

A close-up photograph of a hand holding a yellow rubber band stretched between the thumb and index finger of both the left and right hands. The rubber band is taut and horizontal. A semi-transparent white rectangular box is overlaid on the center of the image, containing the word "Elasticities" in a bold, black, serif font.

# Elasticities

# Recall: The Law of Demand

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- As the price of a good falls, the quantity of the good demanded increases.
- As the price of a good go up , the quantity of the good demanded decreases.
- **The law of Demand:** The **negative** causal relationship between price and quantity demanded.

➡ **Negative relationship.**

➡ **Causal relationship.**

*How much  
quantity responds  
to change in price?*

# Elasticity

**Elasticity is a measure of the responsiveness of a variable to changes in price or any of the variable's determinants.**

In this chapter, We will examine:

- Price elasticity of demand (PED)
- Income elasticity of demand (YED)
- Price elasticity of supply (PES)

A close-up photograph of a hand stretching a yellow rubber band between the thumb and index finger of both the left and right hands. The rubber band is taut and horizontal, spanning the width of the frame. The background is a plain, light-colored surface.

# **Price Elasticity of demand (PED)**

I am a psychological therapist. My hourly charge rate: 400 RMB and I have 20 patients (one hour each per week)

I want to buy a small flat in shanghai, so I want to raise my overall income, I am considering to raise my hourly charge rate to 500 RMB.

What is the effect of my rise in price? How much quantities of demand will fall if I charge 500 RMB/hour?



# Price elasticity of demand (PED)

**Price elasticity of demand (PED):** a measure of the responsiveness of the quantity of a good demanded to changes in its price.

$$\text{Price elasticity of demand (PED)} = \frac{\% \text{ change in quantity demanded}}{\% \text{ change in price}} = \frac{\% \Delta Q}{\% \Delta P}$$

- It measures how much quantity responds to change in price. i.e.: the price-sensitivity of buyers' demand.
- We use percentage changes rather than units change.

# The formula for PED

Price elasticity of demand (PED)

$$= \frac{\text{\% change in quantity demanded}}{\text{\% change in price}} = \frac{\text{\% } \Delta Q}{\text{\% } \Delta P}$$

$$\text{PED} = \frac{\frac{\Delta Q}{Q} * 100}{\frac{\Delta P}{P} * 100} = \frac{\frac{\Delta Q}{Q}}{\frac{\Delta P}{P}} \quad (\text{Always take the absolute value})$$

$\Delta Q = Q_{\text{final value}} - Q_{\text{initial value}}$

$Q = Q_{\text{initial value}}$

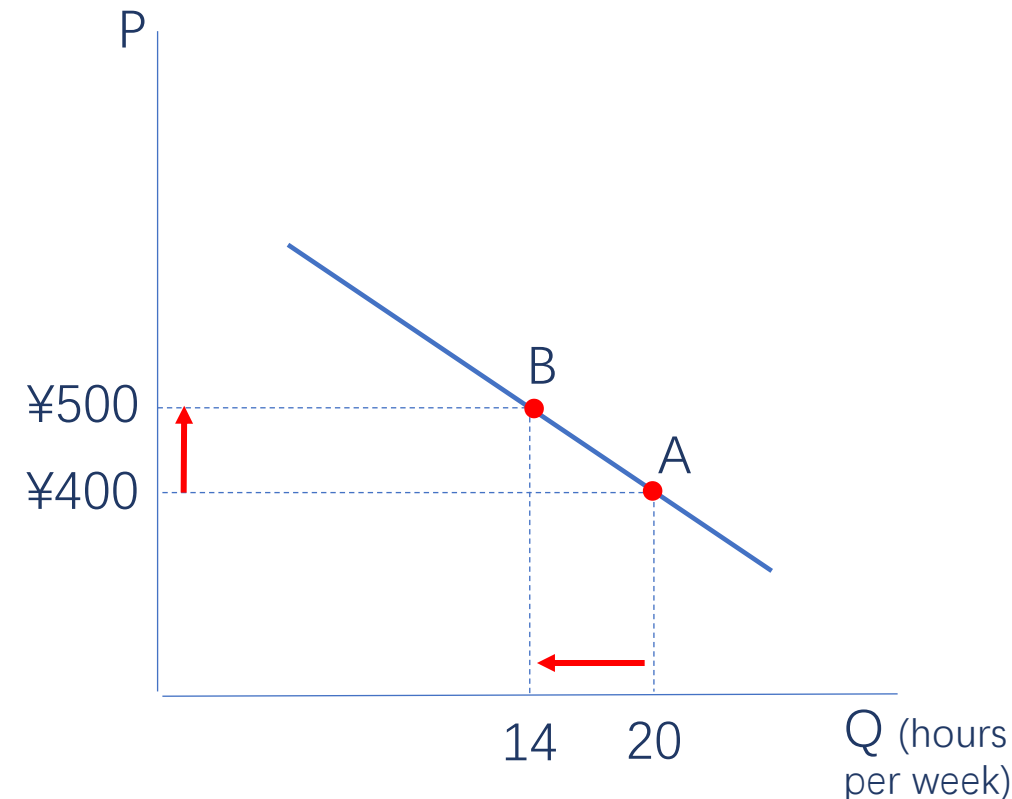
$\Delta P = P_{\text{final value}} - P_{\text{initial value}}$

$P = P_{\text{initial value}}$

# Calculation of the percentage change

$$\begin{aligned}\% \Delta Q &= (Q_{\text{final value}} - Q_{\text{initial value}}) / Q_{\text{initial value}} * 100\% \\ &= (14 - 20) / 20 * 100\% = 30\%\end{aligned}$$

$$\begin{aligned}\% \Delta P &= (P_{\text{final value}} - P_{\text{initial value}}) / P_{\text{initial value}} * 100\% \\ &= (500 - 400) / 400 * 100\% = 25\%\end{aligned}$$





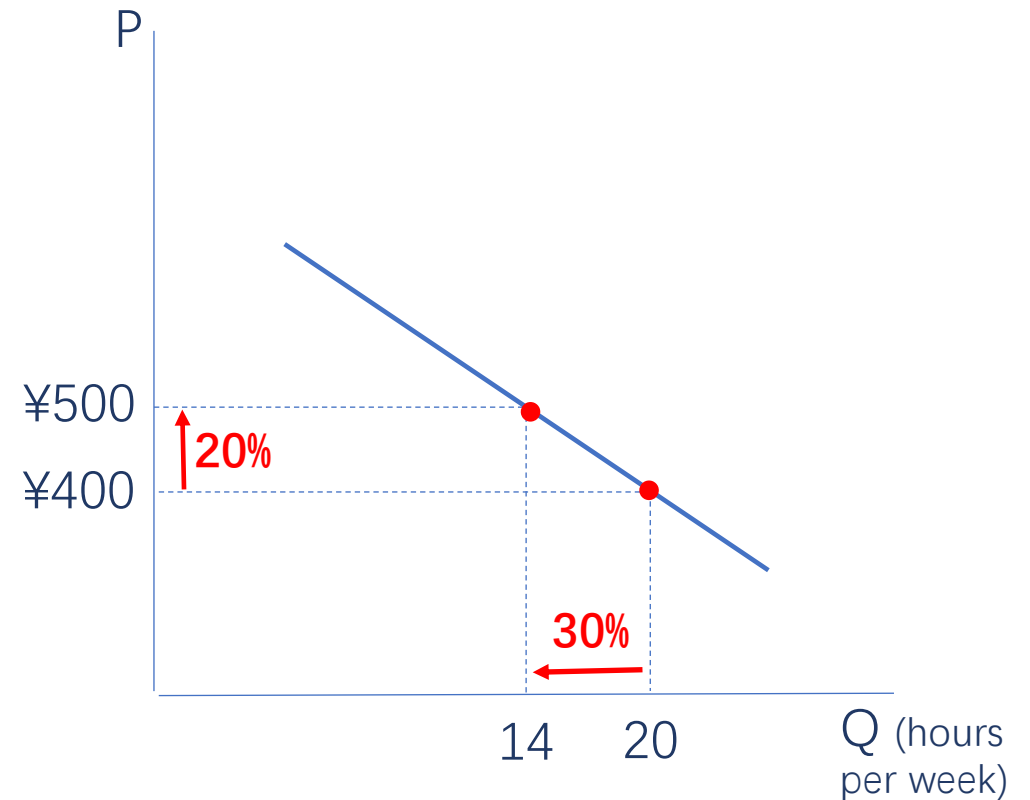
# Calculation of the PED

$$\text{Price elasticity of demand (PED)} = \frac{\% \Delta Q}{\% \Delta P}$$

As my hourly rate increased by 25%, the demand for my therapy service decreased by 30%

$$\text{PED} = 30\% / 25\% = 1.2$$

\* P & Q have negative causal relationships, thus the PED will be negative. For better comparison, we drop the minus sign and use absolute value for the PED.



# Calculation of PED

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- If we know the PED = 3, the % change in Q is 15%, we could calculate the % change in P

$$\text{PED} = 3 = 15\% / \% \Delta Q$$

$$\% \Delta Q = 15\% / 3 = 5\%$$

Similar calculation method for %  $\Delta P$ .

# Class exercise



The original price for beach house hotel on one Maldives' island was 200 dollar/room/per night  
demand=20 room/per night

The owner of the hotel launched a big discount to 150 dollar/room/night, the demand increase to 30 room/per night.

Calculate the PED.



# Excise answer

$$\begin{aligned}\% \Delta Q &= (Q_{\text{final value}} - Q_{\text{initial value}}) / Q_{\text{initial value}} * 100\% \\ &= (30 - 20) / 20 * 100\% = 50\%\end{aligned}$$

$$\begin{aligned}\% \Delta P &= (Q_{\text{final value}} - Q_{\text{initial value}}) / Q_{\text{initial value}} * 100\% \\ &= (150 - 200) / 200 * 100\% = 25\%\end{aligned}$$

$$\boxed{\text{Price elasticity of demand (PED)}} = \frac{\boxed{\% \Delta Q}}{\boxed{\% \Delta P}} = 50\% / 25\% = 2$$



# Price elasticity of demand (PED)

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- If quantity demanded is highly responsive to a change in price  
→ Price elastic
- If quantity demanded is not very responsive to a change in price  
→ Price inelastic

# The range of values for PED

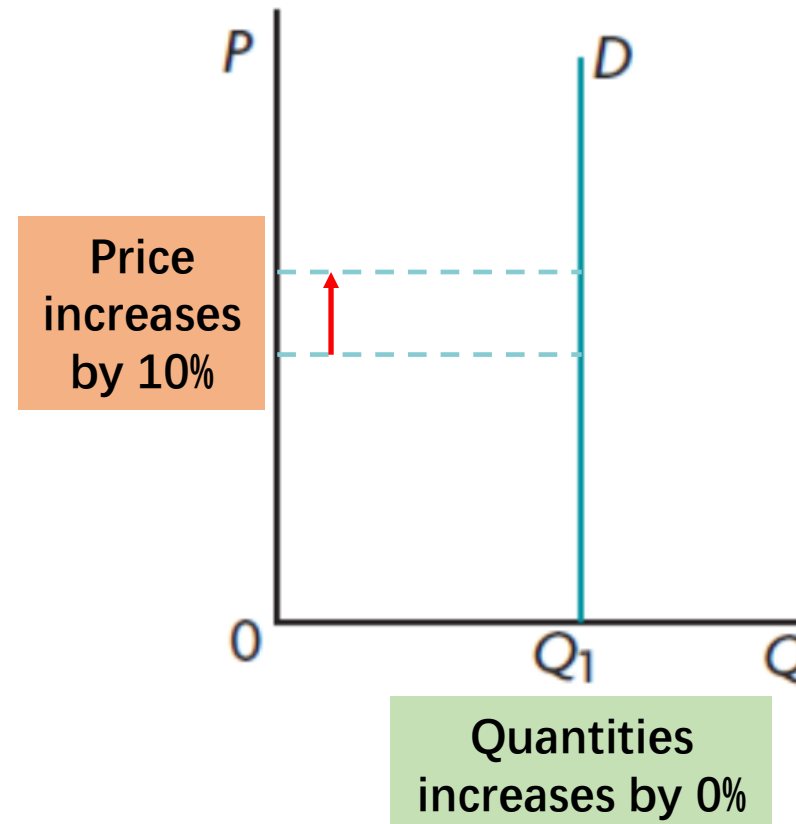
$$\text{Price elasticity of demand (PED)} = \frac{\% \Delta Q}{\% \Delta P} = \frac{0}{10\%} = 0$$

1. when  $PED = 0$ , Demand is **perfectly inelastic**

- Shape: Vertical
- Consumer' sensitivity to price: None
- Q always keep constant no matter what happens to price.

\*Special case

d Perfectly inelastic demand:  $PED = 0$



# The range of values for PED

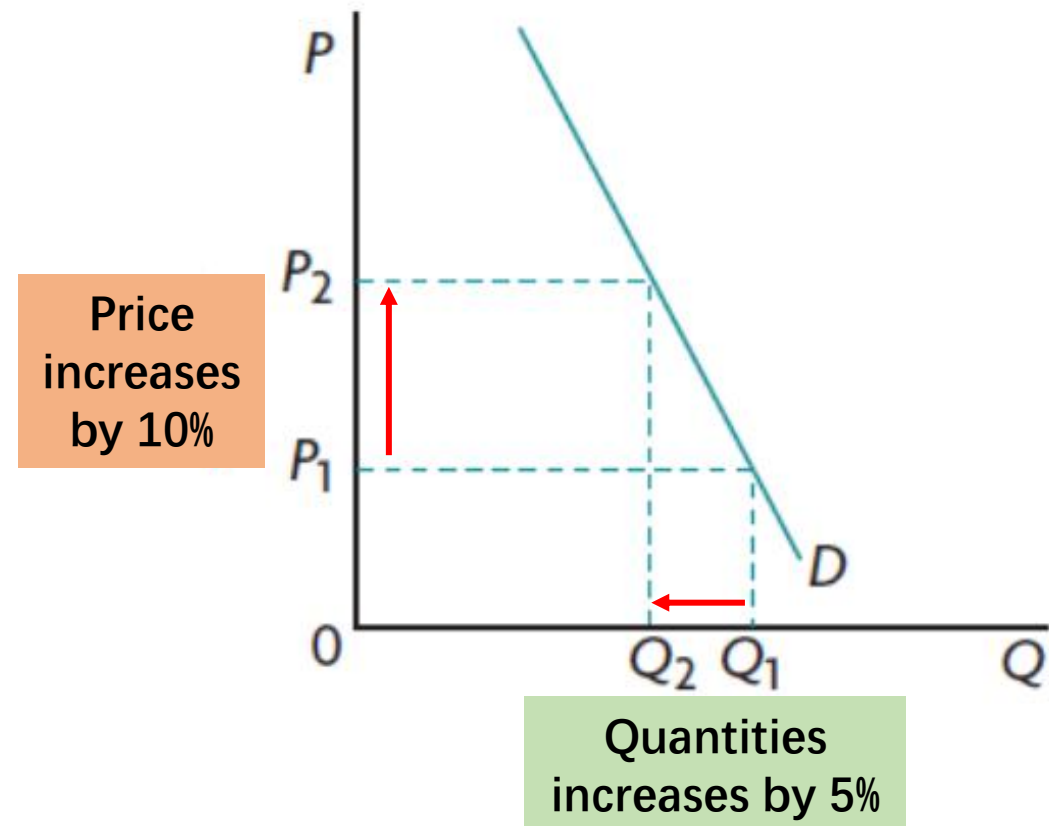
$$\text{Price elasticity of demand (PED)} = \frac{\% \Delta Q}{\% \Delta P} = \frac{5\%}{10\%} = 0.5$$

2. When  $0 < PED < 1$  : **Price inelastic**

The % change in quantity demanded is smaller than the % change in price.

- Shape: Relatively steep
- Consumer' sensitivity to price: relatively low
- Q is relatively unresponsive to  $\Delta$  in price.

a Price inelastic demand:  $0 < PED < 1$



# The range of values for PED

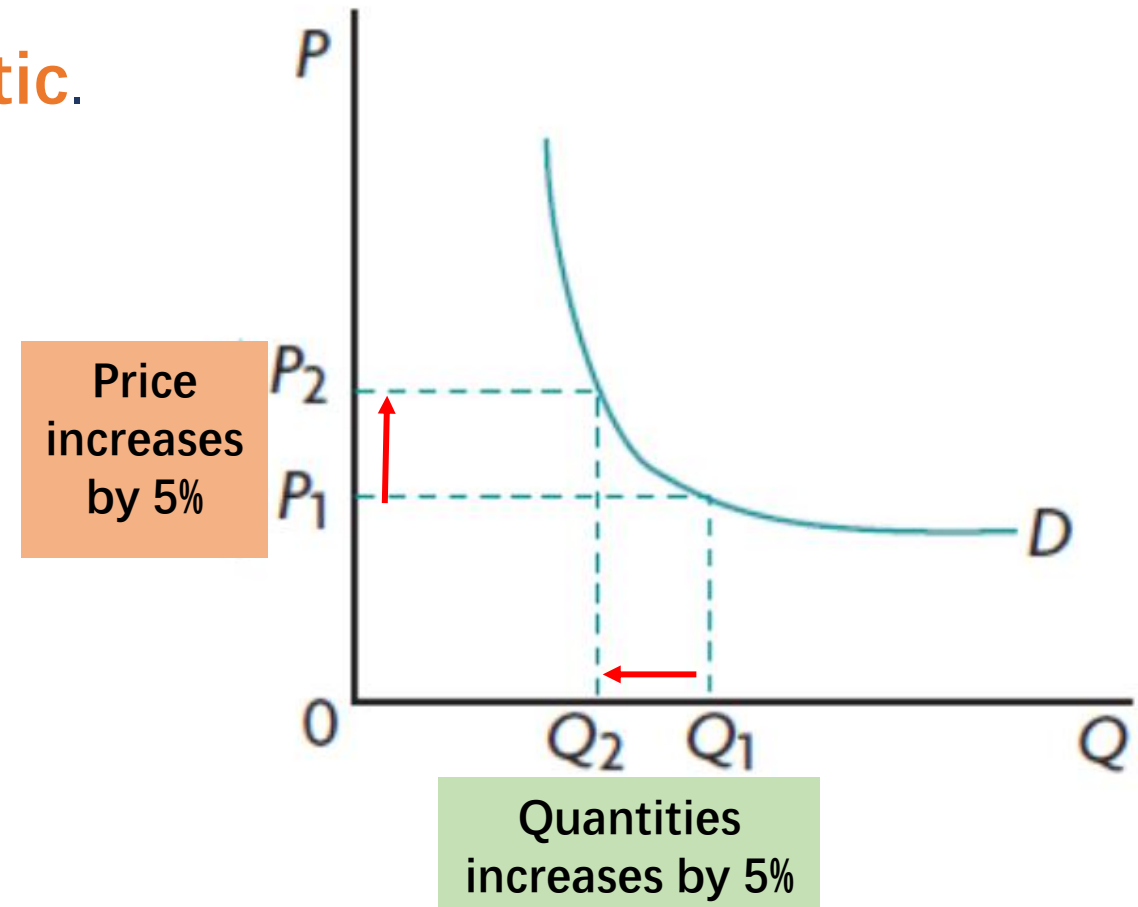
$$\text{Price elasticity of demand (PED)} = \frac{\% \Delta Q}{\% \Delta P} = \frac{5\%}{5\%} = 1$$

Unit elastic demand:  $PED = 1$

3. when  $PED = 1$  Demand is **unit elastic**.

- Shape: intermediate
- Consumer' sensitivity to price: intermediate
- unitary PED.

\*Special case





# The range of values for PED

$$\boxed{\text{Price elasticity of demand (PED)}} = \frac{\boxed{\% \Delta Q}}{\boxed{\% \Delta P}} = \frac{10\%}{5\%} = 2$$

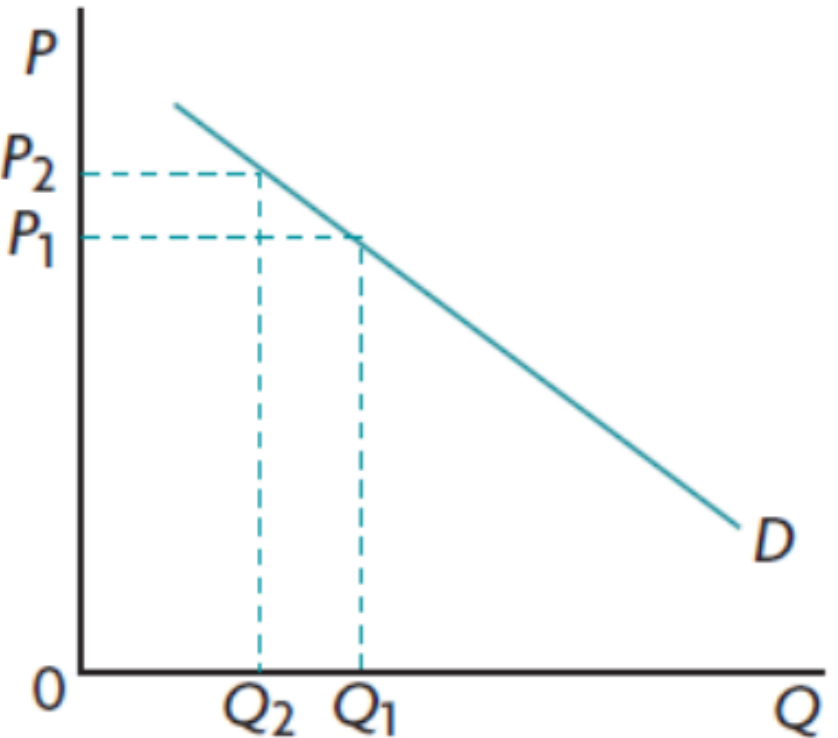
**b** Price elastic demand:  $1 < PED < \infty$

4. When  $1 < PED < \infty$ : **Price elastic**

The % change in quantity demanded is larger than the % change in price.

- Shape: Relatively flat
- Consumer' sensitivity to price: relatively high
- Q is relatively responsive to  $\Delta$  in price.

Price  
increases  
by 5%



Quantities  
increases by 10%

# The range of values for PED

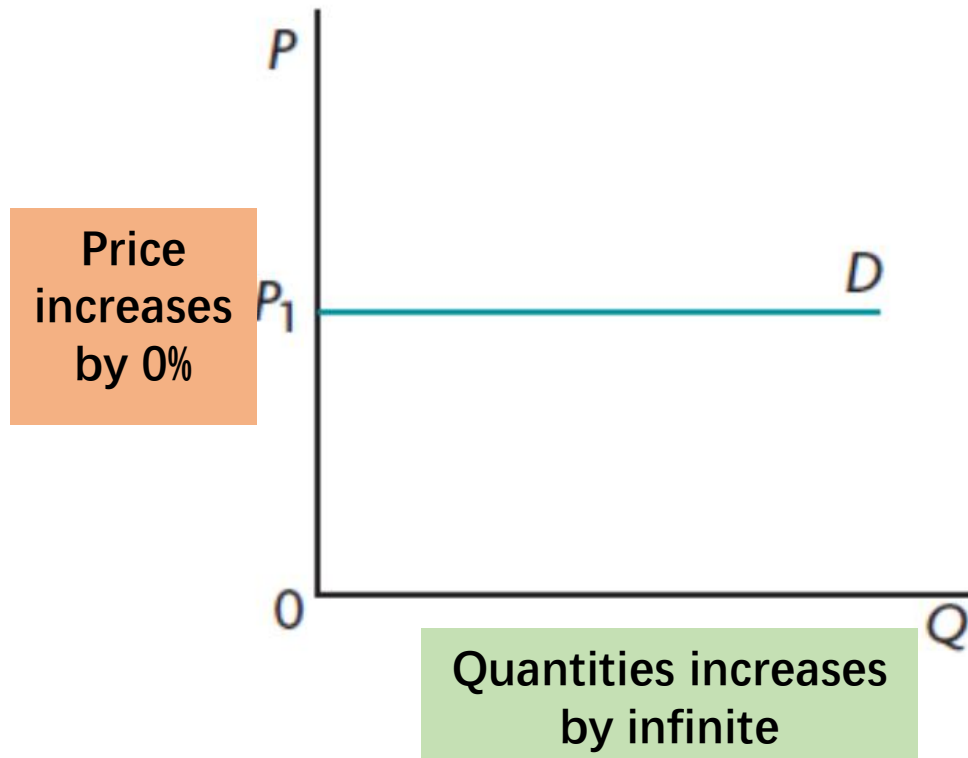
$$\text{Price elasticity of demand (PED)} = \frac{\% \Delta Q}{\% \Delta P} = \frac{\text{Any } \%}{0\%} = \text{infinity}$$

5. Demand is **perfectly elastic** when  $PED = \text{infinity}$

- Shape: horizontal
- Consumer's sensitivity to price: extremely high
- A change in price results in an infinitely large response in quantity demanded.

\*Special case

e Perfectly elastic demand:  $PED = \infty$



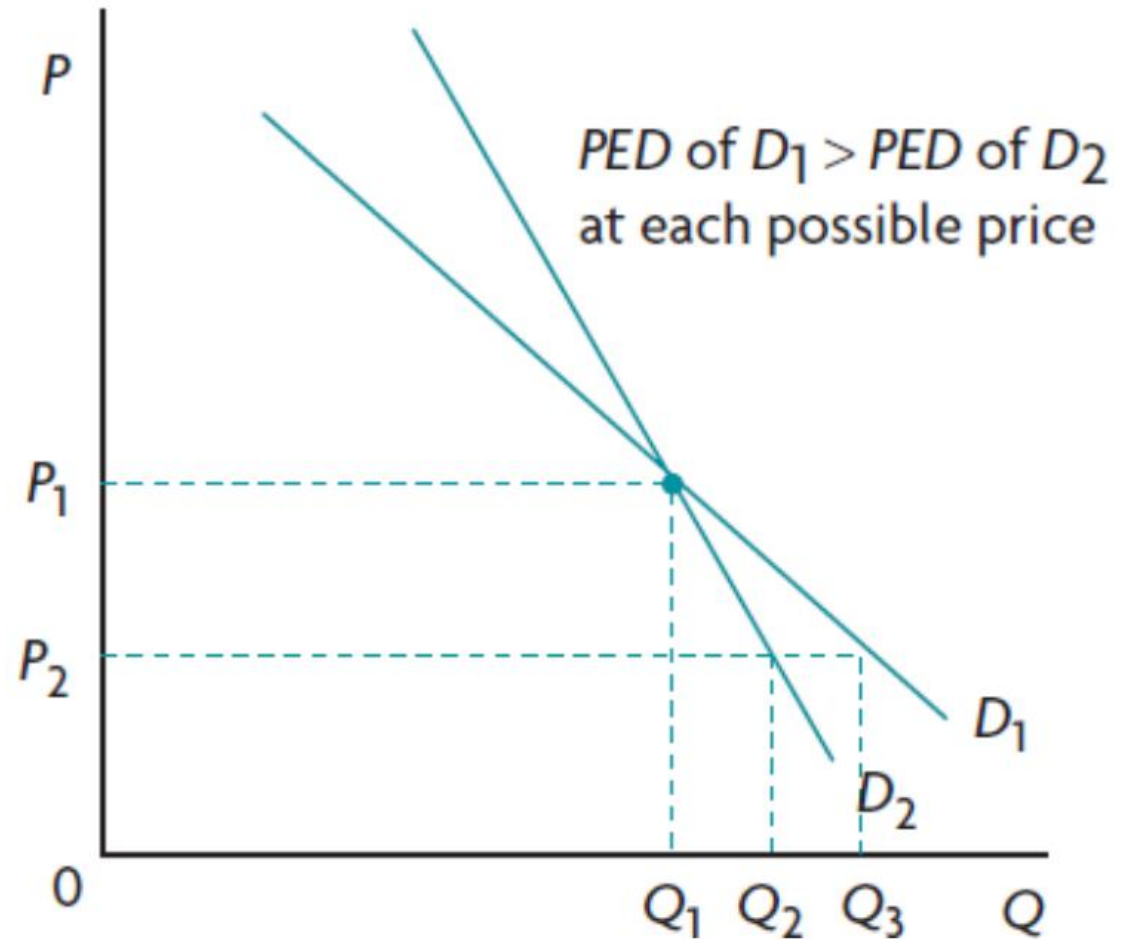
# Summary

Value of <i>PED</i>	Classification	Interpretation
<b>Frequently encountered cases</b>		
$0 < PED < 1$ (greater than zero and less than one)	price inelastic demand	quantity demanded is relatively unresponsive to price
$1 < PED < \infty$ (greater than 1 and less than infinity)	price elastic demand	quantity demanded is relatively responsive to price
<b>Special cases: constant PED along the length of the demand curve</b>		
$PED = 1$	unit elastic demand	percentage change in quantity demanded equals percentage change in price
$PED = 0$	perfectly inelastic demand	quantity demanded is completely unresponsive to price
$PED = \infty$	perfectly elastic demand	quantity demanded is infinitely responsive to price

# PED & the steepness of the demand curve

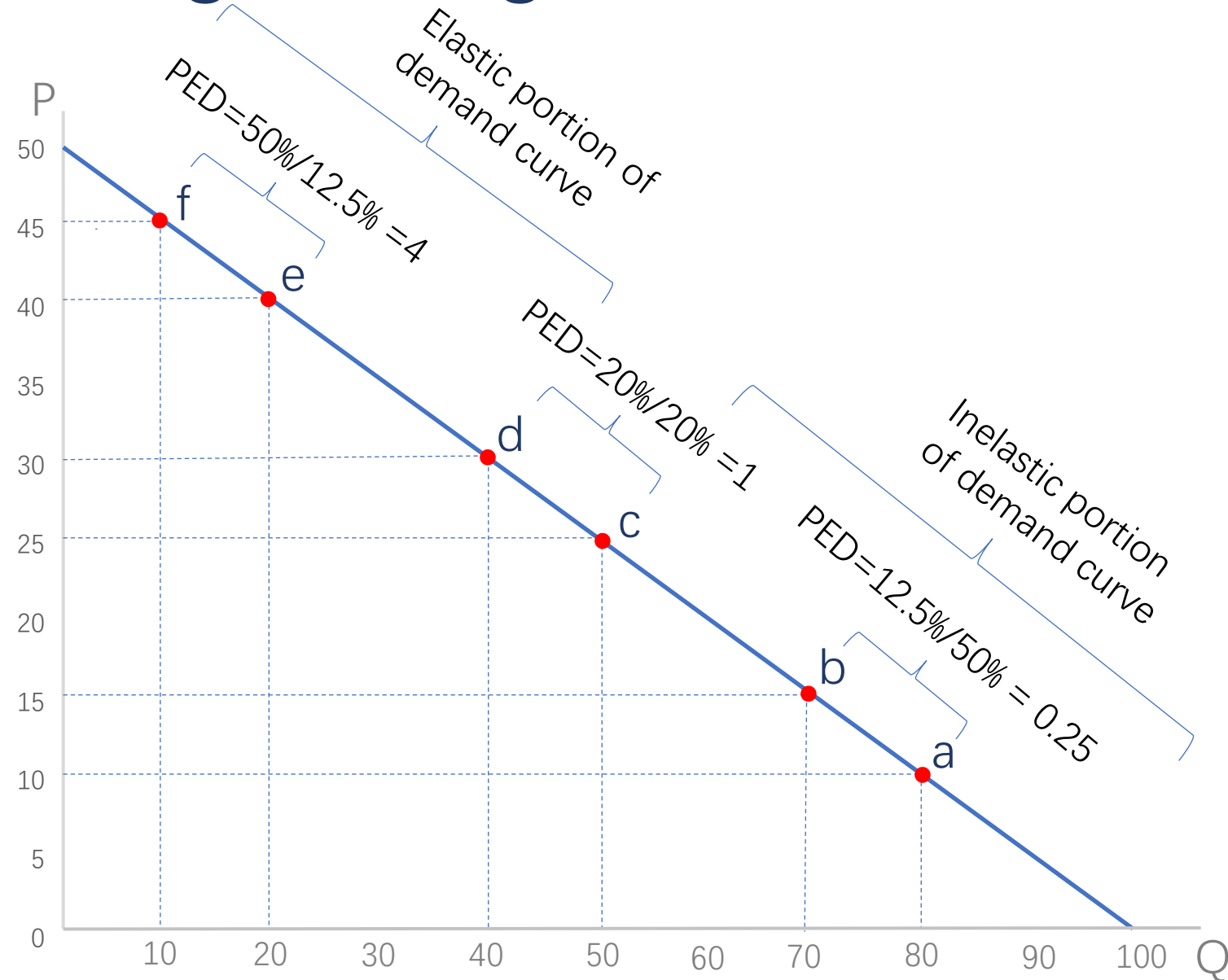
- When demand curves intersect at some point:
- The flatter the demand curve, the more elastic the demand (higher)
- The steeper the demand curve, the less elastic the demand.(lower)

Intersecting demand curves and PEDs



# Variability of PED along a straight-line demand

- Moving along a demand curve, the slope keeps constant while the PED varies.
- With low price and high quantity, demand is inelastic.
- With high price and low quantity, demand is elastic.



# Determinants of price elasticity of demand

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- The price of Milk tea increased by 20%
- The price of gasoline increased by 20%

Which product will lose more quantity of demand? Why?





# Determinants of price elasticity of demand

- Milk tea has numbers of substitutes, such as ice tea, coffee, soft drinks, etc. Buyers are more price sensitive, they can easily switch to other products

→ higher elasticity

- Gasoline have no substitute, so buyers have to buy despite of the price level

→ lower elasticity

## 1. Number of substitutes

The more substitutes a good or services has, the more elastic is its demand.



# Determinants of price elasticity of demand

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- The price of “Xi Cha” increased by 20%
- The price of iPhone increased by 20%
- Which product will lose more quantity of demand? Why?





# Determinants of price elasticity of demand

- “Xi Cha” has numbers of close substitutes, there are huge numbers of similar milk tea brands around providing similar taste of drinks. Buyers are more price sensitive, they can easily switch to other brands  
→ higher elasticity
- iPhone's has higher function and system uniqueness so buyers are less sensitive to the price increase  
→ lower elasticity.

## 2. Closeness of substitutes

The closer two substitutes are to each other, the greater the responsiveness of quantity demanded to a change in the price of the substitute, hence the greater the PED.



# Determinants of price elasticity of demand

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- The price of cherry increased by 20%
- The price of fruit increased by 20%

Which product will lose more quantity of demand? Why?





# Determinants of price elasticity of demand

- Cherry is a relatively narrow definition, when the price of cherry increase, consumer can easily switch to buy other types of fruit.  
→ higher elasticity
- Fruit is a broader definition with less alternative opportunities  
→ lower elasticity.



## 3. The definition extent of the goods

Whether the good is defined broadly or narrowly.

# Determinants of price elasticity of demand

- The price of targeted medicine for cancer increased by 20%
- The price of beach house increased by 20%
- Which product will lose more quantity of demand? Why?



# Determinants of price elasticity of demand

- Targeted medicine are necessities for the cancer patient, they will be less price sensitive  
→ lower elasticity.
- Beach house is a luxury consumption which is not essential.  
→ higher elasticity

## 4. Necessities versus luxuries

The demand for necessities is less elastic than the demand for luxuries.





# Determinants of price elasticity of demand

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- The price of gasoline increased by 20%
  - In 6 months – short run
  - In 5 years – long run
- What is the effect to quantity of gasoline demand in short run and long run? Why?

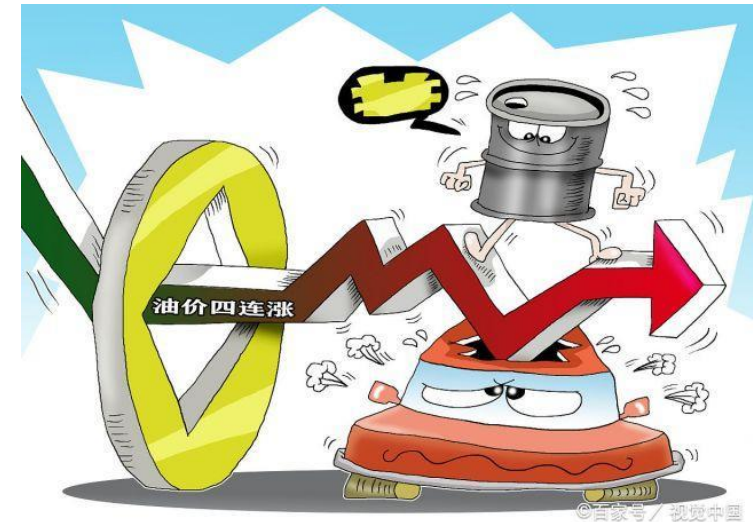
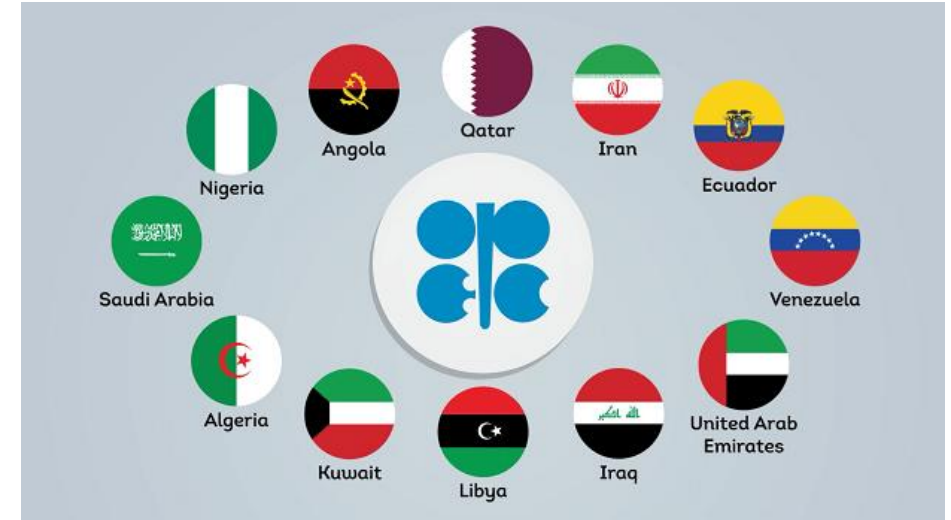


# Determinants of price elasticity of demand

- In short period, consumers are unable to change their demand for gasoline, so the demand will be less elastic.
- In long period, consumers will try to reduce their cost by purchasing lower fuel consumption car or electrical car. So the demand will be elastic in long run.

## 5. Length of time

The longer the time period in which a consumer makes a purchasing decision, the more elastic the demand.



# Determinants of price elasticity of demand

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- The price of metro ticket increased by 20%
- The price of car increased by 20%

Which product will lose more quantity of demand? Why?





# Determinants of price elasticity of demand

- Metro ticket only takes up a small proportion of one's income, consumer will be less sensitive to the price increase.  
→ price relatively inelastic demand
- Car takes up a big proportion of one's income, consumer will be more sensitive to the price change.  
→ price relatively elastic demand

## 6. Proportion of income spent on a good

The larger the proportion of one's income needed to buy a good, the more elastic the demand.



# Total Revenue(TR) and PED

**Total revenue** is the amount of money received by firms when they sell a good (or service), and is equal to the price (P) of the good times the quantity(Q) of the good sold.

$$TR = P * Q$$

As a therapist, when I raise my hour rate from 400 to 500 RMB,

- Higher P means I will earn more for each unit of hour.
- But according to the law of demand, I will sell less (Q)

So which factor will have bigger influence on my revenue, it will depends on my PED...

# When demand is elastic ( $PED > 1$ )

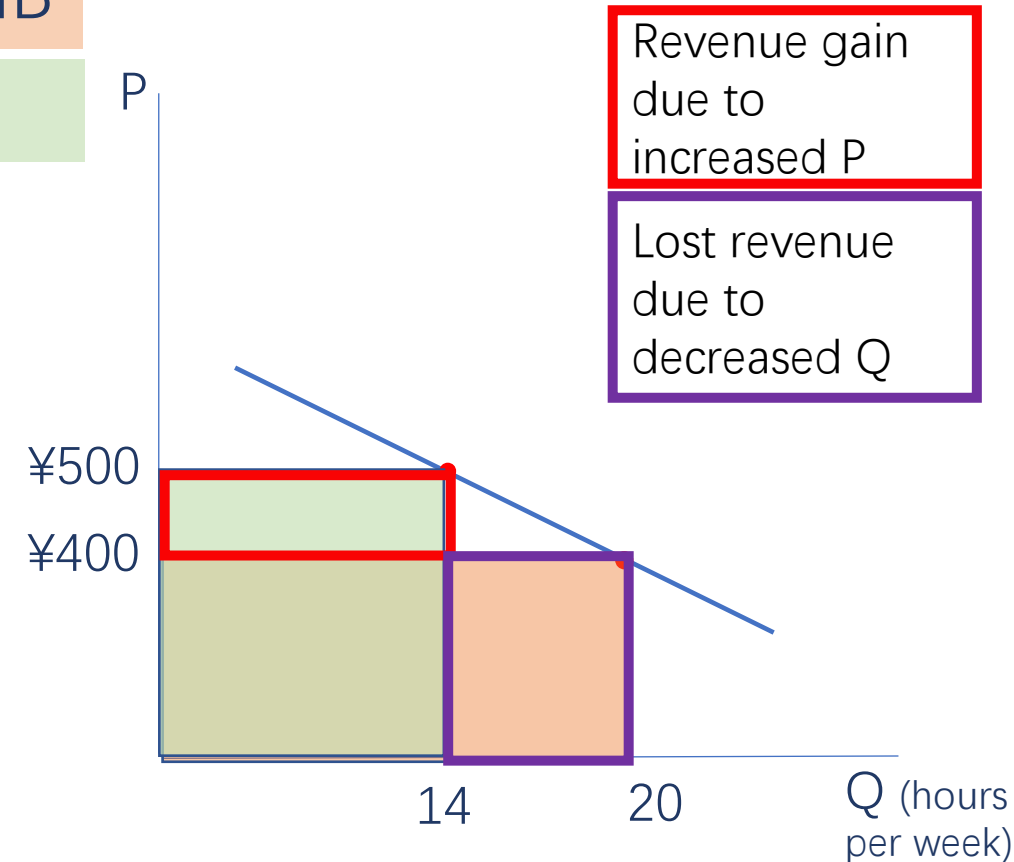
If I raised my hourly rate from 400 to 500 RMB, my clients decreased from 20 to 14, my  $PED = 30\% / 25\% = 1.2$

My original TR =  $P \cdot Q = 400 \cdot 20 = 8,000$  RMB

My new TR =  $P \cdot Q = 500 \cdot 14 = 7,000$  RMB



- **P increase**  $\rightarrow$  larger decrease in Q  
Effect to TR:  $P < Q \rightarrow$  **TR falls**
- **P decrease**  $\rightarrow$  larger increase in Q  
Effect to TR:  $P < Q \rightarrow$  **TR rises**



# When demand is elastic ( $PED > 1$ )

If I raised my hourly rate from 400 to 500 RMB, my clients decreased from 20 to 14, my  $PED = 30\% / 25\% = 1.2$

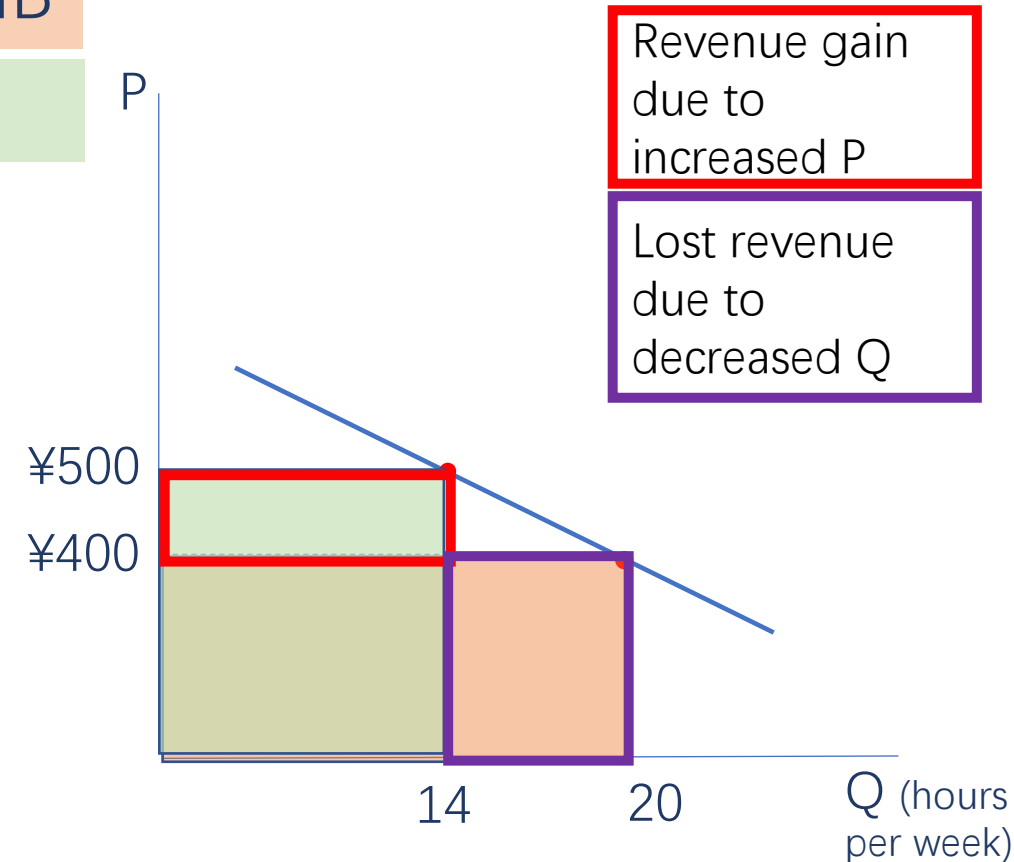
My original TR =  $P \cdot Q = 400 \cdot 20 = 8,000$  RMB

My new TR =  $P \cdot Q = 500 \cdot 14 = 7,000$  RMB



When demand is elastic,  $\% \Delta Q > \% \Delta P$  :

- an increase in price causes a fall in total revenue
- a decrease in price causes a rise in total revenue.



# When demand is inelastic ( $0 < PED < 1$ )

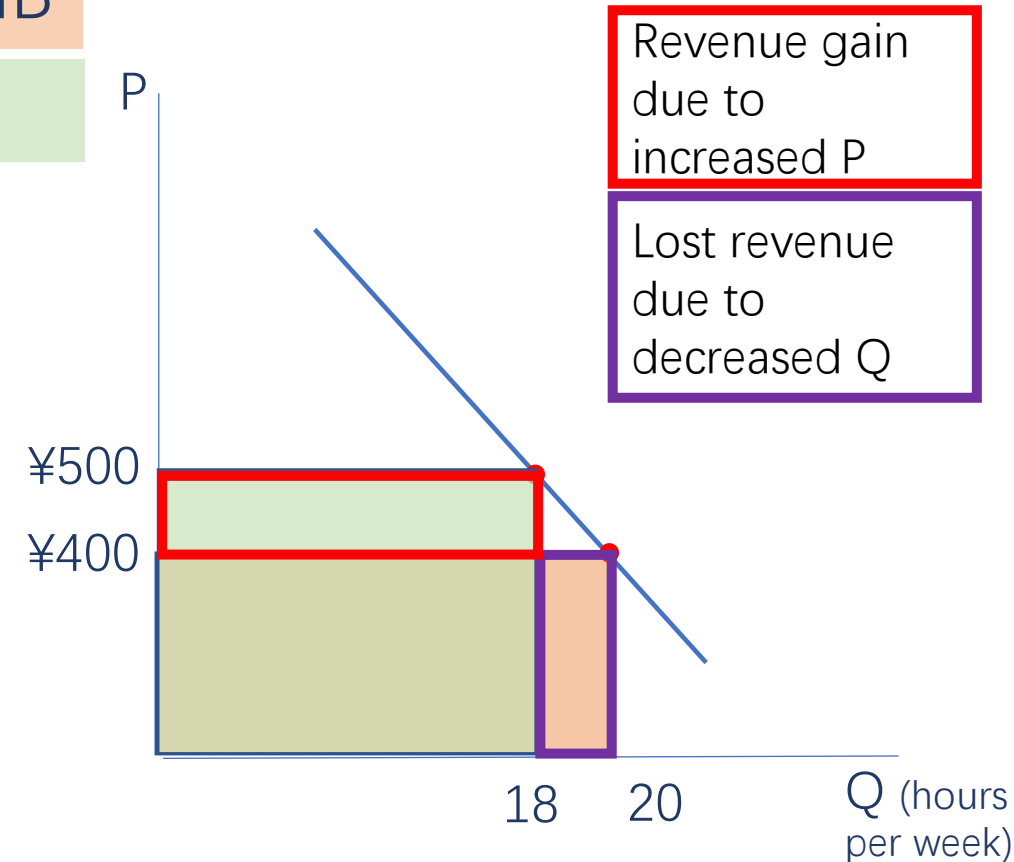
If I raised my hourly rate from 400 to 500 RMB, my clients decreased from 20 to 18, my  $PED = 10\% / 25\% = 0.4$

My original  $TR = P \cdot Q = 400 \cdot 20 = 8,000$  RMB

My new  $TR = P \cdot Q = 500 \cdot 18 = 9,000$  RMB



- P increase  $\rightarrow$  smaller decrease in Q  
Effect to TR:  $P > Q \rightarrow TR$  rises
- P decrease  $\rightarrow$  smaller increase in Q  
Effect to TR:  $P > Q \rightarrow TR$  falls



# When demand is inelastic ( $0 < PED < 1$ )

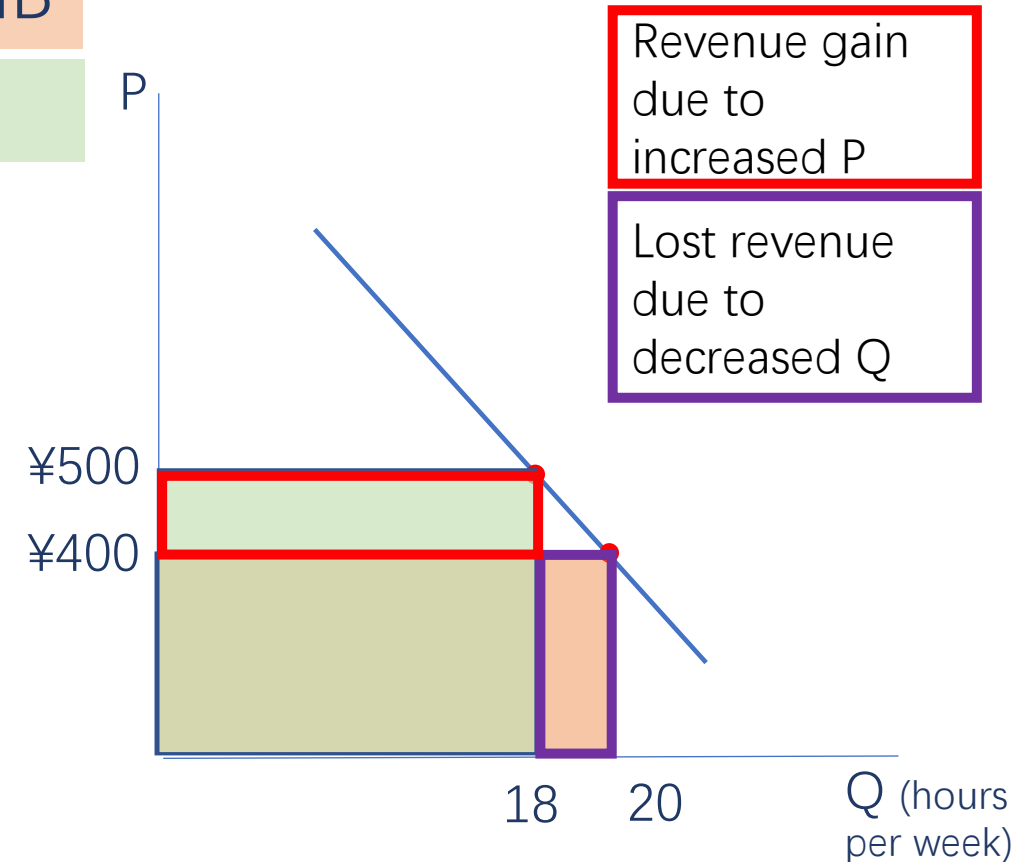
If I raised my hourly rate from 400 to 500 RMB, my clients decreased from 20 to 18, my  $PED = 10\% / 25\% = 0.4$

My original  $TR = P \cdot Q = 400 \cdot 20 = 8,000$  RMB

My new  $TR = P \cdot Q = 500 \cdot 18 = 9,000$  RMB



When demand is inelastic,  $\% \Delta Q < \% \Delta P$  :  
an increase in price causes a rise in total revenue  
a decrease in price causes a fall in total revenue.

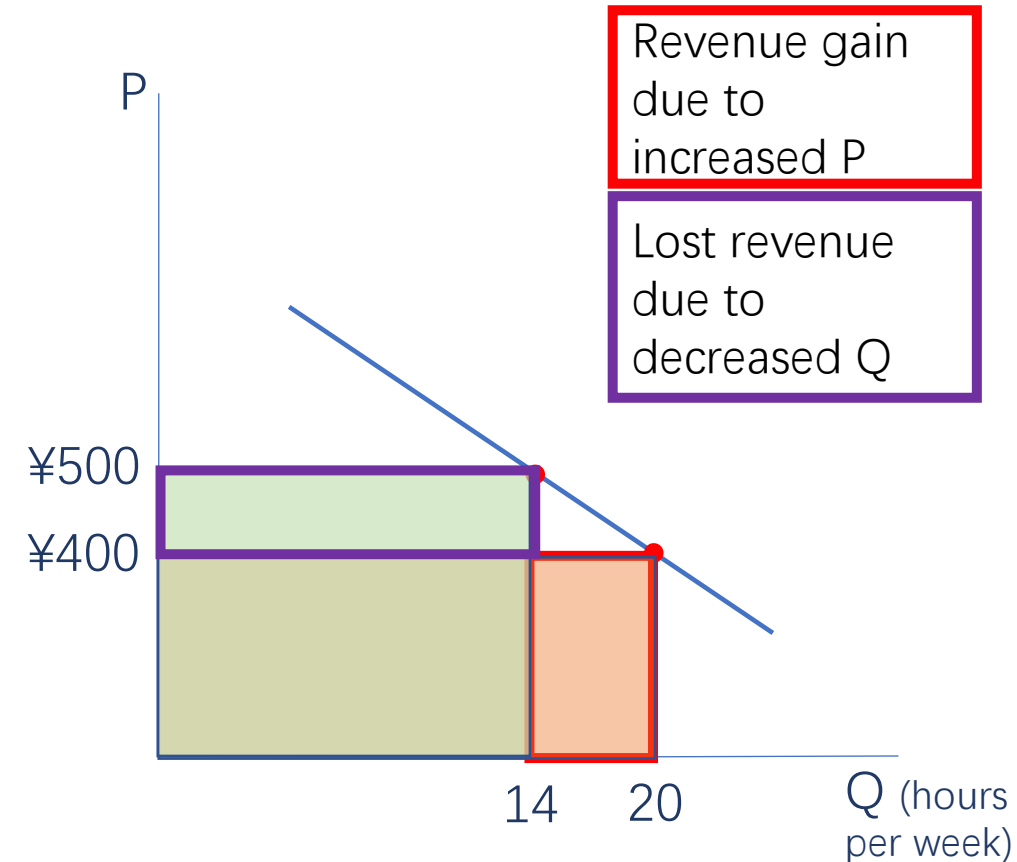


# When demand is unit elastic (PED = 1)

If I raised my hourly rate from 400 to 500 RMB, my clients decreased from 20 to 15, my PED = 25% / 25% = 1



- P increase → same proportional decrease in Q  
Effect to TR:  $P = Q \rightarrow$  TR keeps the same
- P decrease → same proportional decrease in Q  
Effect to TR:  $P = Q \rightarrow$  TR keeps the same

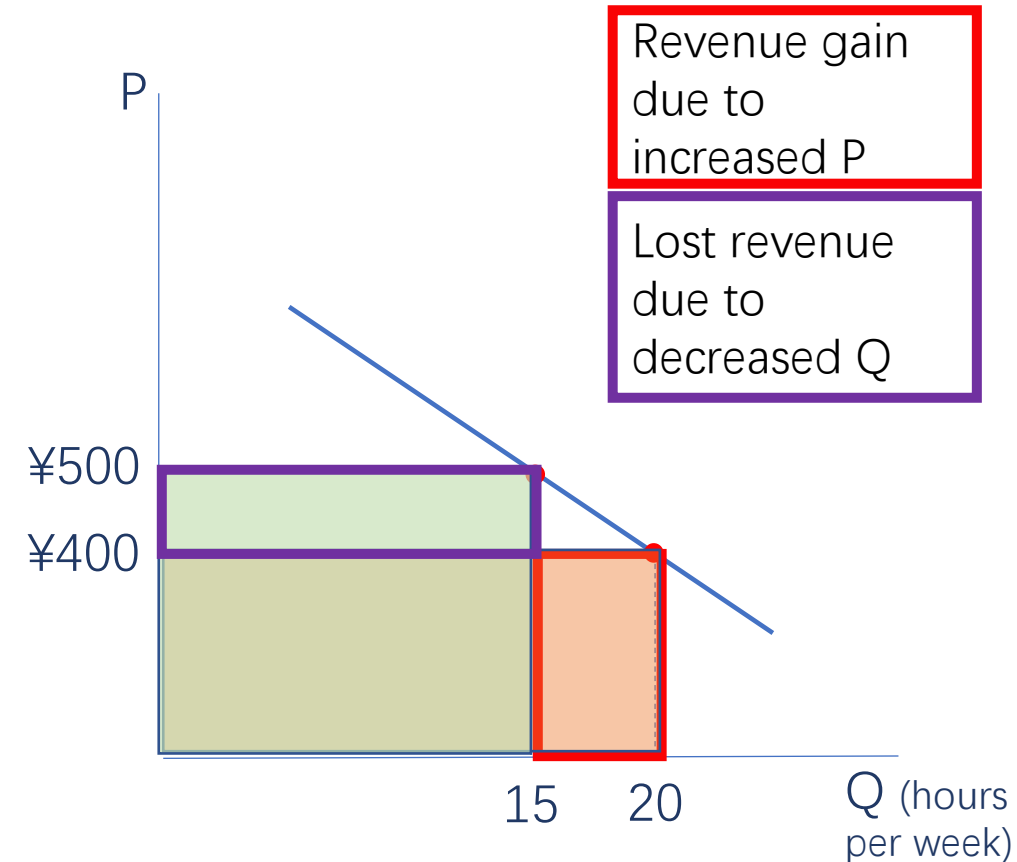


# When demand is unit elastic (PED = 1)

If I raised my hourly rate from 400 to 500 RMB, my clients decreased from 20 to 15, my PED = 20% / 20% = 1



In unit elastic demand,  $\% \Delta Q = \% \Delta P$  :  
The gain of TR = The loss of TR  
Total revenue keeps constant





# PED and firm pricing decisions (AO3)

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When firm is making the pricing decision:

- If their product demand is elastic → lower the price
  - E.g: FMCG(fast moving consumer goods)
- If their product demand is inelastic → increase the price
  - E.g.: drugs, patented product, etc.
- If their product demand is unit elastic → unable to change their TR.

# PED and indirect taxes (AO3)

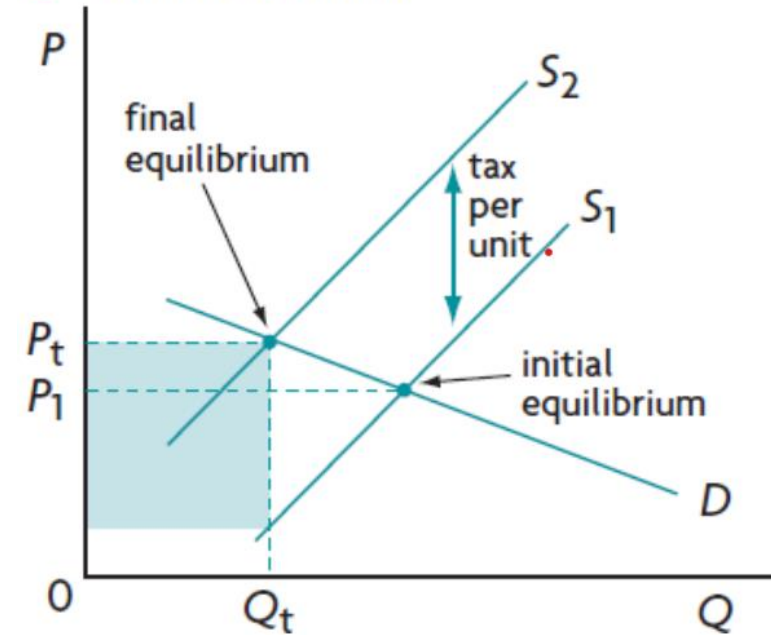
- If you are a government policy advisor, for the purpose of increasing tax revenue, which kind of product/services would you suggest to impose higher indirect taxes? (VAT, tariff, consumption tax)
- Before we decide, we shall consider the effect of PED...



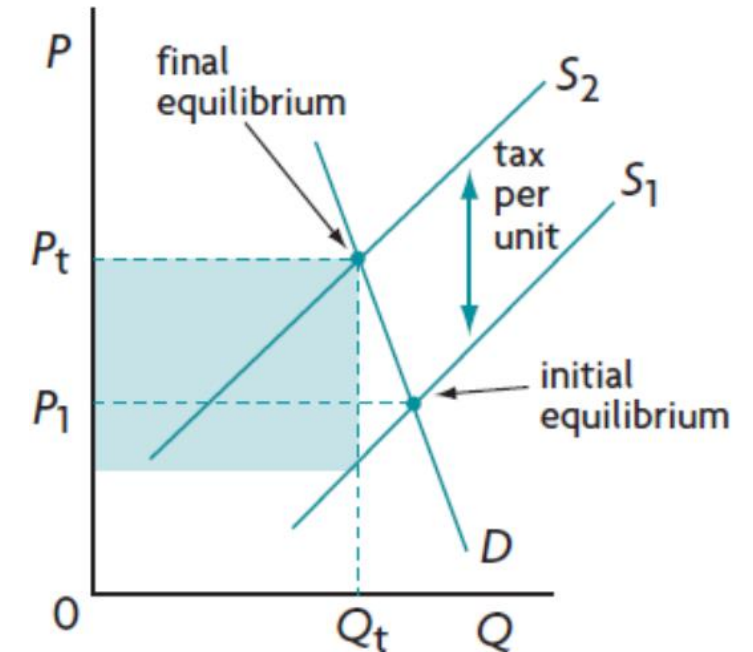
# Diagram Illustration

- Tax shift the S curve upwards(leftwards) with the vertical distance between  $S_1$  and  $S_2$  equals to the tax per unit of output.
- New equilibrium with  $P_t$  and  $Q_t$ .
- Government's tax revenue = tax per unit \*  $Q_t$ . (blue shadow area)
- Consumers pay for the amount above  $P_1$ .
- Firms pay for the amount below  $P_1$ .

b Elastic demand



a Inelastic demand

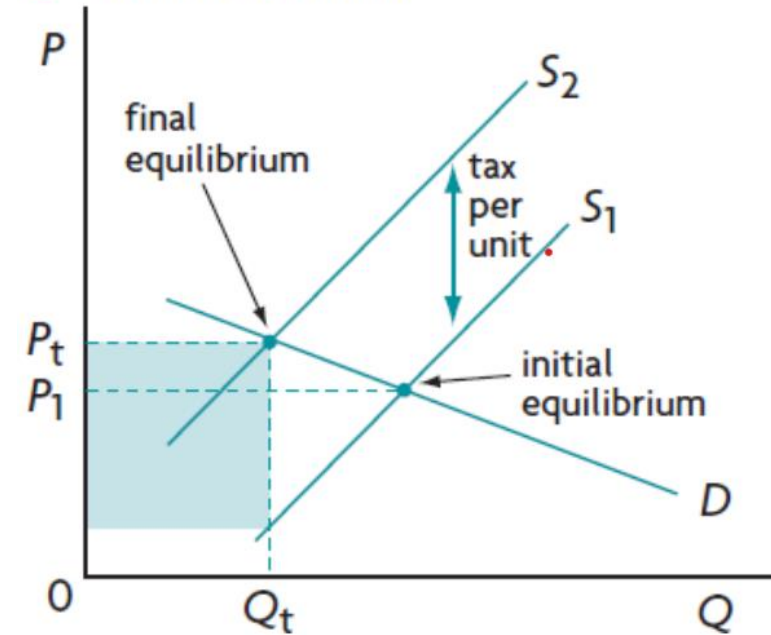


# PED and indirect taxes

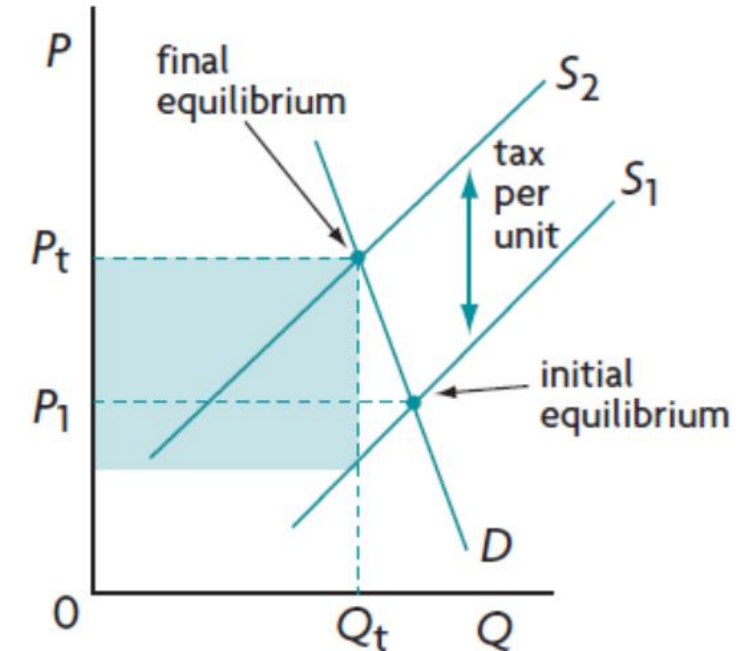
- In order to receive higher tax revenue, we need to choose the company with higher total revenue. It is the tax base.
- Tax adds up cost to the product, thus it will increase the price. To maximize the TR, (with smaller decrease in  $Q$ ) we need to **choose the product with inelastic demand**.
- The lower the price elasticity of demand for the taxed good, the greater the government tax revenues.

\* We decide to impose indirect tax on those products with lower PED, such as cigarettes, alcohol, etc.

b Elastic demand



a Inelastic demand



# Primary commodities

## V.s. Manufactured products

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**Primary commodities** are goods arising directly from the use of natural resources (factor of production “land”)

- Agricultural products (food, cotton, rubber, etc.)
- fishing and forestry products
- Extractive industries products (oil, coal, minerals, etc.)

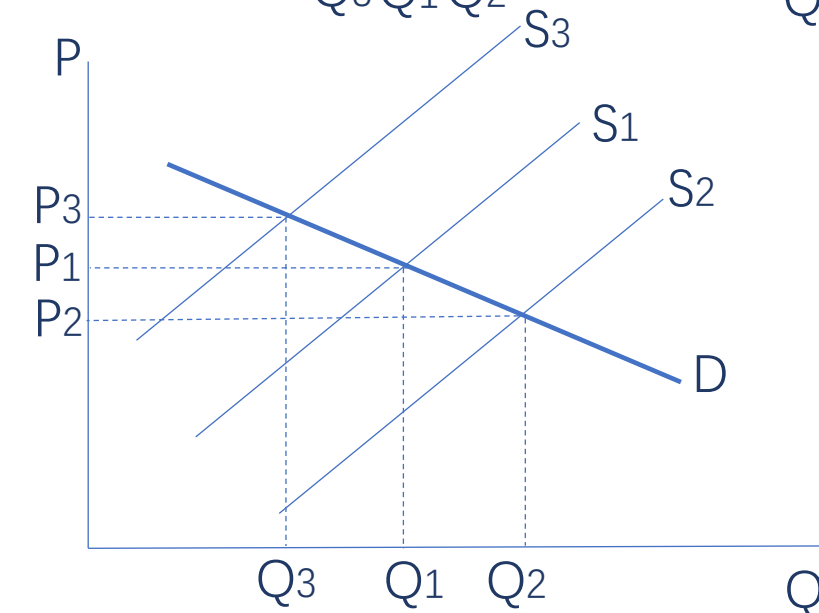
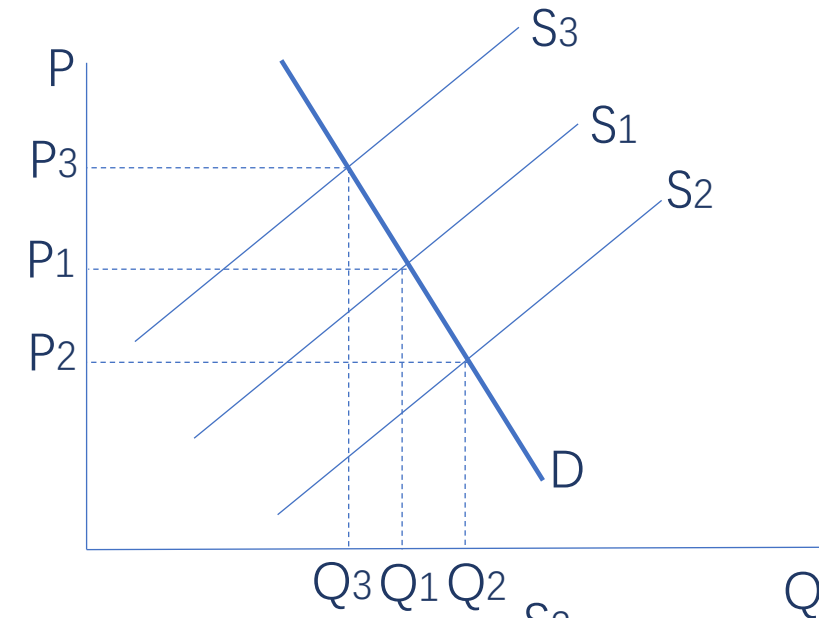
Relatively  
low PED  
Necessity  
Less substitutes

**Manufactured products** are goods produced by labour usually working together with capital as well as raw materials. E.g. TV, computer, cell phone, etc.

Relatively  
high PED  
more substitutes.

# Compare these two types of product

	Commodity goods	Manufactured goods
<b>Nature</b>	Production uncertainty	Production certainty
<b>PED</b>	Inelastic demand	Elastic demand
<b>When supply shift leftwards</b>	<ul style="list-style-type: none"> <li>• <math>\% \Delta \text{ of } Q &lt; \% \Delta \text{ of } P</math></li> <li>• Large price increase</li> <li>• TR(producer's income) increase</li> </ul>	<ul style="list-style-type: none"> <li>• <math>\% \Delta \text{ of } Q &gt; \% \Delta \text{ of } P</math></li> <li>• Small price increase</li> <li>• TR(producer's income) decrease</li> </ul>
<b>When supply shift rightwards</b>	<ul style="list-style-type: none"> <li>• <math>\% \Delta \text{ of } Q &lt; \% \Delta \text{ of } P</math></li> <li>• Large price decrease</li> <li>• TR(producer's income) decrease</li> </ul>	<ul style="list-style-type: none"> <li>• <math>\% \Delta \text{ of } Q &gt; \% \Delta \text{ of } P</math></li> <li>• Small price decrease</li> <li>• TR(producer's income) increase</li> </ul>



# Dilemma for farmers

- Inelastic demand for their goods

In good harvest year, increased quantity will lead to relatively bigger price drop, and the total revenue(farmer's income) will decrease.

In bad harvest year, decreased quantity and bigger impact on price increase will ironically increase the total revenue.





# **Income elasticity of demand (YED)**



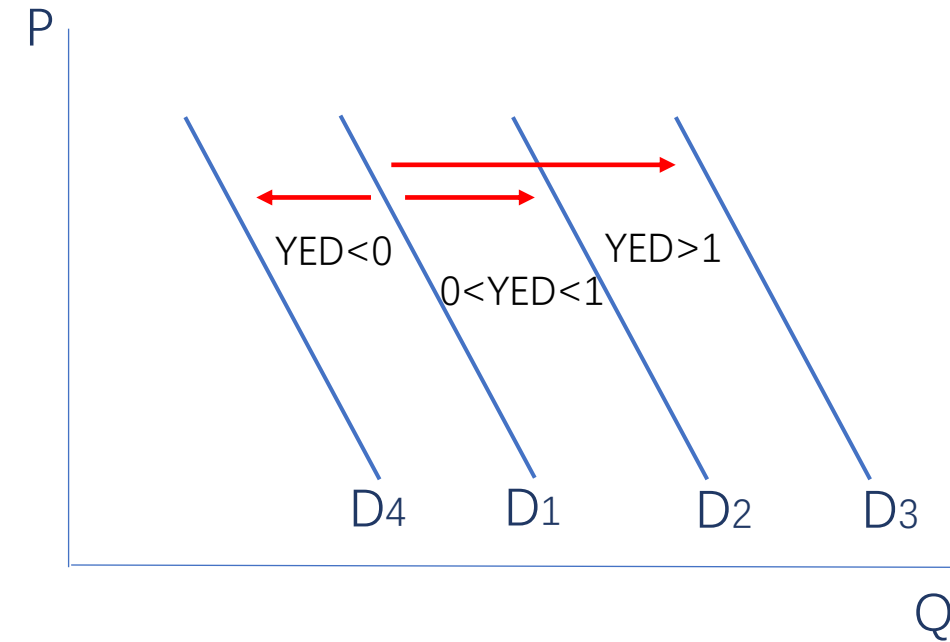
# Income elasticity of demand (YED)

**Income elasticity of demand** is a measure of the responsiveness of demand to changes in income, and involves demand curve shifts. It provides information on the direction of change of demand given a change in income and the size of the change.

$$\text{Income elasticity of demand (YED)} = \frac{\% \text{ change in quantity demanded of good x}}{\% \text{ change in income}} = \frac{\% \Delta Q}{\% \Delta Y}$$

# The Sign of YED

- YED can be positive or negative
- The sign of YED tells us whether a good is normal or inferior good.
- **When  $YED > 0$ : normal good.** An increase in income lead to increase in demand. Demand for the good and income change in the same direction.
  - ✓  $0 < YED < 1$  Necessities (Income inelastic demand)
  - ✓  $YED > 1$  Luxuries and services (Income elastic demand)
- **When  $YED < 0$ : inferior good.** Demand for the good and income move in opposite directions. (bus, second-hand goods, inferior goods in supermarket)



# Calculation of YED

As a popular psychological therapist, my weekly income increased from 8000 to 12000 RMB. My purchasing habit have the following changes.

- 1) my taxi travel increased from 5 times to 10 times.
- 2) My bus travel decreased from 25 times to 20 times.
- 3) My fruit expenditure increased from 28 to 30 units.

$$\begin{array}{l} \text{1) YED of taxi} = \frac{\% \text{ change of } Q}{\% \text{ change of income}} = \frac{(10-5)/5}{(12000-8000)/8000} = \frac{1}{0.5} = 2 \\ \text{Service (elastic)} \end{array}$$

$$\begin{array}{l} \text{2) YED of bus} = \frac{\% \text{ change of } Q}{\% \text{ change of income}} = \frac{(20-25)/25}{(12000-8000)/8000} = \frac{-0.2}{0.5} = -0.4 \\ \text{Inferior goods} \end{array}$$

$$\begin{array}{l} \text{3) YED of fruit} = \frac{\% \text{ change of } Q}{\% \text{ change of income}} = \frac{(30-28)/28}{(12000-8000)/8000} = \frac{0.07}{0.5} = 0.14 \\ \text{Necessities (inelastic)} \end{array}$$

# YED in real world application

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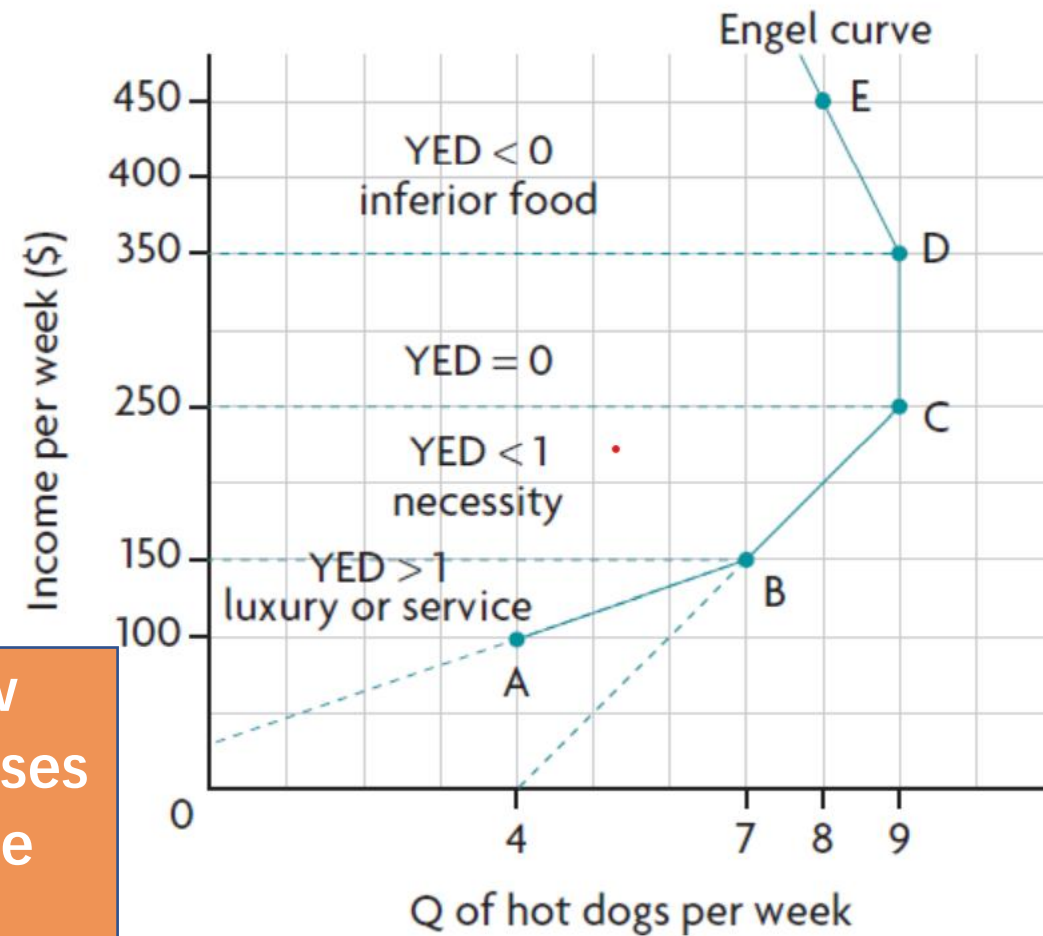
What is a necessity and what is a luxury depends on income levels.

- People in extremely poor country, even food and clothing are luxury goods.
  - Coffee and desert is necessity for western countries while it is luxury goods in poor countries.
  - Education is necessity in most countries, but it maybe luxuries for poor countries and those countries in war.
  - For super stars, maybe luxury brand goods are necessity because it is part of their daily appearance in TV.
- 
- As income increases, certain items that used to be luxuries become necessities.
    - YED of food in Developed countries: 0.15-0.2
    - YED of food in poor countries: 0.8

# The Engel curve (*by Ernst Engel*)

Study the relationship between one's weekly income and quantity demanded for hotdogs (normal good).

- Point A → B: When income rise from 100 to 150, hotdog increase from 4 to 7. ( $YED > 1$ , luxury or services)
- Point B → D: When income rise from 150 to 350, hotdog only increase 2 unit. ( $YED < 1$  or  $YED = 0$ , necessity)
- Point D → E, When income goes above 350, hotdog demand start to decrease. ( $YED < 0$  inferior food)



The Engel curve shows a continuum: at very low incomes a good maybe a luxury; as income increases it becomes a necessity and finally at high income levels it becomes inferior.

# YED and producers:

## The rate of expansion of industries (AO3)

If you are a investor with huge amount of money, which industry would you invest?

You can use the YED as a important indicator.

### At times of economic growth:

- **For goods/services**  $YED > 1$ , demands for them grows at a higher rate than average rate. (e.g. restaurants, movies, health care, travel, etc.)
  - Higher growing and expanding speed than the whole economy.
- **For goods/services**  $YED < 1$ , demand for these grows at a rate below average rate. (food, clothing, other necessities)
  - Lower growing and expanding speed than the whole economy.

# YED and producers:

## The rate of expansion of industries (AO3)

### At times of recession:

- For goods/services  $YED > 1$ , largest declines in sales.
- For goods/services  $YED < 1$ , smaller loss in sales.
- For goods/services  $YED < 0$ : Increase in sales.

# YED and the sectoral structure of the economy - -(AO3)

## Every economy has three sectors:

1. **The primary sector** (agriculture, forestry, fishing and extractive industries)
  - $YED < 1$ , income inelastic.
  - The demand for primary sector goods grow slower than the growth in income.
2. **The manufacturing sector** (computer, clothing, cars, etc.)
  - $YED > 1$ , income elastic.
  - As the society's income grows, the demand for manufacturing sector goods grows faster than income.
3. **The service sector** (entertainment, travel, banking, etc.)
  - $YED > 1$ , income elastic.
  - The fastest development of service sector in recent years.

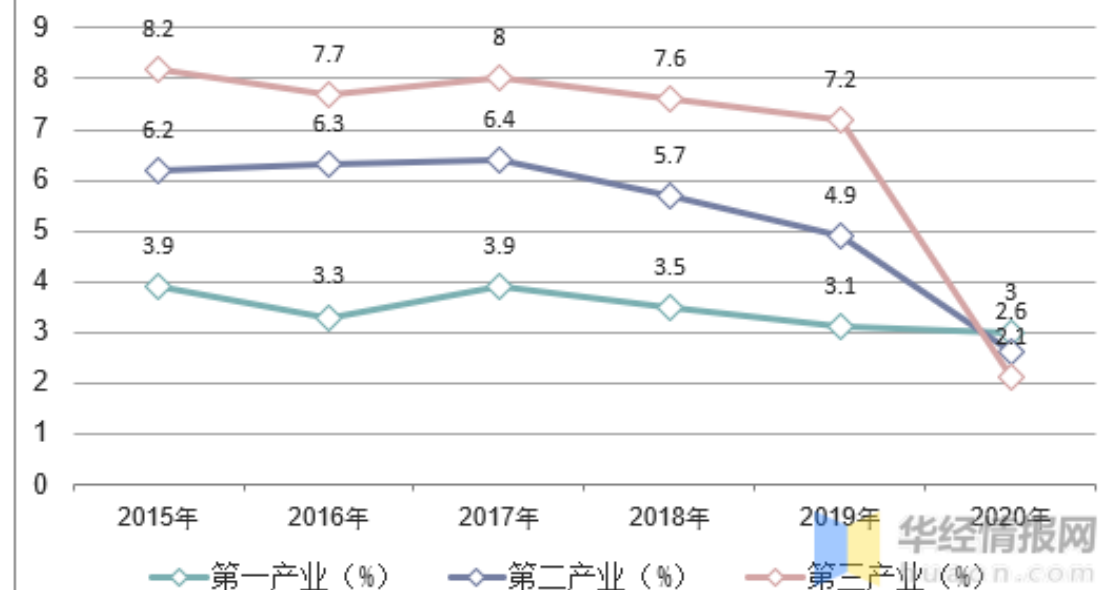


# Application In China

图1 2016-2020年国内生产总值及其增长速度

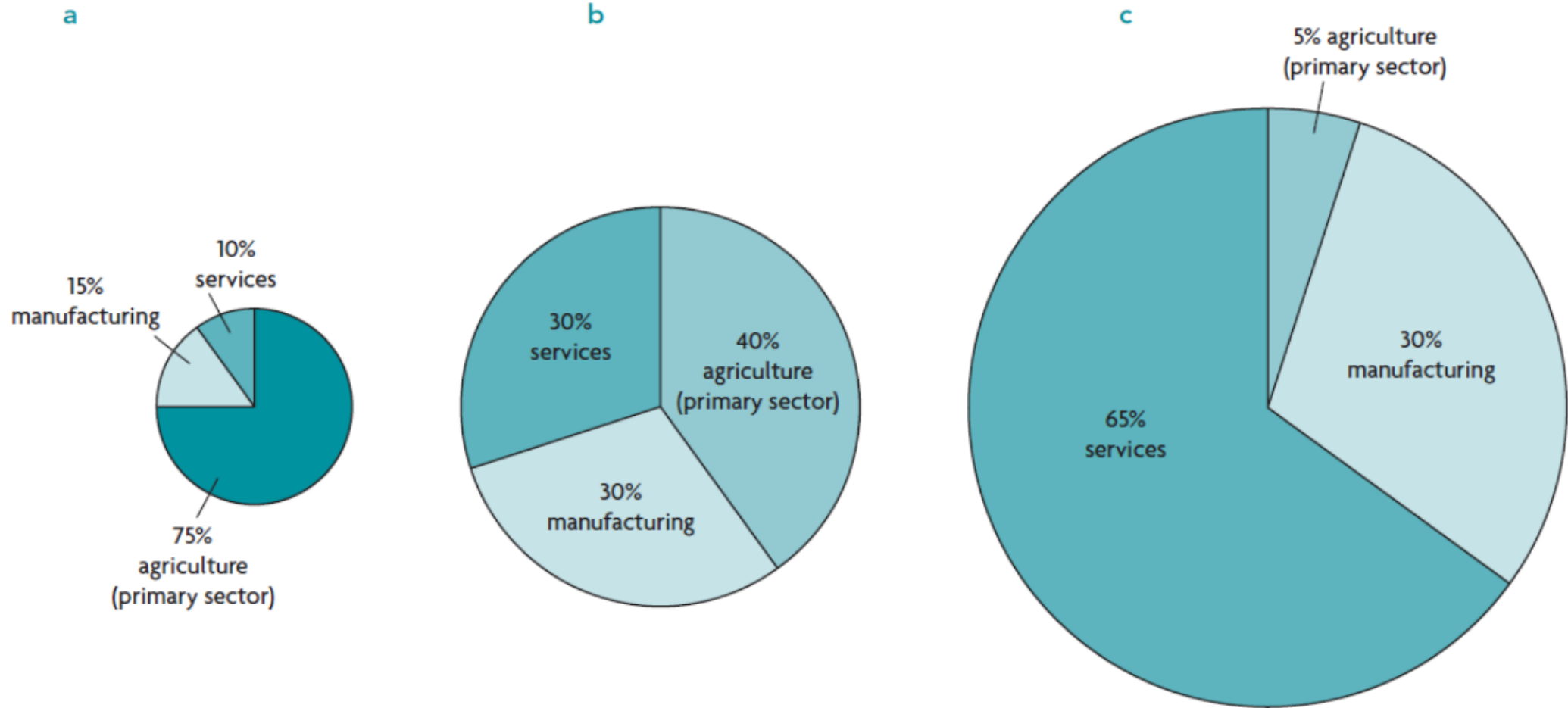


2015-2020年三大产业增加值增速统计图



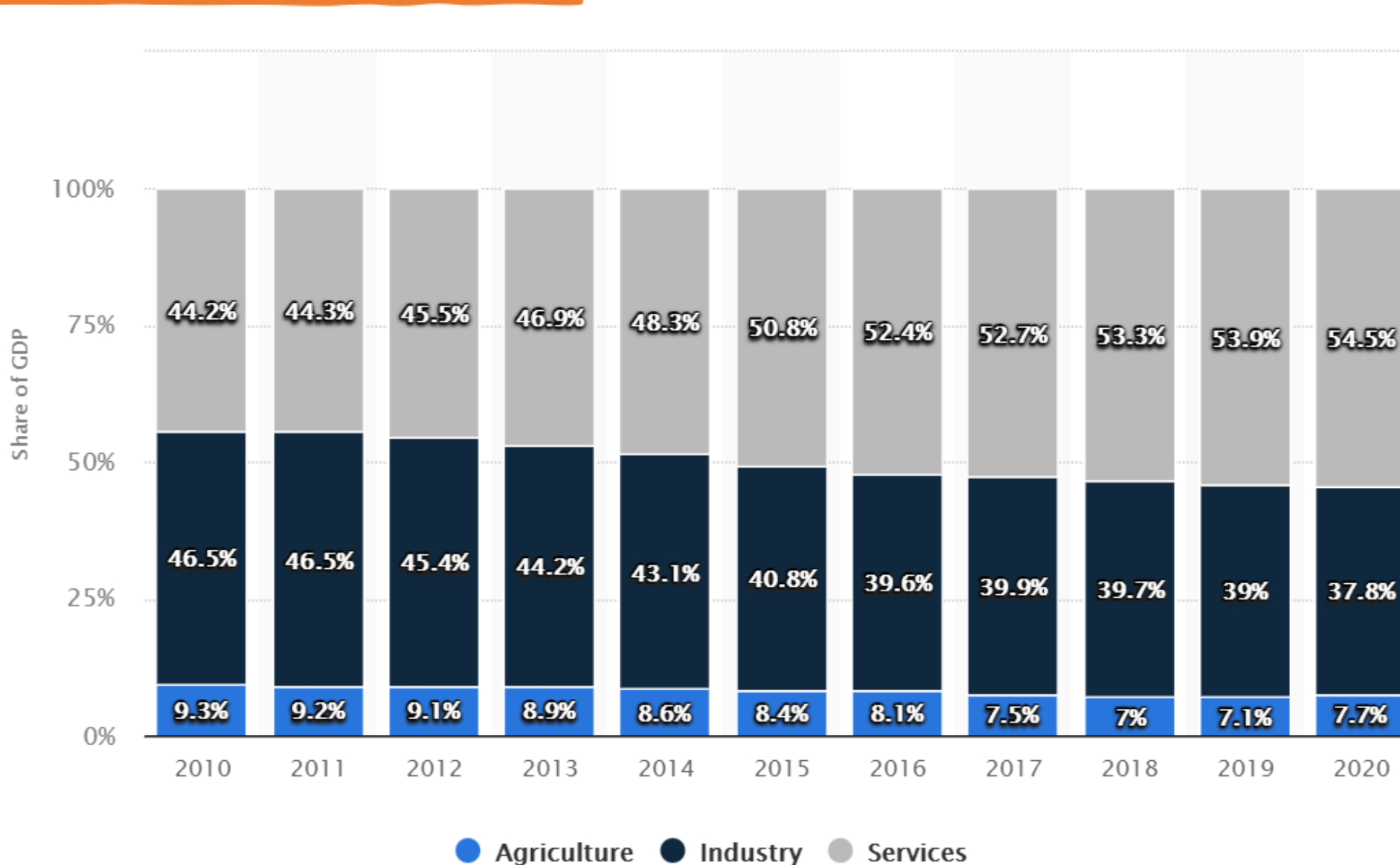
# Growing economy:

## The size of three sectors change overtime



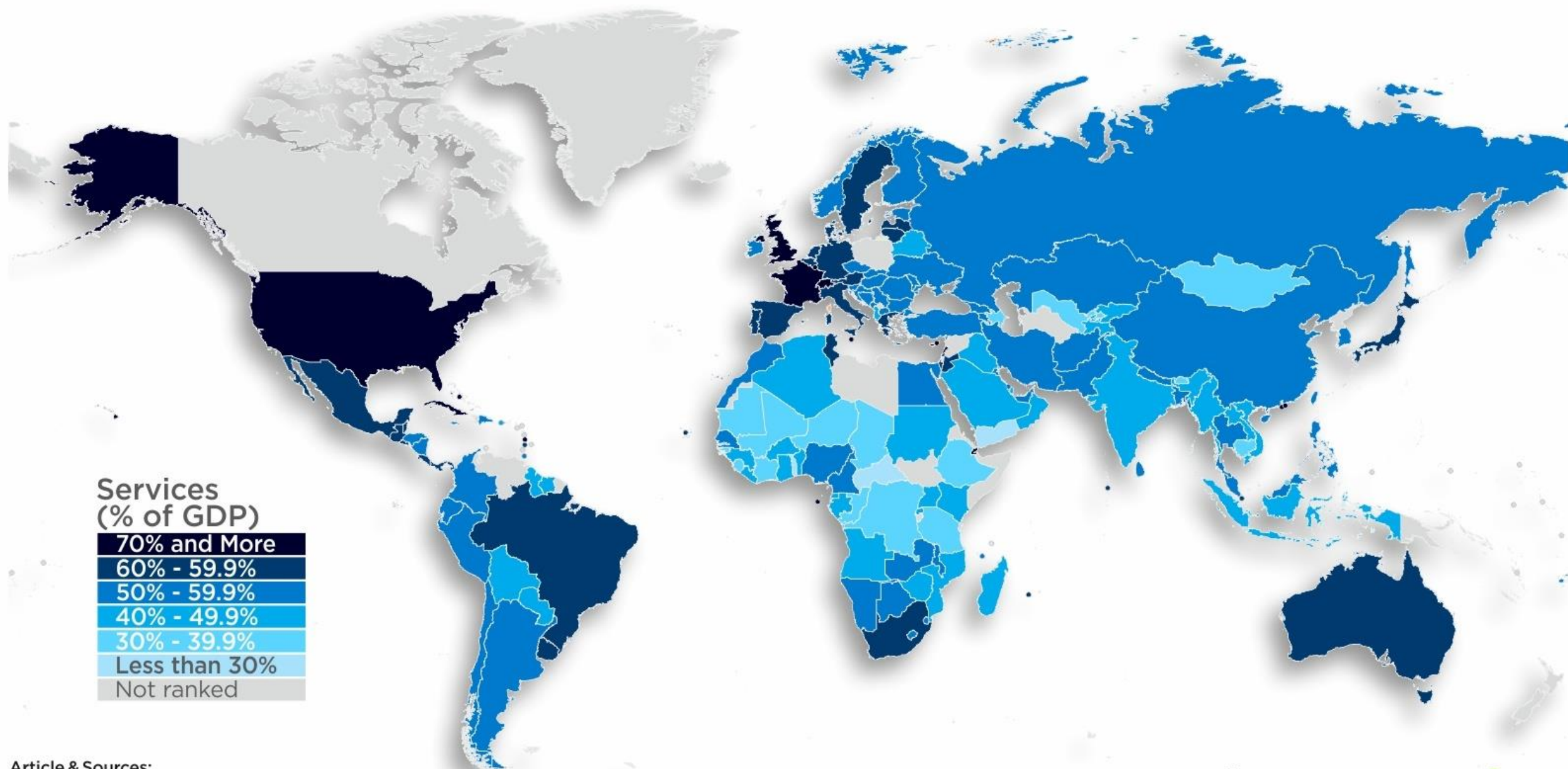
**Figure 3.12:** Changing relative shares (as percentage of total output) of primary, manufacturing and services sectors for a hypothetical economy as it grows

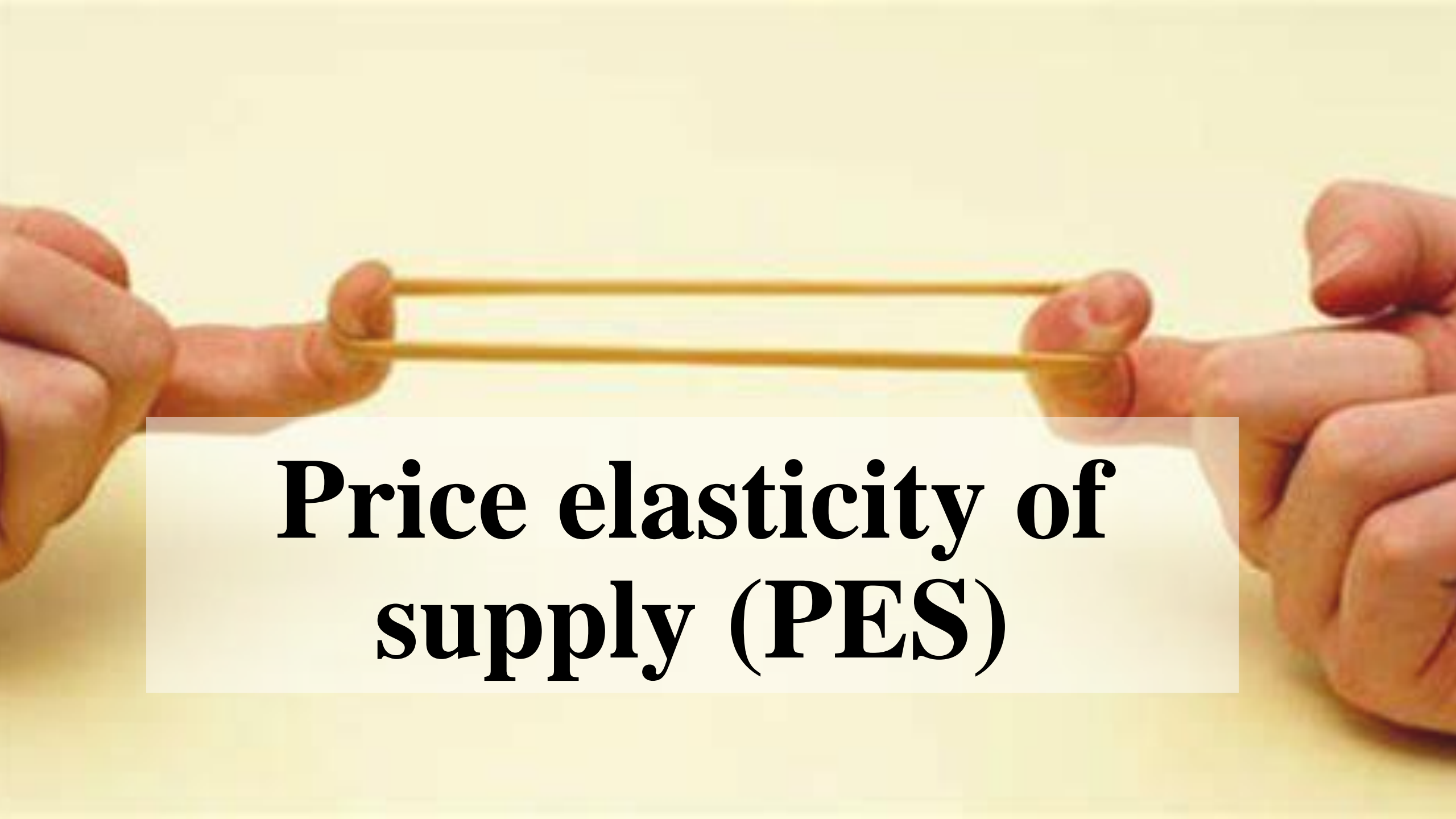
# Data for China in past 10 years



# The Role of Services in the World Economy

Services as Share of Total GDP (%)





# **Price elasticity of supply (PES)**



# The law of supply

- Higher price  $\rightarrow$  profit increase  $\rightarrow$  produce more (supply increase)
- Lower price  $\rightarrow$  profit decrease  $\rightarrow$  produce less (supply decrease)

➡ **Positive Causal relationship.**

**The law of supply:** There is a positive causal relationship between the quantity of a good supplied over a particular time period and its price, ceteris paribus.

✓ **The supply curve slope upward**



*If price change, by how much does quantity supplied change?*



# Definition

---

**Price elasticity of supply (PES)** is a measure of the responsiveness of the quantity of a good supplied to changes in its price.

→ Test Seller's price sensitivity.

- It's calculated along a given supply curve.
- If there is a relatively **big responsiveness**, supply is **elastic**.
- If there is a relatively **small responsiveness**, supply is **inelastic**.

# Formula of PES

Price elasticity of supply (PES)

$$= \frac{\text{\% change in quantity of good x supplied}}{\text{\% change in price of good X}} = \frac{\text{\% } \Delta Q}{\text{\% } \Delta P}$$

$$\text{PES} = \frac{\frac{\Delta Q}{Q} * 100}{\frac{\Delta P}{P} * 100} = \frac{\frac{\Delta Q}{Q}}{\frac{\Delta P}{P}} \quad (\text{Always take the absolute value})$$

$\Delta Q = Q_{\text{final value}} - Q_{\text{initial value}}$

$Q = Q_{\text{initial value}}$

$\Delta P = P_{\text{final value}} - P_{\text{initial value}}$

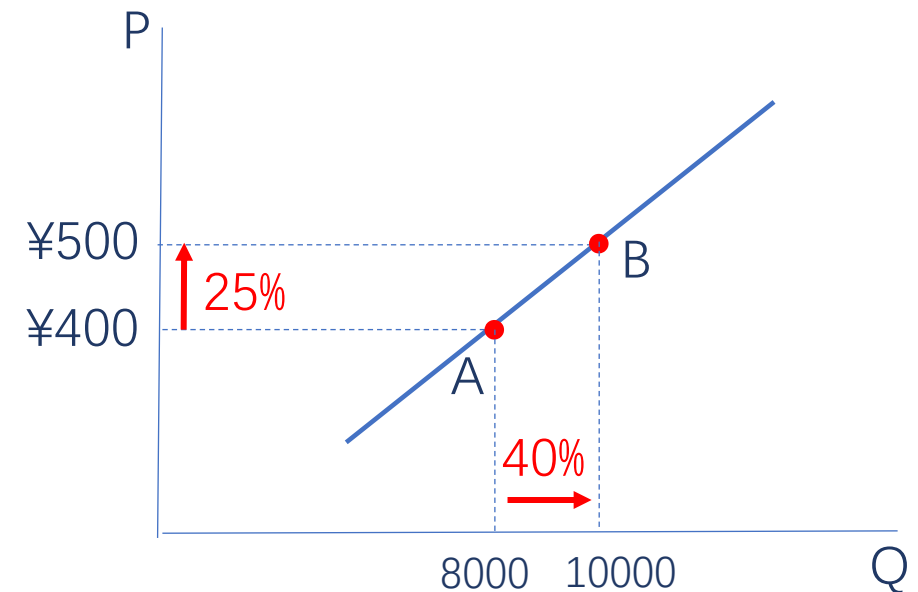
$P = P_{\text{initial value}}$

# Example of PES Calculation

$$\text{Price elasticity of supply (PES)} = \frac{\% \text{ change in quantity of good x supplied}}{\% \text{ change in price of good X}} = \frac{\% \Delta Q}{\% \Delta P}$$

When the market average price for psychological therapist increased from 400 to 500 RMB, supply increased from 10000 to 14000 hours in SH.

$$\text{PES} = \frac{(14000-10000)/10000}{(500-400)/400} = 0.4/0.25 = 1.6$$



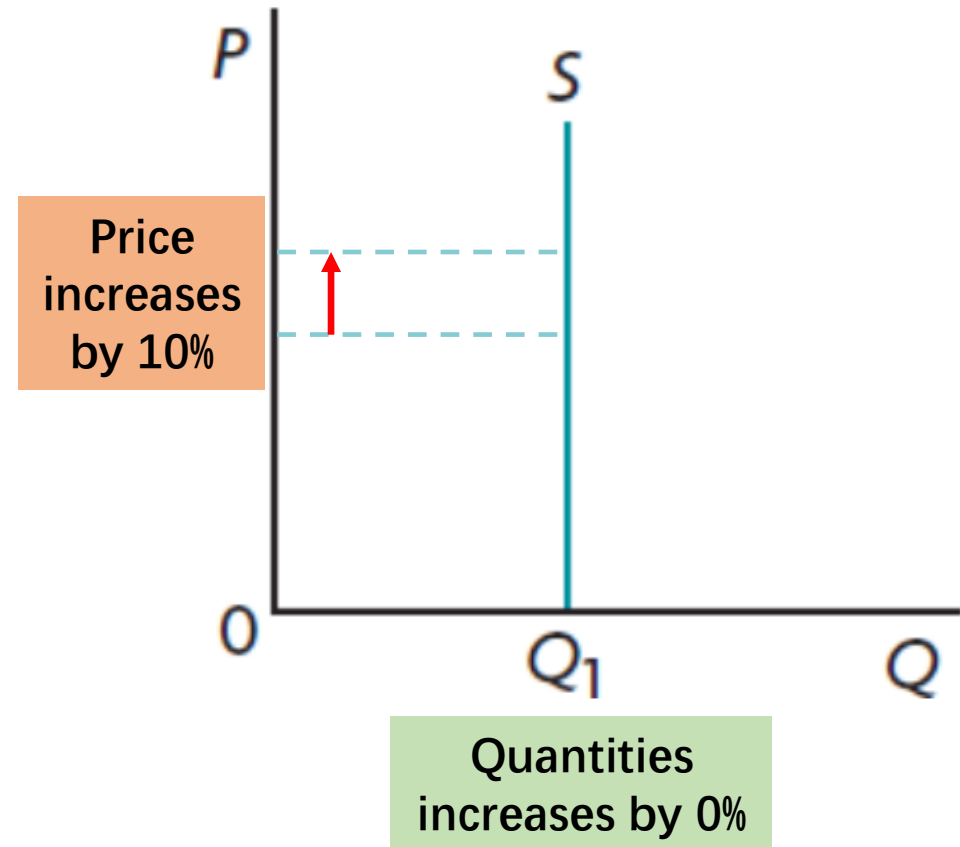
# The range of values for PES

$$\text{Price elasticity of supply (PES)} = \frac{\% \Delta Q}{\% \Delta P} = \frac{0}{10\%} = 0$$

1. when PES = 0, Demand is **perfectly inelastic**

- Shape: Vertical
- Supplier' sensitivity to price: None
- Q always keep constant no matter what happens to price.

\*Extreme case

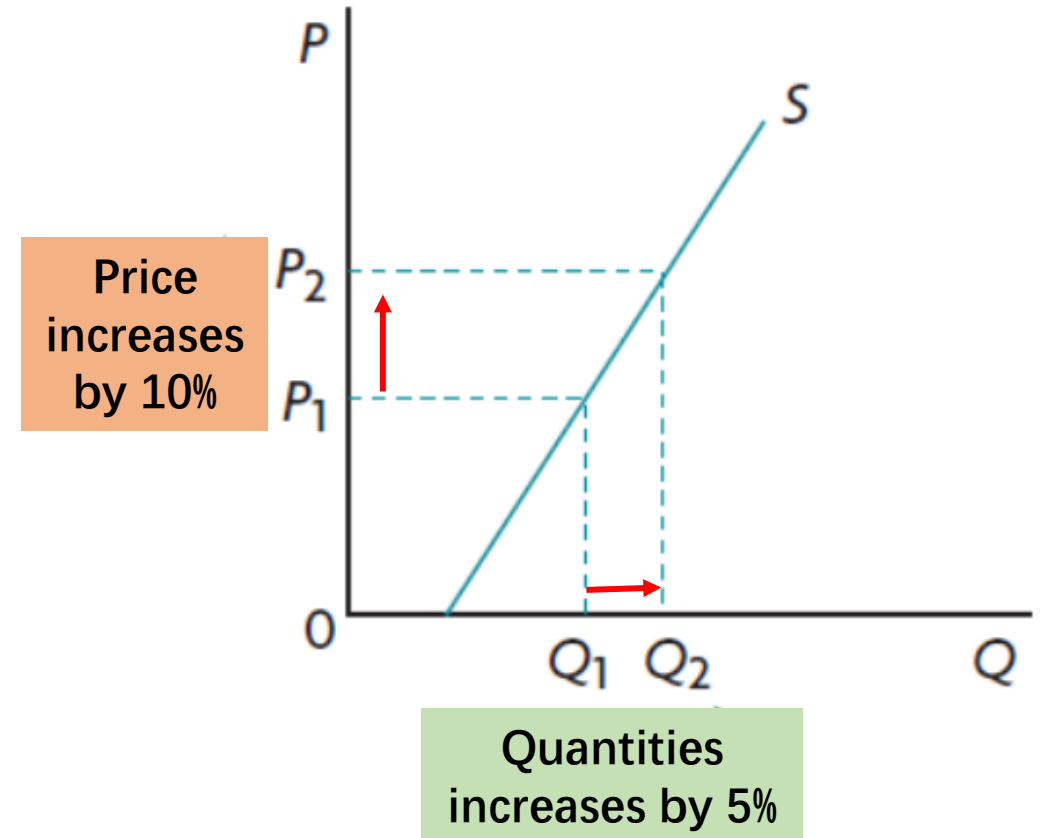


# The range of values for PES

$$\text{Price elasticity of supply (PES)} = \frac{\% \Delta Q}{\% \Delta P} = \frac{5\%}{10\%} = 0.5$$

1. when  $0 < \text{PES} < 1$ , Demand is **price inelastic**

- Shape: relatively steep
- Supplier' sensitivity to price: relatively low
- Q is relatively unresponsive to  $\Delta$  in price.
- The supply curve extends upward and to the right from the horizontal axis; its end-point cuts the horizontal axis.

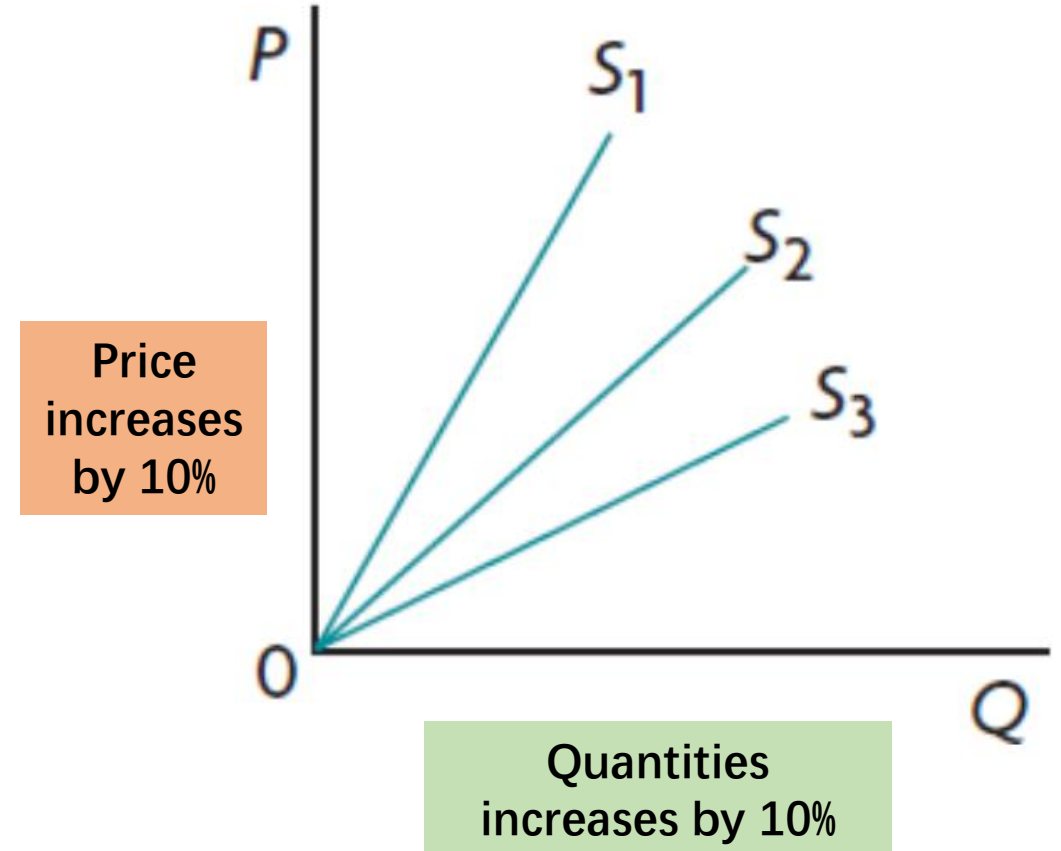


# The range of values for PES

$$\text{Price elasticity of supply (PES)} = \frac{\% \Delta Q}{\% \Delta P} = \frac{10\%}{10\%} = 1$$

1. when PES = 1, Demand is **unit inelastic**

- Shape: supply curve pass the origin.
- Supplier' sensitivity to price:  
Intermediate
- unitary PES: the % change in Q is equal to the % change in P.
- Any supply curve that passes through the origin has a PES equal to unity.  
( $Y=kX$ )





# The range of values for PES

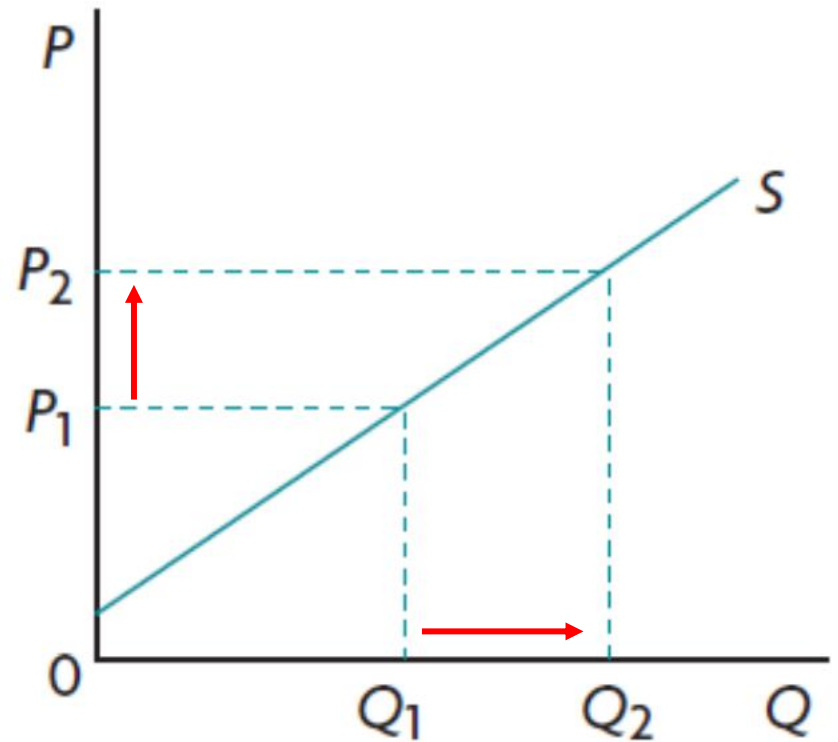
$$\text{Price elasticity of supply (PES)} = \frac{\% \Delta Q}{\% \Delta P} = \frac{15\%}{10\%} = 1.5$$

1. when  $\text{PES} > 1$ , Demand is

**Price elastic**

- Shape: relatively flat
- Supplier' sensitivity to price: relatively high
- Q is relatively responsive to  $\Delta$  in price.
- The supply curve extends upward and to the right from the vertical axis; its end-point cuts the vertical axis.

Price  
increases  
by 10%



Quantities  
increases by 15%

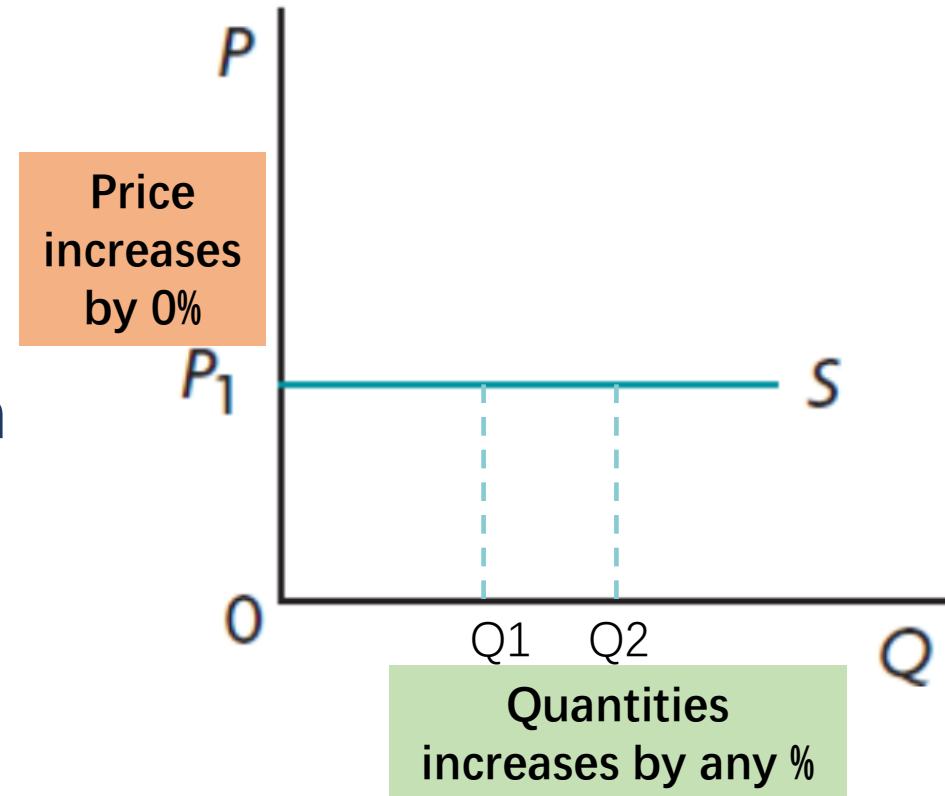
# The range of values for PES

$$\text{Price elasticity of supply (PES)} = \frac{\% \Delta Q}{\% \Delta P} = \frac{\text{Any } \%}{0\%} = \text{infinity}$$

1. when PES = infinity, Demand is **perfectly elastic**

- Shape: horizontal
- Supplier' sensitivity to price:  
Extreme
- Any change in price results in an infinitely large response in quantity supplied.

\*Another extreme case



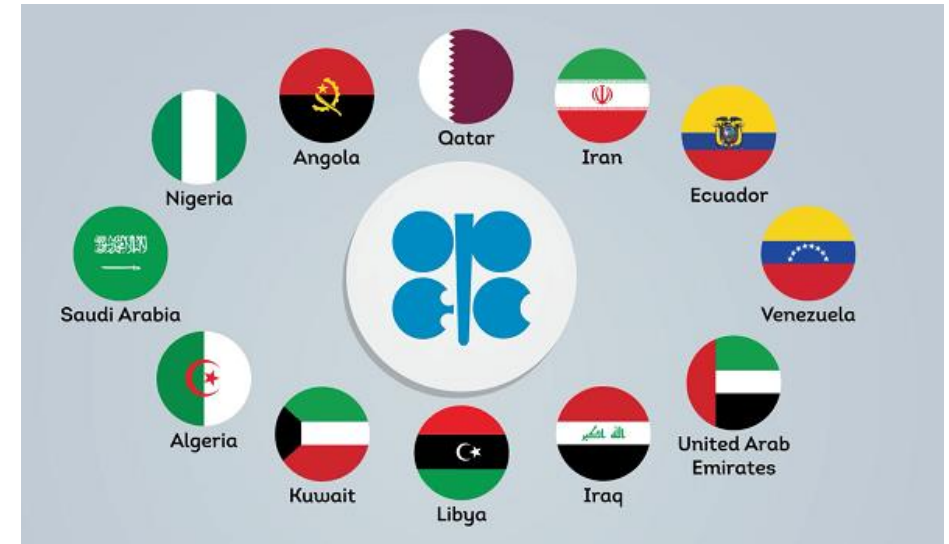
# Summary of PES

Value of PES	Classification	Interpretation
<b>Frequently encountered cases</b>		
$0 < PES < 1$ (greater than zero and less than one)	inelastic supply	quantity supplied is relatively unresponsive to price
$1 < PES < \infty$ (greater than one and less than infinity)	elastic supply	quantity supplied is relatively responsive to price
<b>Special cases</b>		
$PES = 1$	unit elastic supply	percentage change in quantity supplied equals percentage change in price
$PES = 0$	perfectly inelastic supply	quantity supplied is completely unresponsive to price
$PES = \infty$	perfectly elastic supply	quantity supplied is infinitely responsive to price

# Determinants of price elasticity of supply

The price of gasoline increased by 20%, how should the supply response to it:

- In 6 months
- In 5 years

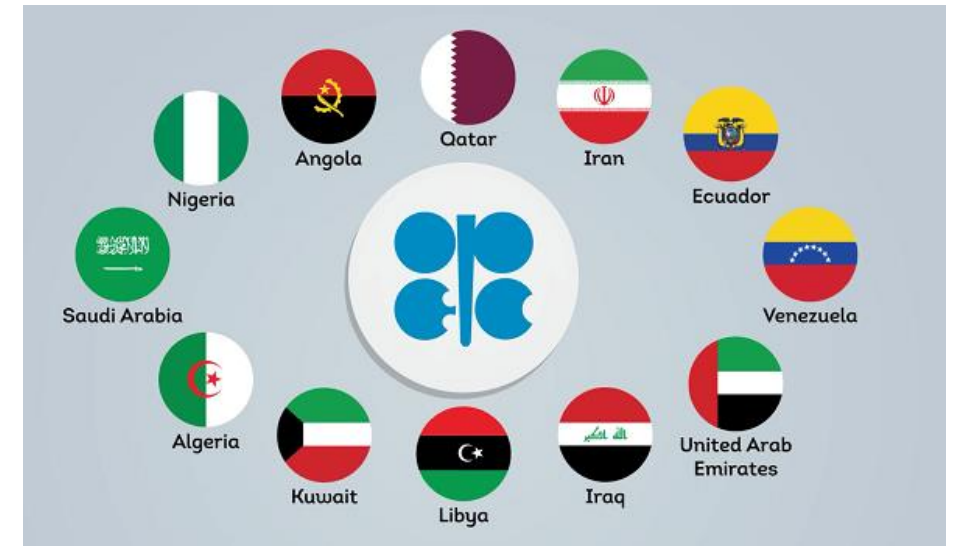


# Determinants of price elasticity of supply

- Over short period of time, the firms are unable to increase its inputs to change the quantity it produces. So the supply won't raise a lot in 6 months. → **relatively inelastic of supply**
- In the long run, oil exploitation industry are able to invest more both in equipment and technology, exploit more oil field. The gasoline supply will increase. → **relatively elastic of supply**

## 1. Length of time

As the length of time that firms have increases, the responsiveness of quantity supplied to price changes begins to rise, and PES increases.





# Determinants of price elasticity of supply

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- The price of MPV car (multi-purpose vehicle) increased by 20%
- The price of “luo shi noodle” increased by 20%

Which product will gain more quantity of supply? Why?



# Determinants of price elasticity of supply

- It is relatively harder to increase the production of MPV in short period of time, since automotive industry involves long period of R&D time, specialized technologies, factories, heavy equipment in their production.

→ price inelastic of supply

- “Luo shi noodle” requires less specialized resources for production, so it is relatively easier for suppliers to add resources to produce more or switch to this industry.

→ Price elastic of supply



## 2. Mobility of factors of production

The more easily and quickly resources can be shifted from one product(industry) to another product (industry), the greater the responsiveness of Q.



# Determinants of price elasticity of supply

---

- Factory A: full capacity employed.
- Factory B: 2 spare workshop

Which factory will be more responsive for the rising price?



# Determinants of price elasticity of supply

- It is relatively harder for a full capacity occupied factory to increase its supply.  
→ price inelastic of supply
- It is relatively easier for a factory with spare capacity to respond with increased output to a price rise.  
→ price elastic of supply



## 3. Spare (unused) capacity of firms

Whether the firm has spare capacity to react to the price rise (increased demand).



# Determinants of price elasticity of supply

---

- The price of fruit decreased 20%
- The price of gold decreased 20%

What kinds of supplier behavior is likely to appear for these two products?



# Determinants of price elasticity of supply

- The stock time for fruit is fairly short. The seller have no choice but sell the fruit in lower price.

→ Price inelastic supply

- Gold can stock as long as you want. So if the price goes down, the seller can withhold their stock and wait for the price to go up again.

→ Price elastic supply

## 4. Ability to store stocks

Firms have the ability to store stocks are likely to have a higher PES for their products than firms that cannot store stocks.



# Determinants of price elasticity of supply

---

Pig likes to eat corn. Two scenario:

1. The price of corn keeps stable
2. The price of corn increase by 20%

What kinds of pig supplier behavior is likely to appear for these two scenarios?





# Determinants of price elasticity of supply

Corn is one important pig feed (cost of production), if the price of corn increased, the supplier will be less willing to expand their output quickly. – lower PES

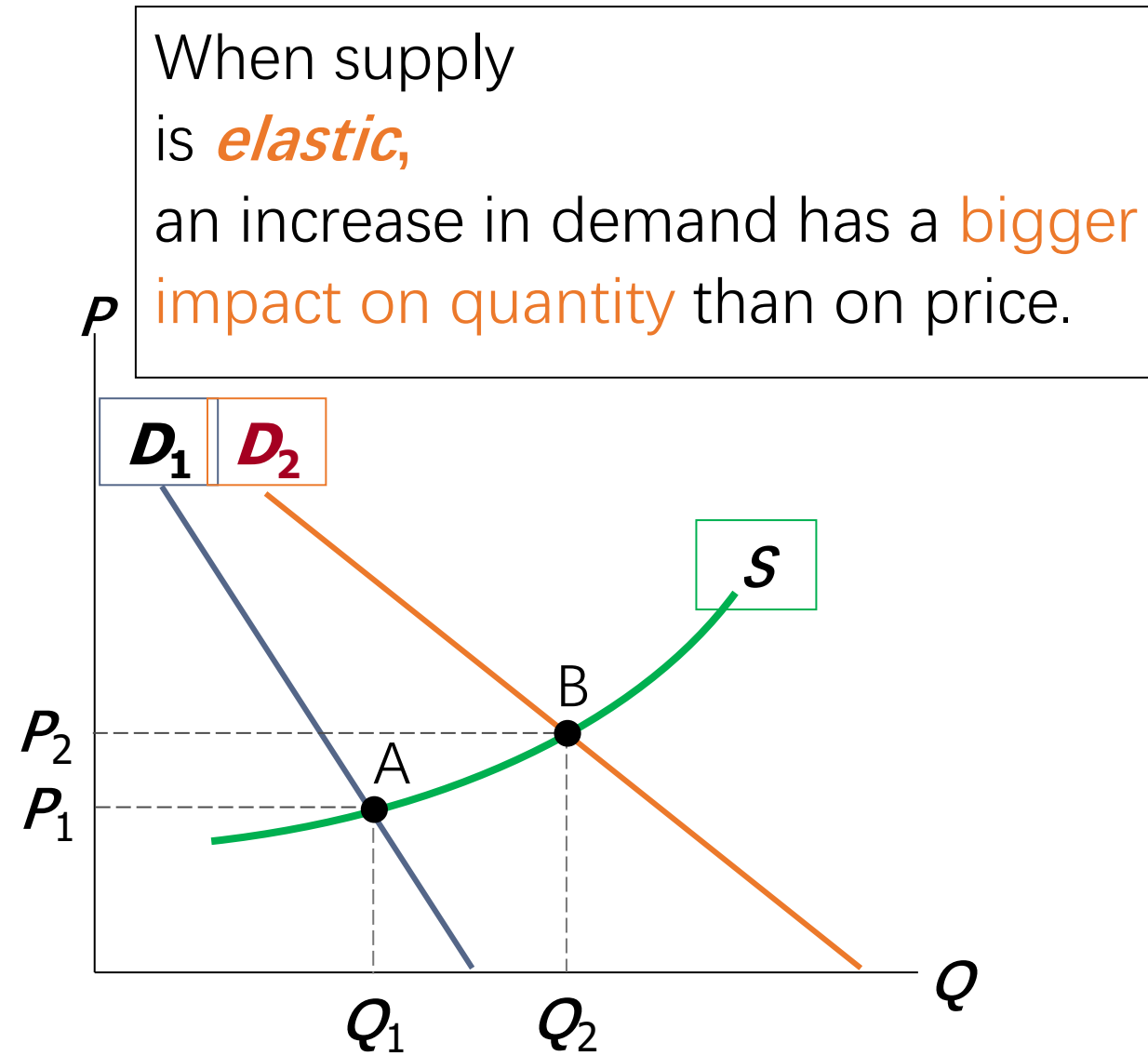
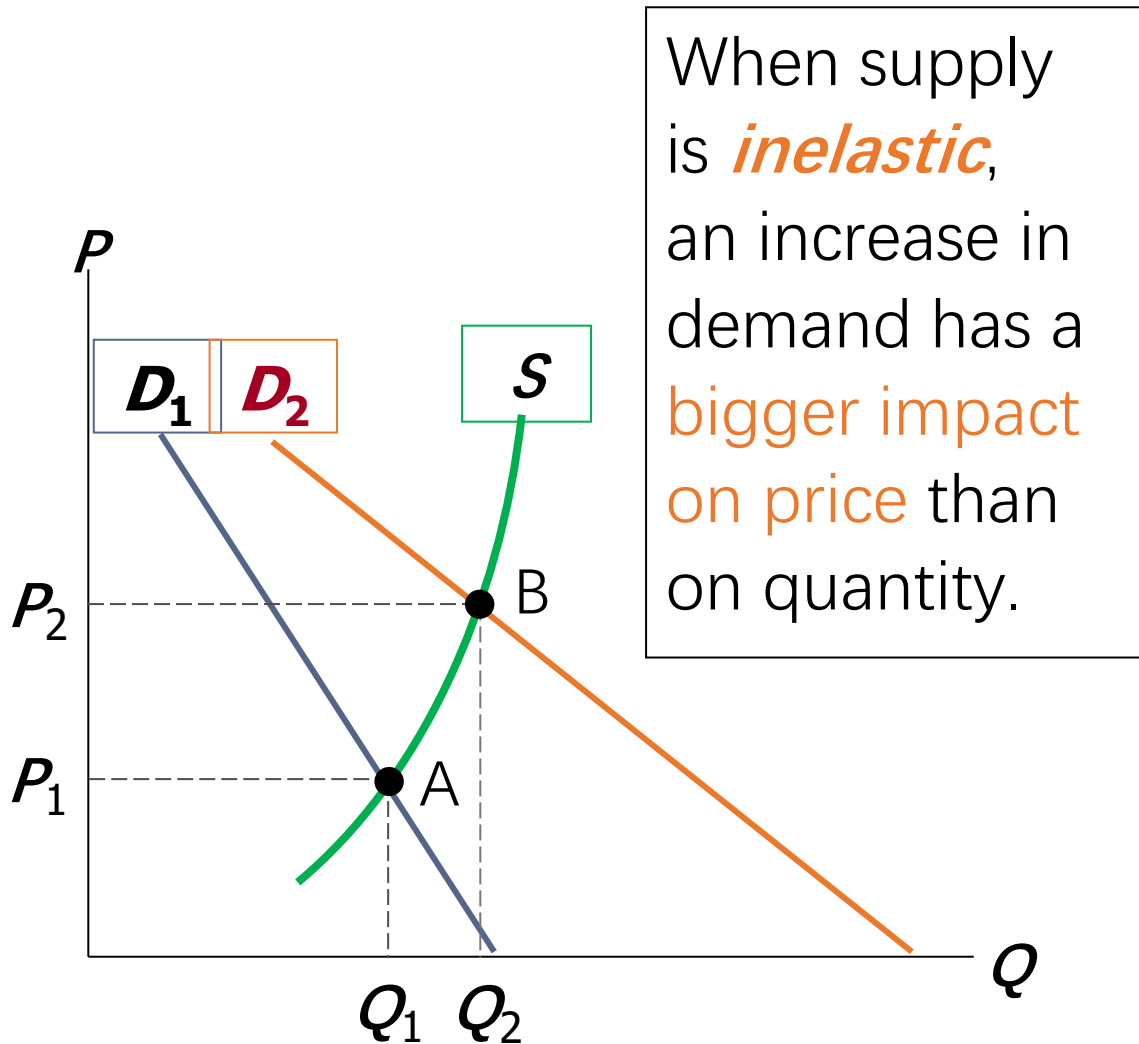


## 5. Rate at which costs increase

When the cost of producing extra output increase rapidly, firms will be less willing to expand their production, then supply will be inelastic. Vice versa.



# Comparing elastic & Inelastic of supply



# PES in relation to: Primary commodities & manufactured products

- **Primary commodities**

- **lower PES.** Longer time needed for resources to be shifted in and out of the industry.

- a) The farmer need a planting season to react to high price, shortage of land, environmental destruction, longer R&D time, etc.
    - b) For products like Oil, natural gas, minerals, time is needed to make the necessary investments and to begin production.

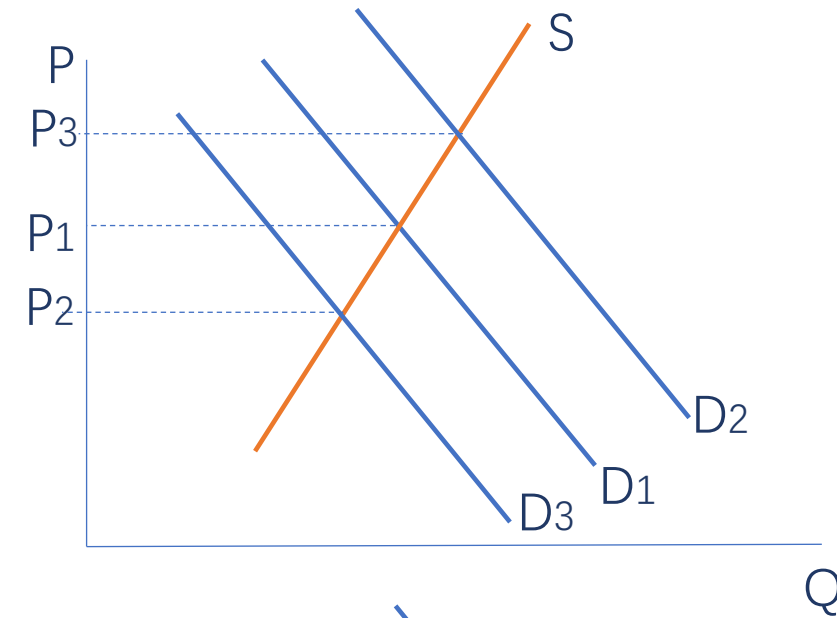
- **Manufactured products**

- **higher PES.** Relatively shorter time needed for quantity supplied to respond to price changes.

# Compare between Primary commodities & manufactured products

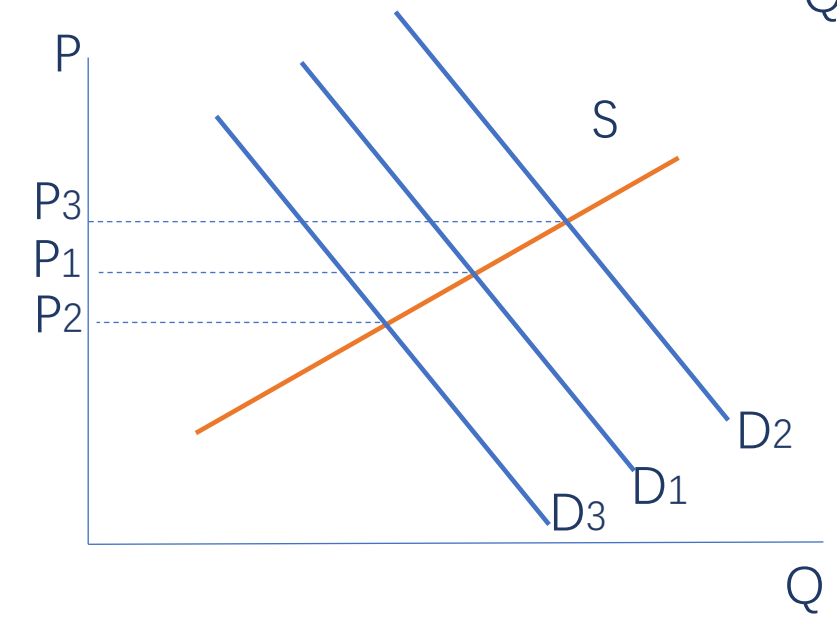
- **Primary commodities – inelastic of supply**

- Larger price fluctuation
- Relatively Unstable revenue for producers.



- **Manufactured products– elastic of supply**

- Smaller price fluctuation
- Relatively stable revenue for producers.



# Short-term V.S. long term

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Commodity	Short-term <i>PES</i>	Long-term <i>PES</i>
Cabbage	0.36	1.20
Carrots	0.14	1.00
Cucumbers	0.29	2.20
Onions	0.34	1.00
Green peas	0.31	4.40
Tomatoes	0.16	0.90
Cauliflower	0.14	1.10
Celery	0.14	0.95

# Summary of PED

Elasticity	Possible values	Description	Examples
Price elasticity of demand $PED = \frac{\% \Delta Q}{\% \Delta P}$	$PED = 0$	perfectly inelastic	concept used in economic theory
	$0 < PED < 1$	price inelastic	gasoline, cigarettes, food
	$PED = 1$	unit elastic	concept used in economic theory
	$PED > 1$	price elastic	yachts, expensive holidays
	$PED = \infty$	perfectly elastic	concept used in economic theory

# Summary of YED

Elasticity	Possible values	Description	Examples
Income elasticity of demand $YED = \frac{\% \Delta Q}{\% \Delta Y}$	$YED > 0$	normal good	new cars, new clothes
	$YED < 0$	inferior good	used cars, used clothes
	$YED > 1$	income elastic, luxury	expensive cars and clothes, many services
	$YED < 1$	income inelastic, necessity	food, medicines



# Summary of PES

Elasticity	Possible values	Description	Examples
Price elasticity of supply $PES = \% \Delta Q / \% \Delta P$	$PES = 0$	perfectly inelastic	concept used in economic theory
	$PES < 1$	price inelastic	oil and gasoline, some agricultural products
	$PES = 1$	unit elastic	concept used in economic theory
	$PES > 1$	price elastic	any good that can be produced quickly
	$PES = \infty$	perfectly elastic	concept used in economic theory

# Key points for elasticities

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## 1. Don't forget to:

- Show elasticity by **steepness** of the demand/supply/Engel curve.
- Explain the **% change** relationship **between price and quantity**
- Explain **referring to the diagram**
- Don't mess it up between calculation formulas
  - 分子分母别弄混
  - How to **calculate % change**.
- When drawing **YED**, always **indicate the specific segment** for the product.