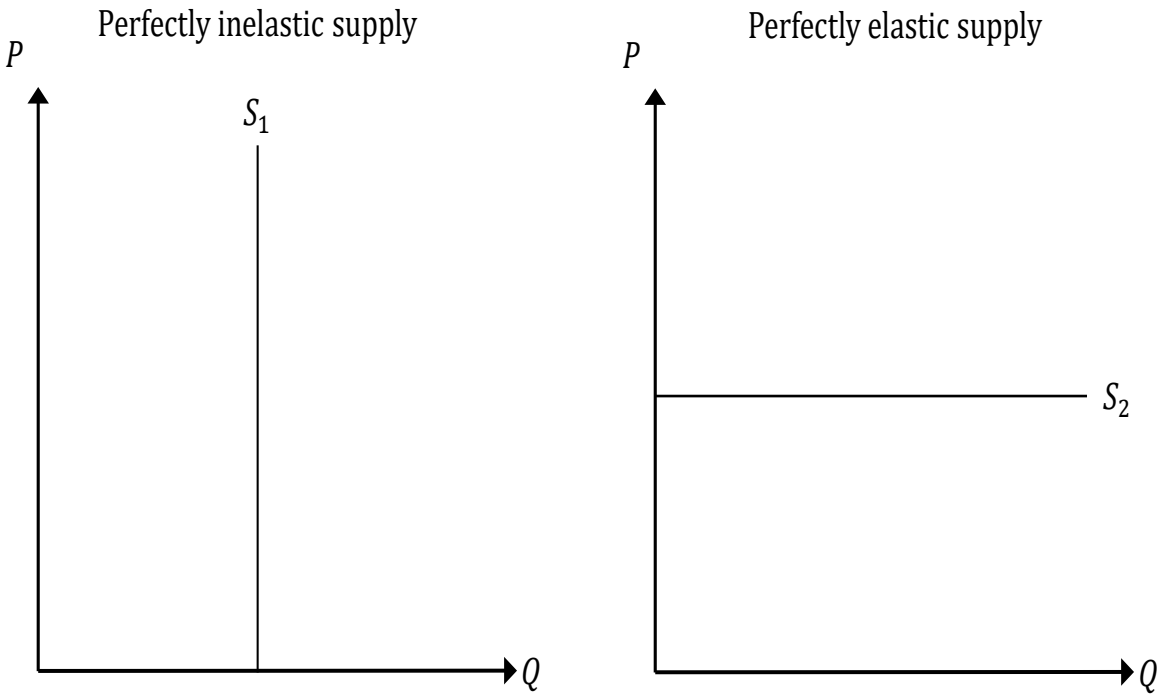
Elasticity of supply

- The elasticity of supply is typically **positive**, due to the law of supply.
- **If $\epsilon_s = 0$ is *perfectly inelastic*.**
  - For a 1% change in price, there is no change in the quantity supplied. The supply curve is vertical.
- **If $0 < \epsilon_s < 1$, supply is *inelastic*.**
  - For a 1% change in price, the change in quantity supplied is less than 1%. The quantity supplied is not very responsive to changes in price.
- **If $\epsilon_s = 1$ supply is unit elastic.**
  - For a 1% change in price, there is a 1% change in quantity supplied – the quantity supplied changes by the same proportion as price.

Elasticity of supply

- **If $\epsilon_s > 1$ supply is *elastic*.**
  - For a 1% change in price, the change in quantity supplied is more than 1% - the quantity supplied is relatively responsive to changes in price.
- **If $\epsilon_s = \infty$, supply is *perfectly elastic*.**
  - For a small decrease in price, quantity supplied will drop to zero.
  - This means that if the price of a good falls at all below a certain price, firms will stop supplying the product. The supply curve is horizontal.

Perfectly inelastic and elastic supply



When supply is perfectly inelastic, the supply curve is vertical (as seen the left panel). When supply is perfectly elastic, the supply curve is horizontal (as seen the right panel).

Cross-price elasticity

- Sometimes we are interested in the relationship between the demand for one good and the price of another related good.

- This relationship can be examined using the ***cross-price elasticity***. This measures how sensitive the demand for a Good A (Q_A) is to changes in price of Good B (P_B).

- For the point method, the cross price elasticity formula is:

$$\varepsilon_{AB} = \frac{\Delta Q_A / Q_A}{\Delta P_B / P_B} = \frac{dQ_A}{dP_B} \cdot \frac{P_B}{Q_A}$$

Cross-price elasticity

- For the midpoint (or arc) method, the formula for cross-price elasticity is:

$$\varepsilon_{AB} = \frac{\Delta Q_A / Q_A^M}{\Delta P_B / P_B^M}$$

- Where the superscript indicates the midpoint value.

Cross-price elasticity - *example*

- Example:
  - Suppose that, when the price of teabags is $4 per box, Candice sells 100 litres of milk. If the price of teabags rises to $8 per box, Candice only sells 60 litres of milk.
  - Use the midpoint formula to calculate cross-price elasticity. Here, $\Delta Q_A = -40$ and $\Delta P_B = 4$. The average values for price and quantity are $Q_M^A = 80$ and $P_M^B = 6$.
  - Therefore, cross-price elasticity is $\epsilon_{AB} = -40/4 \,.\, 6/80 = -0.75$.

Cross-price elasticity - complements

- **If $\epsilon_{AB} < 0$,** an increase in the price of Good B is associated with a fall in the demand for Good A (at any given price of Good A). This means that the Good A and Good B are ***complements***.
  - They are goods that are likely to be consumed together (bacon and eggs, a car and petrol).
  - In other words, if this happens at any given price of Good A – what does it really imply?

Cross-price elasticity - substitutes

- Cross-price elasticity provides some information about the relationship between the two products.

- **If $\epsilon_{AB} > 0$**, an increase in the price of Good B is associated with a rise in the demand for Good A (at any given price of Good A). Goods A and B are ***substitutes***.
  - For example tea and coffee, the bus or the train.

Cross-price elasticity – independent goods

- **If $\epsilon_{AB} = 0$**, an increase in the price of Good B is not associated with any change in the demand for Good A (at any given price of Good A) – they are ***independent*** *goods*.
  - For example, ice cream and chainsaws.

Intermezzo: Cross-price elasticity

- Why is it useful to have an understanding of the responsiveness of demand to a change in the price of a related good?

- Examples:

  - *BUSINESS*: multibrand product management

    How easily do consumers switch between different brands when the price of 1 brand of the product changes?

  - *GOVERNMENT: impact of taxes on consumer behaviour*

    E.g. alcopop tax: how do consumers substitute towards other alcoholic drinks (potentially with higher alcohol levels) – after the imposition of a tax on easy-to-drink alcoholic beverages?

Income elasticity

- The demand for a good may also depend, in part, on a consumer's income.
- **Income elasticity (η)** measures how sensitive the demand for a good (Q) is to changes in income (Y).
- The midpoint formula is, using the midpoints for quantity (Q^M) and income (I^M):

$$\eta = \frac{\Delta Q / Q^M}{\Delta Y / Y^M}$$

- Using the point elasticity formula:

$$\eta = \frac{\Delta Q / Q}{\Delta Y / Y} = \frac{dQ}{dY} . \frac{Y}{Q}$$

Income elasticity – inferior and neutral goods

We can characterize the good, depending upon its income elasticity:

- **If $\eta < 0$**, demand decreases when income rises. This type of good is called an ***inferior*** *good*.
  - For example, consumers might substitute away from an inferior cut of meat as income rises.
- **If $\eta = 0$**, demand is invariant to changes in income; this is a ***neutral*** *good*.

Income elasticity – normal and luxury goods

- **When $0 < \eta \leq 1$**, if income rises by 1%, demand for the good increases by less (or, more correctly, not more) than 1%; this is a ***normal*** *good*.
  - Many (if not most) goods are normal goods, for example food.
- **If $\eta > 1$**, when income rises by 1%, demand for the good increases by more than 1%; this is a ***luxury*** *good*.
  - For example, caviar, sports cars, skiing holidays.

Concluding comments - Elasticity

- Elasticity measures the proportional change in one variable, given a proportional change in another variable.
- This unit-free measure of responsiveness can be applied to any two variables of interest.
  - **Common applications:** the (price) elasticity of demand, the elasticity of supply, cross-price elasticity and income elasticity.
  - However, can be used for **other uses** – like the effectiveness of an advertising campaign or consumers' response to a government subsidy.
- Elasticity will depend on a range of factors, including the **timeframe**.
  - Generally expect greater elasticities in the long run than in the short run.

What next?

- Role of market structure
  - Perfectly competitive markets
    - Characteristics
    - Short run vs. long run
    - Supply: firm and market
    - Short vs. long run market equilibrium