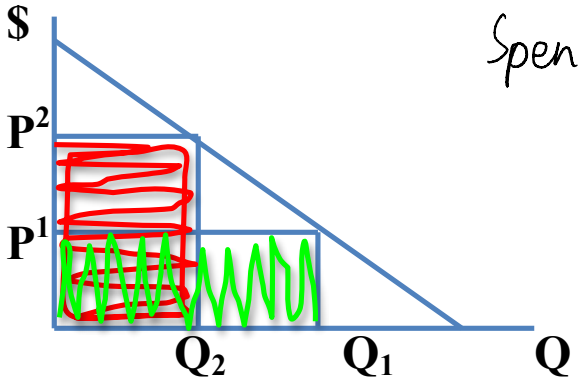
Chapter 6
Elasticity

How sensitive are consumers or producers to the price? When the price changes does a consumer end up spending more or less?



Spending = P x Q

It depends on how much Q^D changes when the price changes.
This is explained by *elasticity*.

Elasticity **refers to how responsive producers and consumers are to changes in price.**

Studying elasticity helps answer an important economic question: How can a business make more money?

- **Revenue = Expenditure =** $Q \times D$

If Q^D or Q^S change a lot in response to a change in price then consumers or producers have elastic demand or supply.

- **Examples of goods with elastic demand:** Luxuries, goods with close substitutes

If Q^D or Q^S do not change a lot in response to a price change then consumers or producers have inelestic demand or sapply.

- **Examples of goods with inelastic demand:** Necessities: gas, basic foods, toilet paper; goods without close substitutes.

<u>Price Elasticity of Demand</u> = the % change in Q^D relative to the % change in price.

Price Elasticity of Demand $= \left| \frac{\%\Delta Q^d}{\%\Delta P} \right|$

<u>Example</u>: Steak dinners at the Keg

The price falls from \$40 to \$30 the quantity demanded for steak dinners increases from 50 to 200.
Calculate the elasticity using the *midpoint method*:

$\%\Delta X = \frac{X_2 - X_1}{(X_1 + X_2)/2} \cdot 100\%$ 百分比差异

$\%\Delta Q = \frac{200-50}{(200+50)/2} \cdot 100\% = 120\%$

$\%\Delta P = \frac{30+40}{(30+40)/2} \cdot 100\% = 28.57\%$

$E = \left| \frac{120\%}{-28.57\%} \right| = 4.2$

Price Elasticity of demand = 4.2

The price elasticity will be the same if you measure the response of an *increase* in price from $30 to $40.

General Formula:

$$\text{Price elasticity of demand} = \left| \frac{\frac{Q_2 - Q_1}{(Q_2 + Q_1)/2} x100\%}{\frac{P_2 - P_1}{(P_2 + P_1)/2} x100\%} \right| = \left| \frac{\frac{Q_2 - Q_1}{Q_2 + Q_1}}{\frac{P_2 - P_1}{P_2 + P_1}} \right|$$

Exercise 1: Calculate the following price elasticities of demand

Suppose that when the price of eggs increases from $3.50 per dozen to $4 per dozen Joe decreases his demand from 16 dozen per year to 15 dozen per year. What is Joe's price elasticity of demand for eggs?

$$\text{Price elasticity of demand} = \left| \frac{\frac{15-16}{15+16}}{\frac{4-3.5}{4+3.5}} \right| = \left| -\frac{1}{31} \cdot \frac{7.5}{0.5} \right| = \frac{15}{31} = 0.48$$

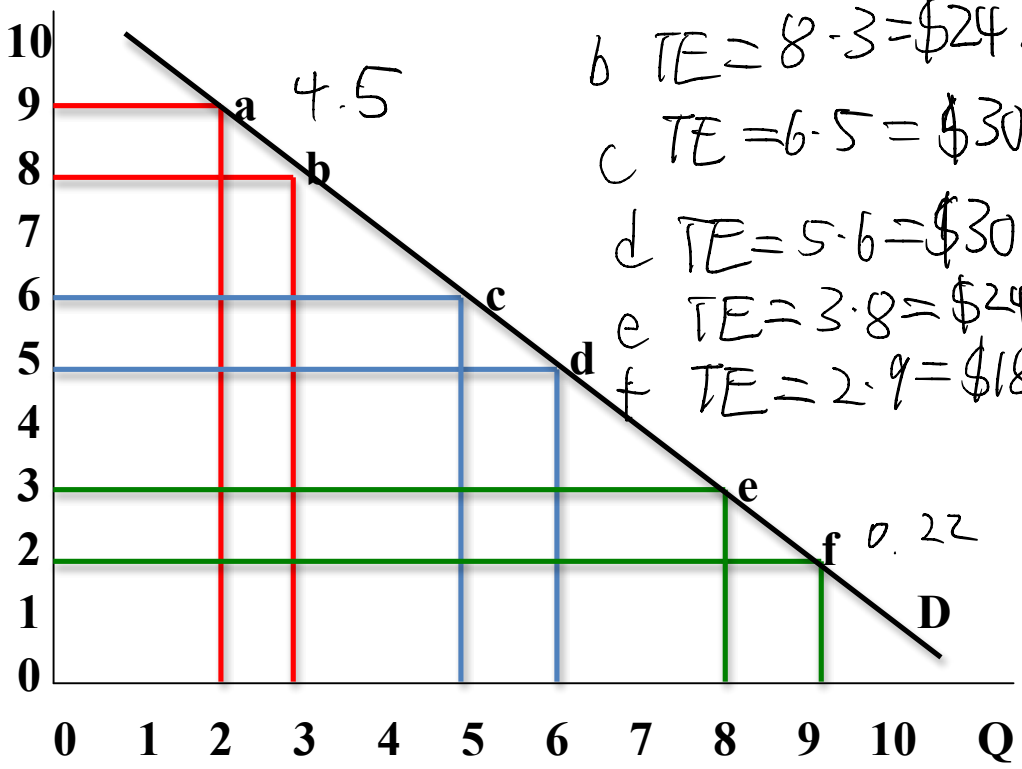
Suppose the price of diamond earrings decreases by 40% and Elaine's price elasticity of demand for diamond earrings is 3.8. By how much % will Elaine's quantity demanded change?

$$\text{Price elasticity of demand} = 3.8 = \left| \frac{\%\Delta Q}{-40\%} \right|$$

$$\%\Delta Q = 3.8 \cdot 40\% = 152\%$$

Elasticity versus Slope: The elasticity will vary along a linear demand curve with a constant slope.

a TE = 9·2 = $18 } elastic
b TE = 8·3 = $24 }
c TE = 6·5 = $30 } unit elastic
d TE = 5·6 = $30 }
e TE = 3·8 = $24 } inelastic
f TE = 2·9 = $18 }



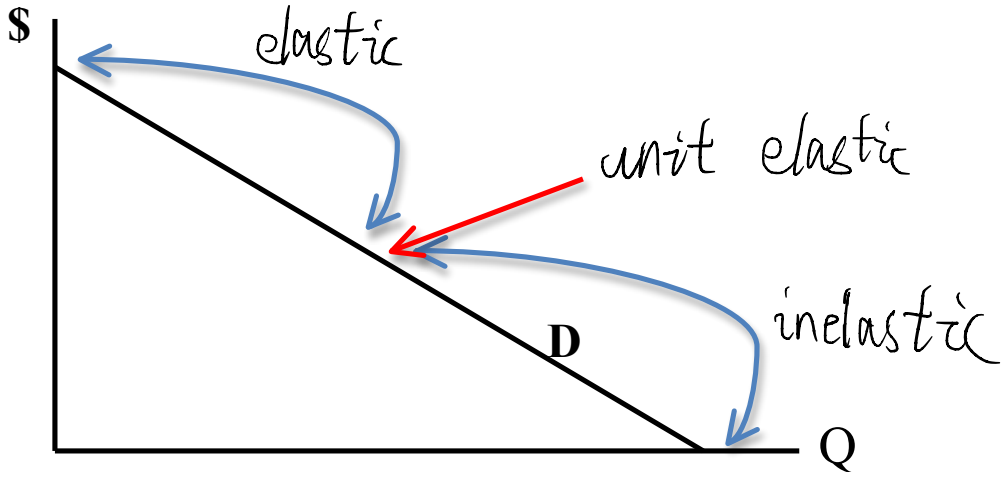
P = −Q + 11

a → b $E = \left| \frac{\frac{3-2}{3+2}}{\frac{8-9}{8+9}} \right| = \frac{1}{5} \cdot 17 = \frac{17}{5} = 3.4$

c → d $E = \left| \frac{\frac{6-5}{6+5}}{\frac{5-6}{5+6}} \right| = 1$

e → f $E = \left| \frac{\frac{9-8}{9+8}}{\frac{2-3}{2+3}} \right| = \frac{1}{17} \cdot 5 = \frac{5}{17} = 0.29$

Demand for a good is elastic if elasticity > 1
Demand for a good is inelastic if elasticity < 1
Demand for a good is unit elastic if elasticity = 1



Elasticity and Total Revenue or Total Expenditure

TR = TE = $P \cdot Q$

Price	0	1	2	3	4	5	6	7	8	9	10
Quantity	10	9	8	7	6	5	4	3	2	1	0
Total Revenue	0	9	16	21	24	25	24	21	16	9	0

elastic — unit elastic — inelastic

$f(p) = kp + b$

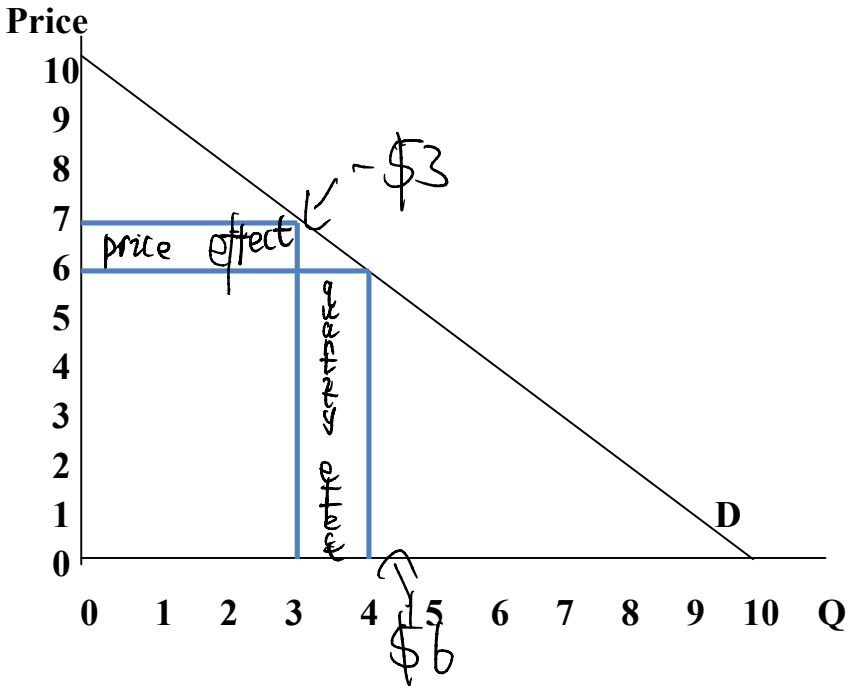
$y = f(p) \cdot p = kp^2 + bp$

$y' = 2kp + b$ when $y' > 0$, elastic; $y' = 0$, unit elastic; $y' < 0$, inelastic

When the price changes there are two effects:

1. **Price effect** = ΔTR because of a different price per unit sold.
2. **Quantity effect** = ΔTR because of the change in Q^D at the new price.

E.g. The price decreases from $7 to $6 per unit



Exercise 2: Calculate the price effect and quantity effect for the three price changes on page 4.

a → b **Price effect =** 3.4

Quantity effect =

c → d **Price effect =**

Quantity effect =

e → f **Price effect =**

Quantity effect =

The *net effect* of a price change on total revenue depends on which effect is stronger.

***Inelastic* demand means** elasticity < 1

$\frac{\%\Delta Q_d}{\%\Delta P} < 1$ or $\%\Delta Q < \%\Delta P$

- **The** price effect is stronger
- **An increase in price will** increase in TR
- **A decrease in price will** decrease in TR

***Elastic* demand means** elasticity > 1

$\frac{\%\Delta Q_d}{\%\Delta P} > 1$ or $\%\Delta Q > \%\Delta P$

- **The** quantity effect is stronger.
- **An increase in price will** decrease TR because $Q\downarrow$
- **A decrease in price will** increase TR because $Q\uparrow$

Elastic Demand

Inelastic Demand

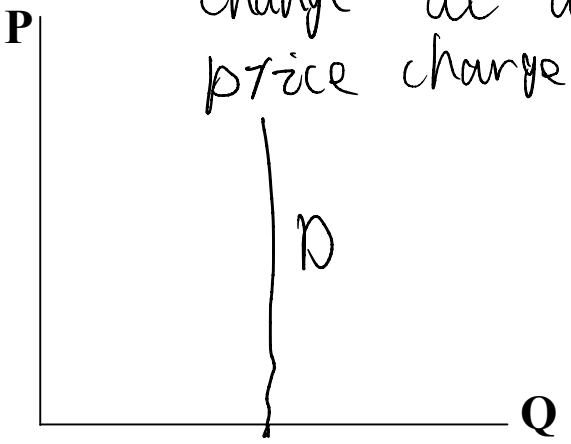
For a *unit* elastic good $\frac{\%\Delta Q_d}{\%\Delta P} = 1$ or $\%\Delta Q = \%\Delta P$

So a change in price will not affect TR.

Comparing and Interpreting Elasticities

Generally *steeper* demand curves are more *inelastic*.

Demand for a good is perfectly inelastic if Q^D does not change at all in response to a price change.

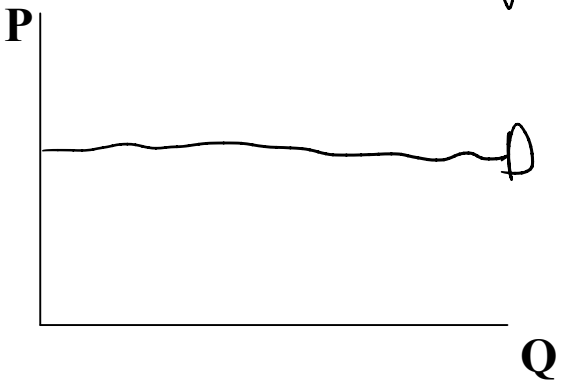


%ΔQ = 0, so elasticity = 0

Example: Insulin

Generally *flatter* demand curves are more *elastic*.

Demand for a good is petectly elastic if Q^D decreases to 0 with any increase in price.



%ΔQ = ∞, so elasticity = ∞

Example: Goods with perfect substitutes – e.g. Esso gas

What Determines Elasticity?

1. **Availability of substitutes:** elasticity is higher if more substitutes are available, and vice versa.
   - **E.g. For eggs elasticity ≈ 0.1**
   - **E.g. Chevrolet automobiles ≈ 4.0**

2. **Necessity:** elasticity is lower if a good is considered a necessity, and vice versa.
   - **E.g. foreign travel elasticity ≈ 4.1**
   - **E.g. restaurant meals elasticity ≈ 2.3**
   - **E.g. coffee ≈ 0.25**

3. **Time:** Over time people find more substitutes.
   So elasticity is often larger when measured over the long run than the short run.
   - **E.g. Gasoline short run elasticity ≈ 0.2**
   - **E.g. Gasoline long run elasticity ≈ 0.7**

Other Demand Elasticities

1. The cross-price elasticity of demand.
How much does a demand curve shift when there is a change in the price of substitutes or complements?

The cross price elasticity of demand describes how much Q^D changes for a good A when the price of related good B changes.

Cross price elasticity between goods A and B = $\frac{\%\Delta Q_A}{\%\Delta P_B} \approx \frac{\frac{Q_2 - Q_1}{Q_2 + Q_1}}{\frac{P_2 - P_1}{P_2 + P_1}}$

For complements there is a negative relationship between P_B and Q^D_A so the cross price elasticity < 0

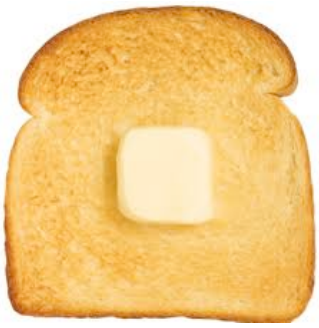
For substitutes there is a positive relationship between P_B and Q^D_A so cross price elasticity > 0

For cross price elasticity:

If the elasticity is small (positive or negative) the
relationship between the two goods is weak.
The larger the elasticity between the two goods the
stronger the relationship.

E.g. Butter and margarine: E = 0.81

E.g. Beef and pork: E = 0.28



2. Income elasticity of demand

How much does the demand curve shift when income changes?

Income elasticity of demand = $\frac{\%\Delta Q^d}{\%\Delta I} = \frac{\frac{Q_2 - Q_1}{Q_2 + Q_1}}{\frac{I_2 - I_1}{I_2 + I_1}}$

- **For <u>normal goods</u> income elasticity is** > 0
- **For <u>inferior goods</u> income elasticity is** < 0

If the income elasticity is:

- **> 1 the good is a** luxury good (income elastic)
- **> 0 but < 1 the good is a** necessity (income inelastic).

<u>Examples</u>:

Food eaten at home: E = 0.5

Restaurant meals: E = 1.4

Cigarettes: E = 0.6

Public transportation: E = - 0.4

Exercise 3: Calculate the following elasticities:

1. When the price of good B increases from \$10 to \$12 Mary changes her quantity demanded for good A from 8 to 9.

a) Calculate Mary's cross price elasticity of demand.

$$\frac{\frac{9-8}{9+8}}{\frac{12-10}{12+10}} = \frac{1}{17} \cdot \frac{22}{2} = \frac{11}{17} > 0$$

b) What type of goods are A and B to Mary? substitute

2. When the price of good B decreases from \$20 to \$18 Mary changes her quantity demanded for good A from 22 to 25.

a) Calculate Mary's cross price elasticity of demand.

$$\frac{\frac{25-22}{25+22}}{\frac{18-20}{18+20}} = \frac{3}{47} \cdot \left(-\frac{38}{2}\right) = -\frac{57}{47} < 0$$

b) What type of goods are A and B to Mary? complement

3. When Josie's income decreases from \$80,000 to \$60,000 she changes her quantity demanded for good A from 45 to 50.

a) Calculate Josie's income elasticity of demand.

$$\frac{\frac{50-45}{50+45}}{\frac{60000-80000}{60000+80000}} = \frac{5}{95} \cdot \left(-\frac{140000}{20000}\right) = -\frac{1}{19} \cdot 7 = -\frac{7}{19} < 0$$

b) What type of good is good A to Josie? Interior

4. When Josie's income increases from \$80,000 to \$90,000 she changes her quantity demanded for good B from 4 to 6.

a) Calculate Josie's income elasticity of demand.

$$\frac{6-4}{6+4} \cdot \frac{90000+80000}{90000-80000} = 3.4 > 1$$

b) What type of good is good A to Josie? Normal luxury.

Price Elasticity of Supply

How much does Q^S change when the price changes?

Price elasticity of supply $= \dfrac{\%\Delta Q^S}{\%\Delta P^S} = \dfrac{\frac{Q_2 - Q_1}{Q_2 + Q_1}}{\frac{P_2 - P_1}{P_2 + P_1}}$

If elasticity < 1 supply is inelastic
If elasticity is > 1 supply is elastic
If elasticity $= 1$ supply is unit elastic.

Example:

P	Q
4	600
3	550
2	450
1	300
0	0

What is the price elasticity of supply when the price changes from $3 to $4?

Price elasticity of supply $= \dfrac{600-550}{600+550} \cdot \dfrac{4+3}{4-3} \approx 0.304$

What affects elasticity of supply?

1. Availability of inputs

- **Difficult to obtain inputs →** inelastic supply
- **Easy to obtain inputs →** elastic supply

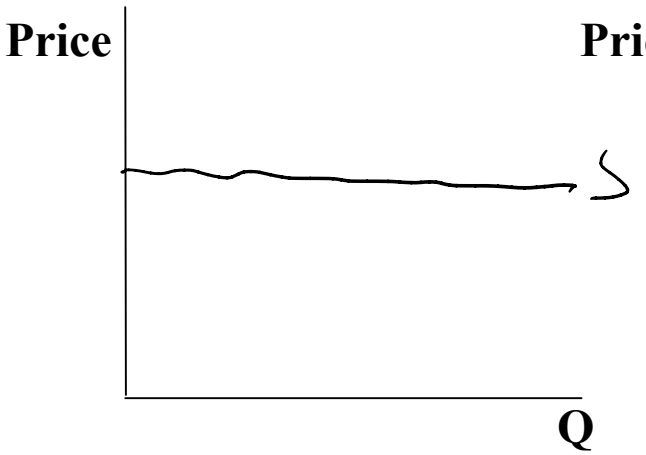
2. Productive capacity

- **If a business has idle capacity they can respond more quickly to a price increase →** elastic supply
- **But if close to full capacity →** inelastic supply

3. Time

- **More time to respond →** more elastic supply
- **E.g. Oil → oil production requires time to explore and set up for extraction, so the Q^S can only change significantly in the long run.**

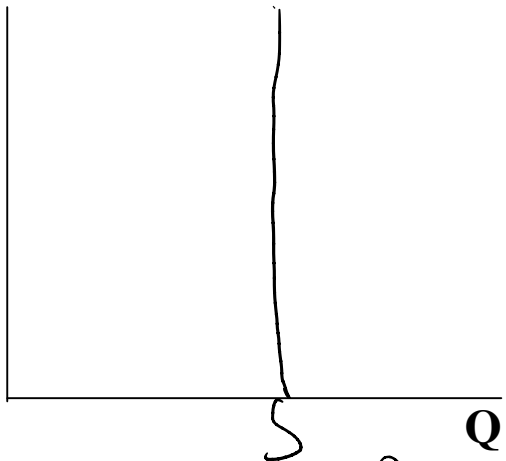
Perfectly elastic supply



Elasticity = ∞

E.g. Online music

Perfectly inelastic supply

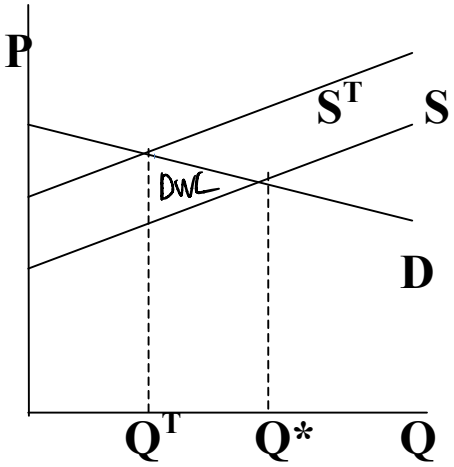


Elasticity = 0

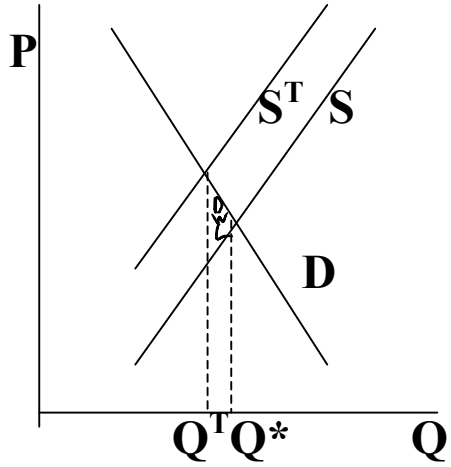
E.g. Land on an island

Elasticities and Taxes

Elastic Supply and Demand



Inelastic Supply and Demand

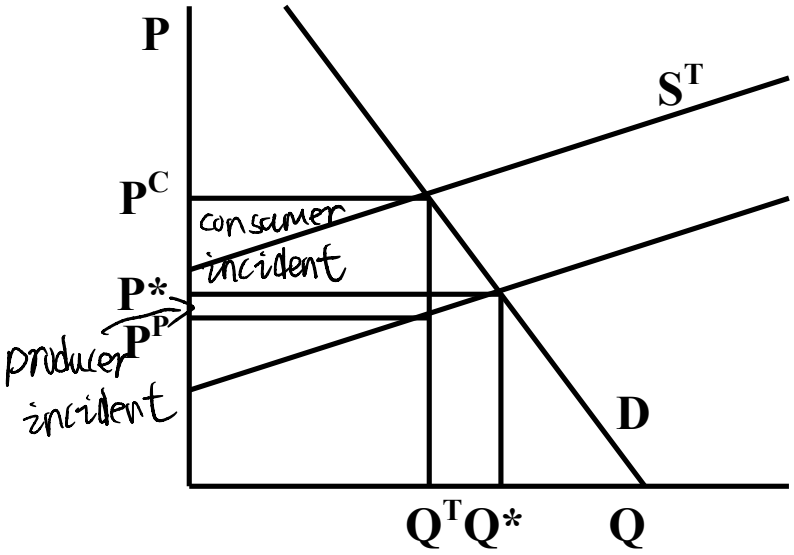


The *change in quantity* is greatest for a market with elastic demand and supply curves → greatest DWL

The tax burden (tax incidence) will fall more on whichever market agents are more inelastic.

When Demand is more inelastic than supply:

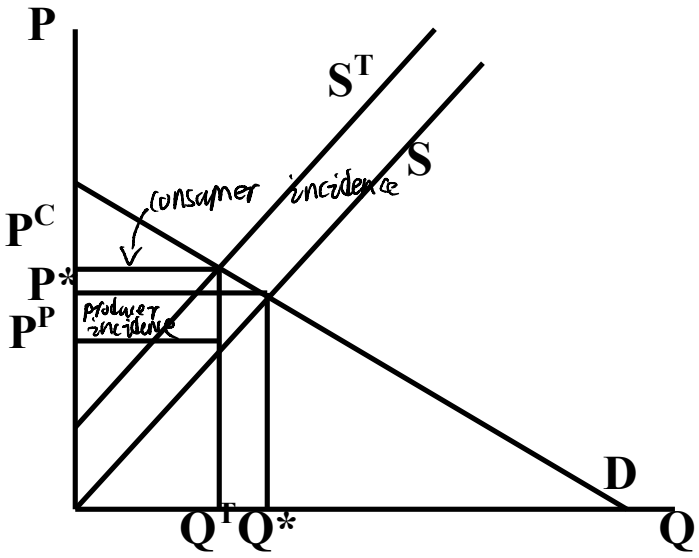
E.g. Milk



Demand is more inelastic so consumers will bear more of the tax burden.

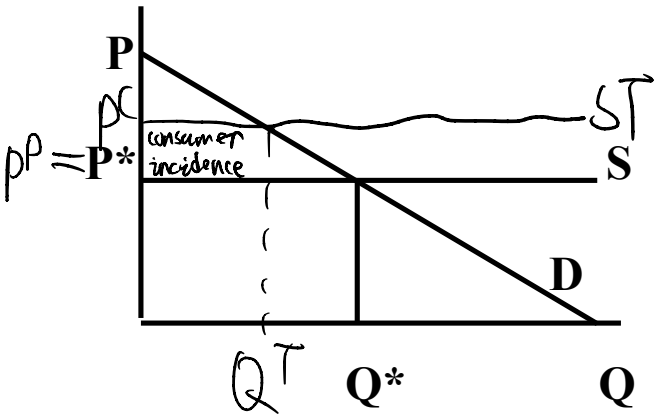
When Demand is more elastic and supply is more inelastic:

E.g. Purple silk socks



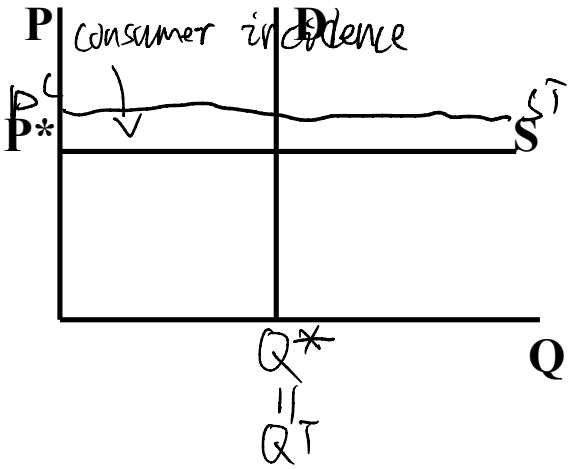
Supply is more inelastic so producers will bear more of the tax burden.

If supply is perfectly elastic:



Consumers bear the entire tax burden.

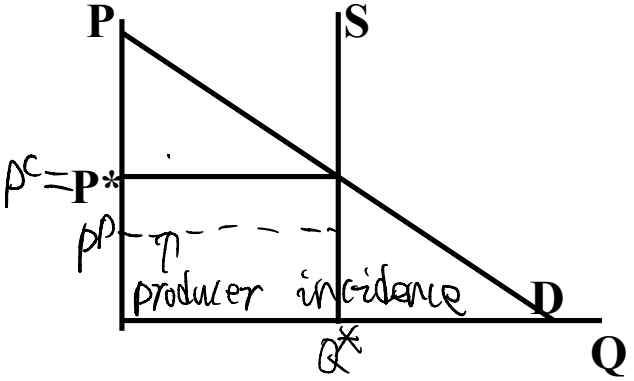
If demand is perfectly inelastic and supply is perfectly elastic:



No deadweight loss because the quantity has not decreased.

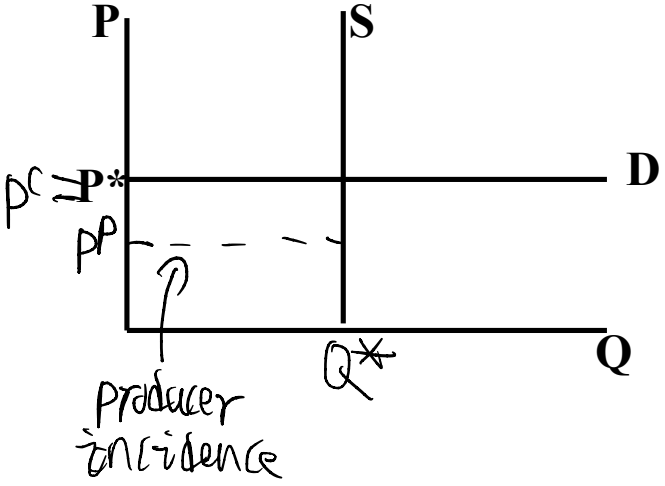
Consumers bear the entire tax burden.

If supply is perfectly inelastic:



Producers bear the entire tax burden.

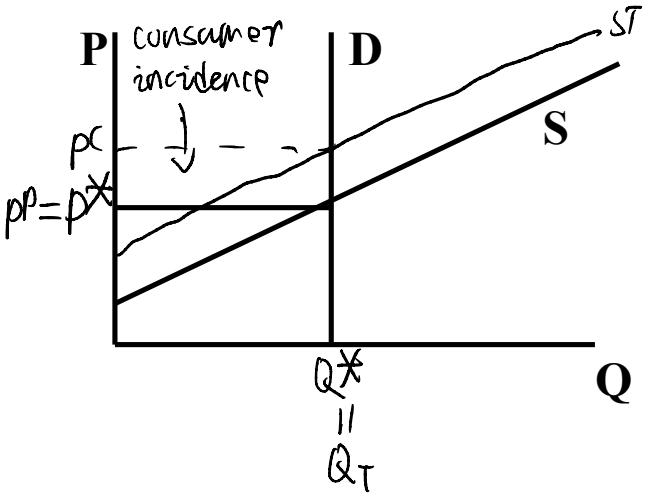
If demand is perfectly elastic and supply is perfectly inelastic:



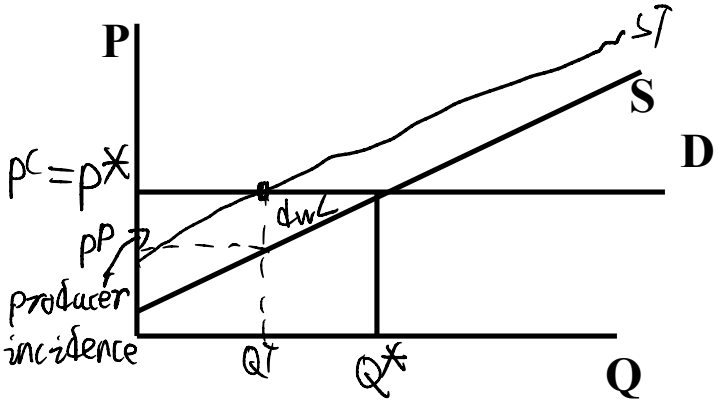
Producers bear the entire tax burden.

<u>Example</u>: Find the demand price (P^C), supply price (P^P), the equilibrium quantity with a tax (Q^T), and any consumer incidence or producer incidence or DWL.

If demand is perfectly inelastic:



If demand is perfectly elastic:



<u>Example</u>: Graph and calculate the consumer and producer incidence to determine which market agents are more inelastic.

Demand: P = 100 – 0.01Q
Supply: P = 20 + 0.03Q
Tax = 5

$100 - 0.01Q = 20 + 0.03Q$

$Q = 2000$

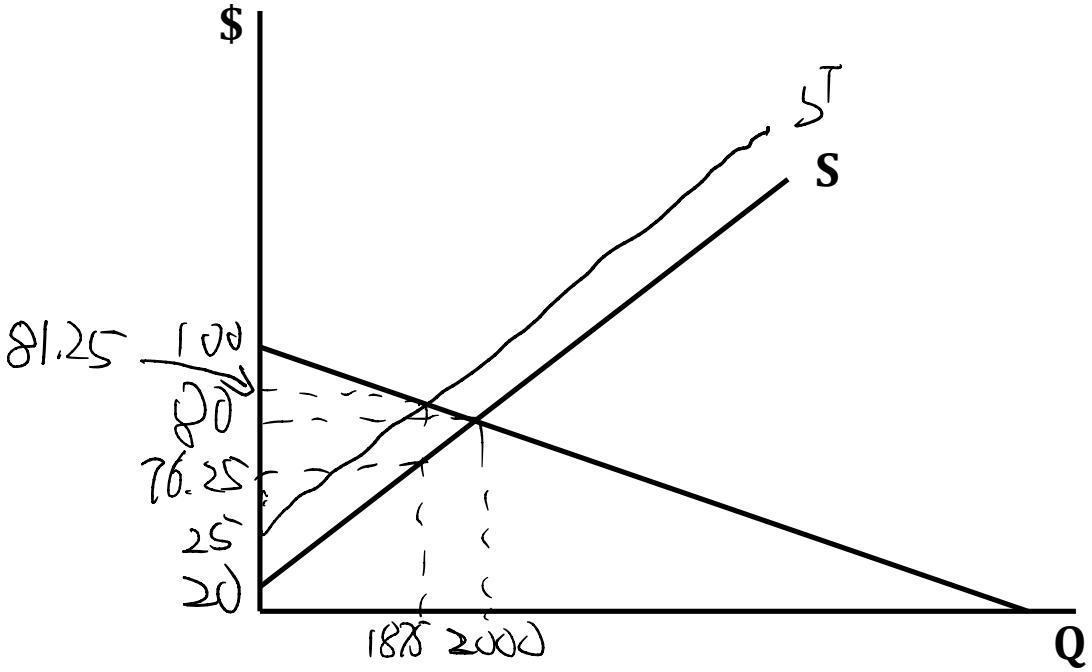
$P = 80$

$P = 0.03Q + 25$

$100 - 0.01Q = 0.03Q + 25$

$Q = 1875$

$P^C = 81.25, P^P = 76.25$



Consumer incidence = $(81.25 - 80)1875 = 2343.75$
Producer incidence = $(80 - 76.25)1875 = 7031.25$
Which market agents are more inelastic?

Suppliers because $PI > CI$