Mathematical Economics

Linear Demand & Supply Functions

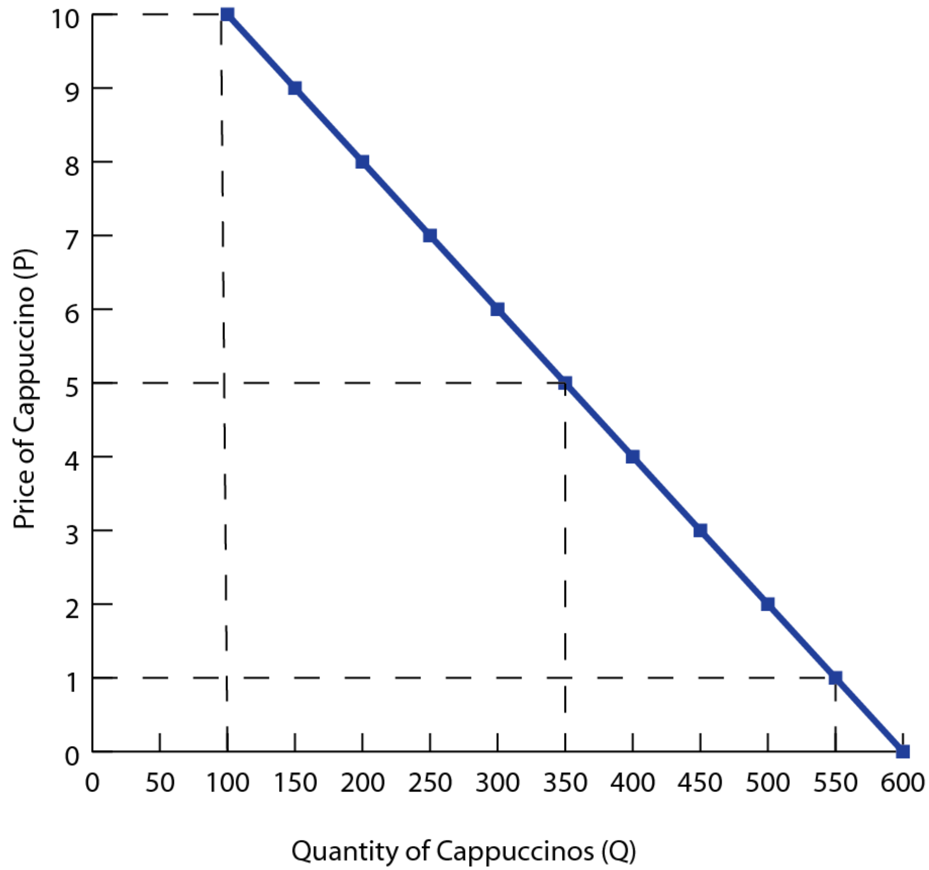
Typical Demand Function

- Demand for a good can be expressed using mathematical functions
- A typical demand function looks like $\mathbf{Q_D = a - bP}$ where,
  - $\mathbf{Q_D}$ represents the quantity demanded
  - **a** represents the autonomous level of demand, or the quantity demanded if the price were zero (**Q-intercept**)
  - **b** represents the change in quantity demanded resulting from a change in price (the slope calculated as $\Delta \mathbf{Q_d} / \Delta P$)
  - **P** represents the price of a single item

Example; Demand for Cappuccinos

- Suppose the demand for cappuccinos in Richmond Hill can be expressed as $\mathbf{Q_D = 600 - 50P}$
    - It is possible to construct both a demand schedule and demand curve from this demand function

Linear demand schedule: Cappuccinos	
Price of Cappuccinos (P)	**Quantity demanded per day (Q_D)**
10	100
8	200
6	300
4	400
2	500
0	600



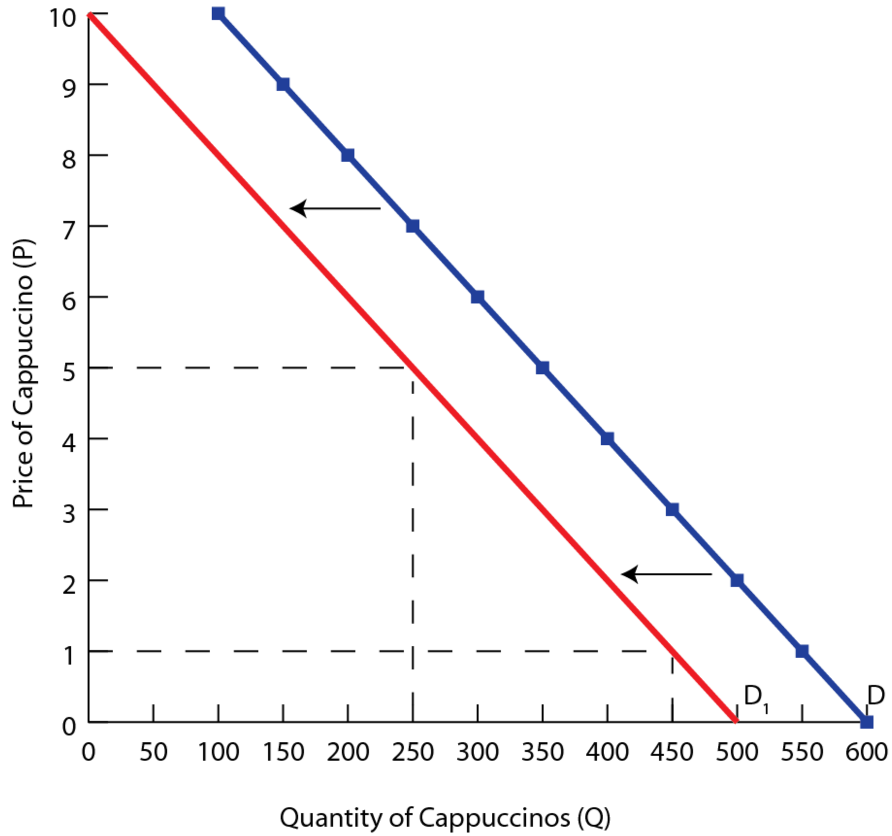
- A movement along the demand curve will occur any time the price of cappuccinos increases or decreases

- At lower prices, more are demanded; at higher prices fewer cappuccinos are demanded by consumers

Changes in 'a'

- If any of the determinants of demand change, then the '**a**' value in the demand function will change
  - The demand curve will shift either left or right
- **Example;** Suppose the demand function changes to $\mathbf{Q_D = 500 - 50P}$

Linear demand schedule: Cappuccinos	
Price of Cappuccinos (P)	**Quantity demanded per day (Q_D)**
10	0
8	100
6	200
4	300
2	400
0	500



- The slope of the new demand curve will be the same as the original curve
- The demand curve shifts left, or down by 100 units at every price
- The Q-intercept is now at 500 rather than 600

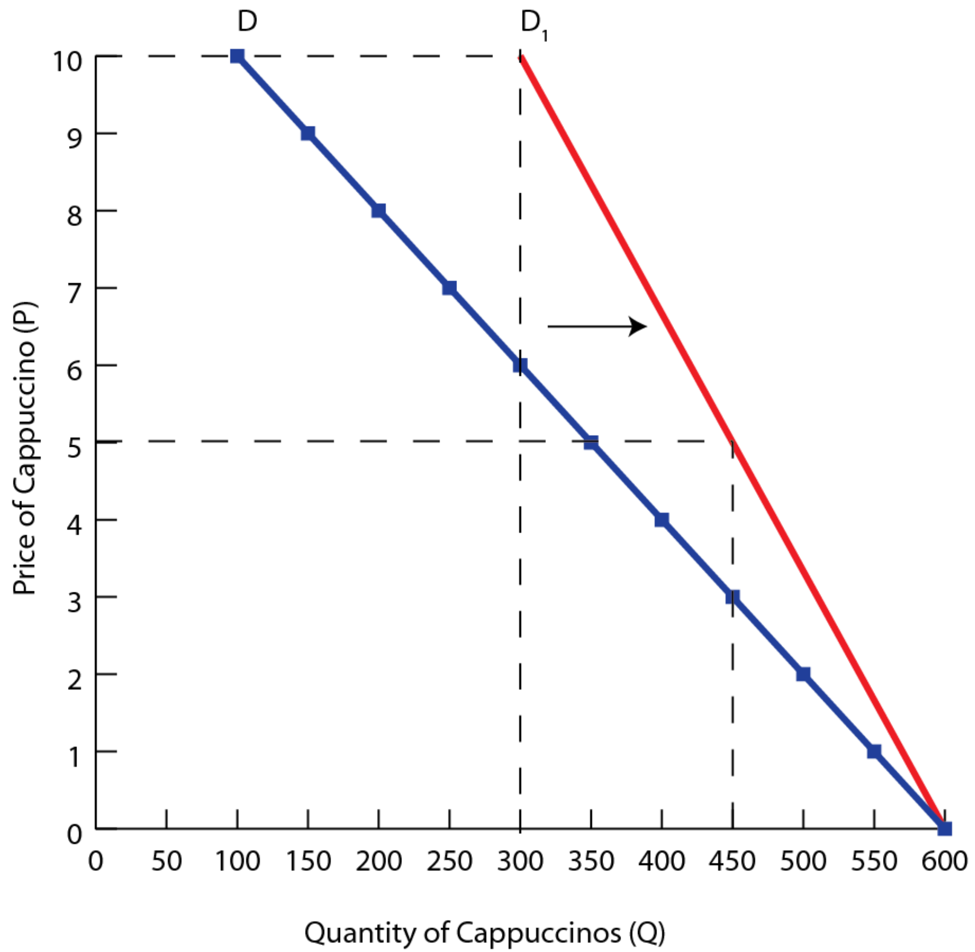
Changes in 'b'

- Changes to the price coefficient **b** will change the steepness of the demand curve

  - This changes the price elasticity of the demand curve

- **Example;** Suppose the demand function changes to $\mathbf{Q_D = 600 - 30P}$

Linear demand schedule: Cappuccinos	
Price of Cappuccinos (P)	**Quantity demanded per day (Q_D)**
10	300
8	360
6	420
4	480
2	570
0	600



- The demand curve has become steeper, indicating consumers are less sensitive to price changes than previously
- The overall demand for cappuccinos has become more inelastic

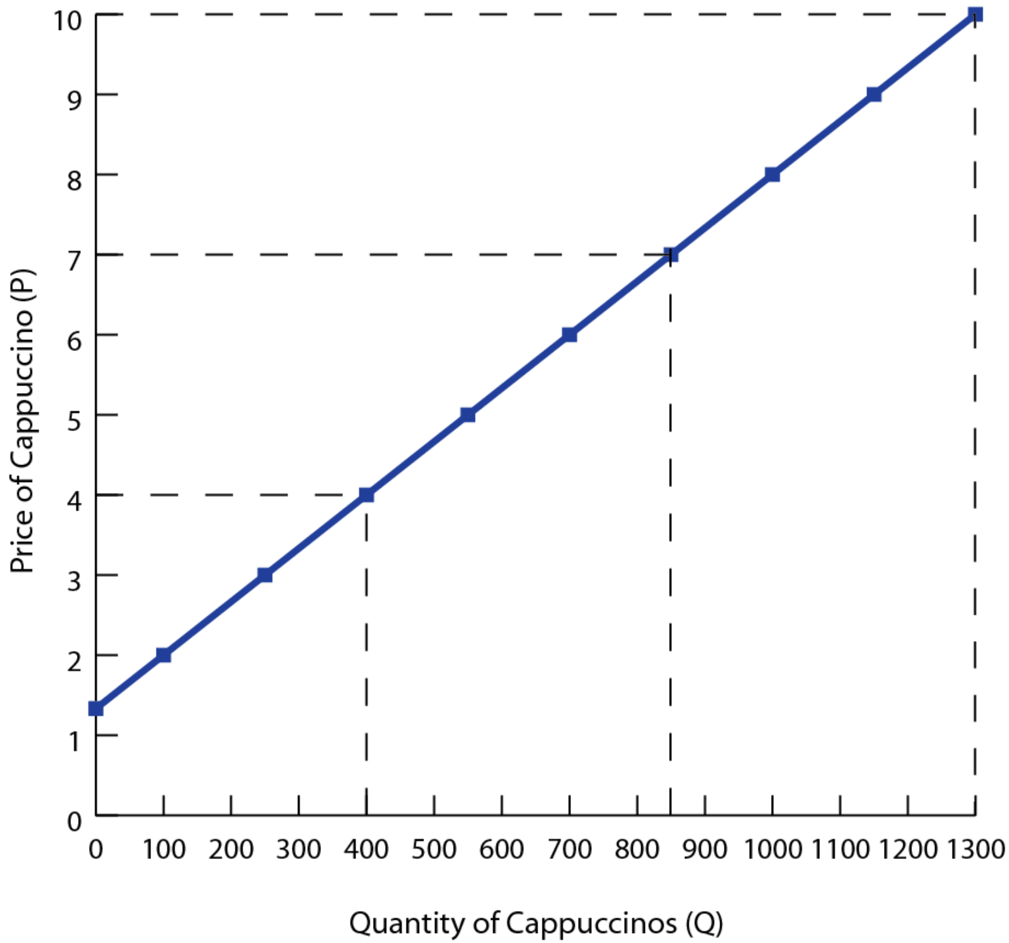
Typical Supply Function

- Supply for a good can also be expressed using mathematical functions
- A typical supply function looks like $\mathbf{Q_S = c + dP}$ where,
  - $\mathbf{Q_S}$ represents the quantity supplied
  - **c** represents the autonomous level of supply, or the quantity produced if the price were zero (**Q-intercept**)
  - **d** represents the rate at which a change in price will cause the quantity supplied to increase (the slope calculated as $\Delta \mathbf{Q_s} / \Delta P$)
  - **P** represents the price of a single item

Example; Supply Cappuccinos

- Suppose the supply of cappuccinos in Richmond Hill can be expressed as **$Q_s = -200 + 150P$**
  - It is possible to construct both a supply schedule and supply curve from this supply function

Linear supply schedule: Cappuccinos	
Price of Cappuccinos (P)	**Quantity supplied per day (Q_D)**
10	1300
8	1000
6	700
4	400
2	100
0	-200

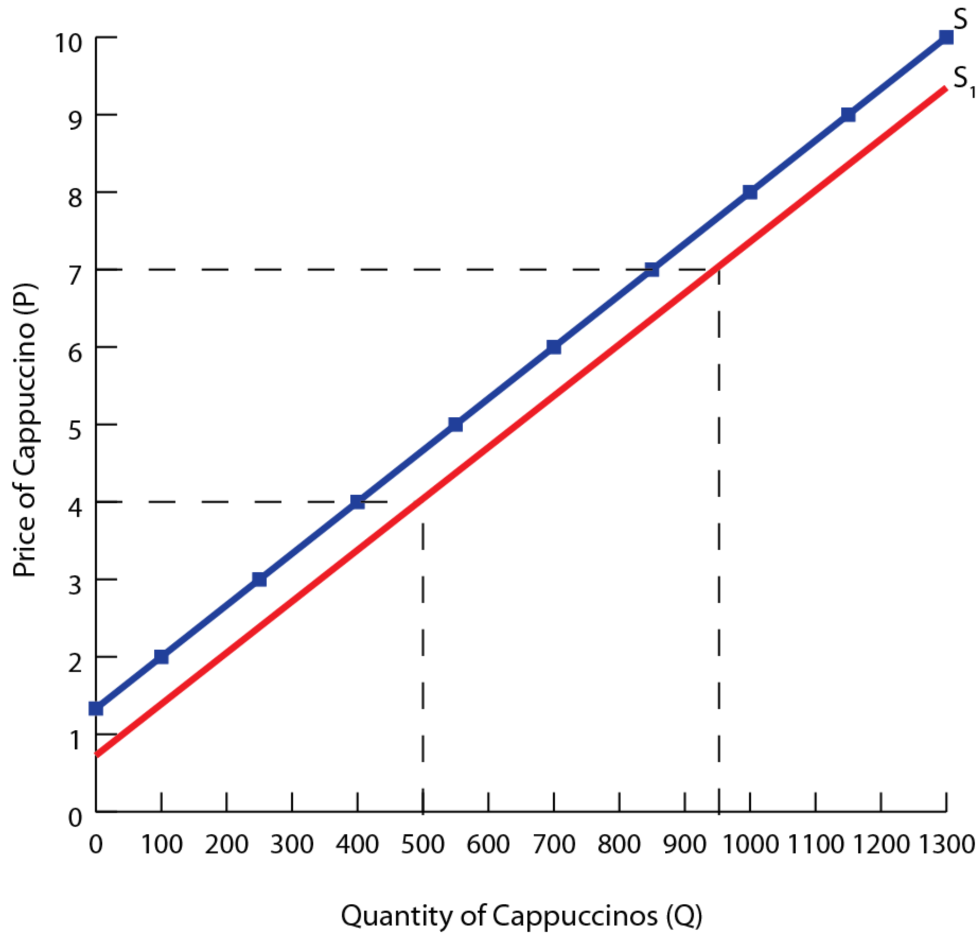


- There is a direct relationship between the price and quantity supplied. As price falls, producers are willing to provide fewer drinks to the market

Changes in ‘c’

- If any of the non-price determinants of supply change, then the ‘**c**’ value in the supply function will change
    - The supply curve will shift either left or right
- **Example;** Suppose the supply function changes to $\mathbf{Q_S = -100 + 150P}$

Linear supply schedule: Cappuccinos	
Price of Cappuccinos (P)	**Quantity supplied per day (Q_D)**
10	1400
8	1100
6	800
4	500
2	200
0	-100

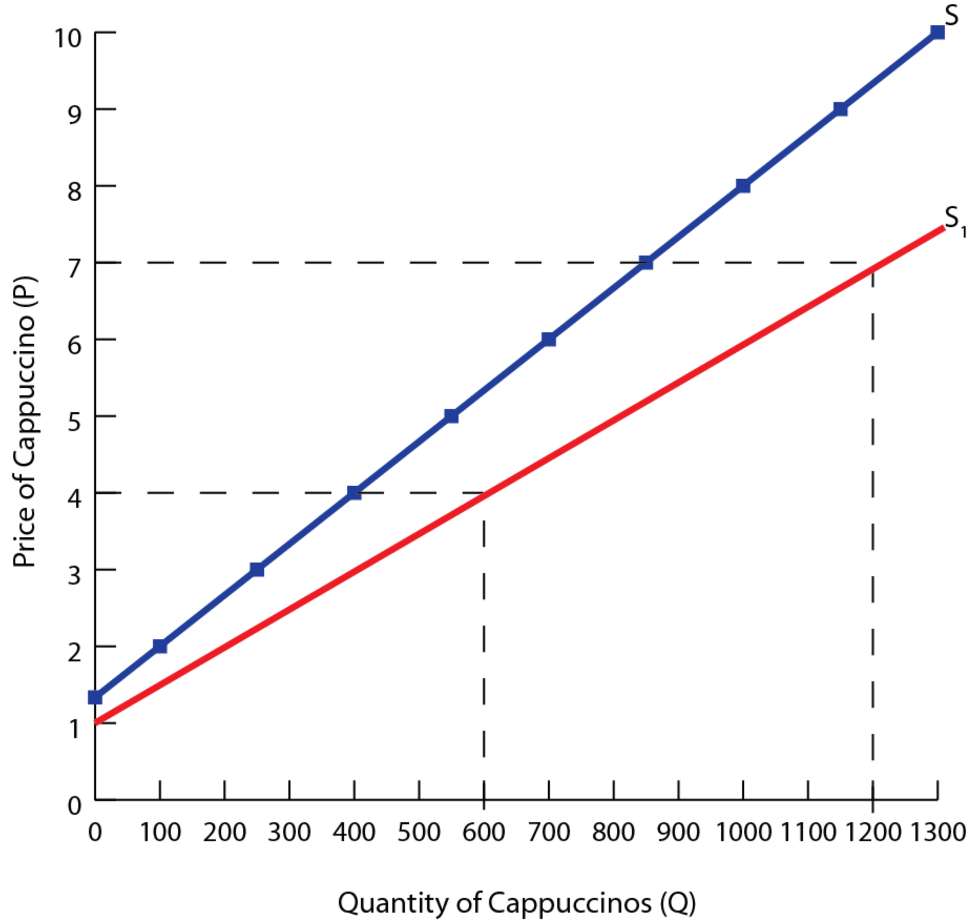


- The quantity supplied at each price level is reduced, but the slope remains the same
- The price intercept is now $0.75 rather than $1.33

Changes in 'd'

- Changes to the price coefficient **d** will change the steepness of the supply curve
  - This changes the price elasticity of the supply curve
- **Example;** Suppose the supply function changes to **Q = -200 + 200P**

Linear supply schedule: Cappuccinos	
Price of Cappuccinos (P)	**Quantity supplied per day (Q_D)**
10	1800
8	1400
6	1000
4	600
2	200
0	-200



- The supply curve is less steep, indicating consumers are more sensitive to price changes than previously
- The overall supply for cappuccinos has become more elastic

Summary

	Component	Change	Impact on Demand/Supply
Linear Demand ($Q_d = a - bP$)	**a** or **c**	Increase	Rightward shift (Increase)
	a or **c**	Decrease	Leftward shift (Decrease)
Linear Supply ($Q_s = c + dP$)	**b** or **d**	Increase	Less steep (Elastic)
	b or **d**	Decrease	More steep (Inelastic)

Study Questions

- **1.** Use the linear demand function, $\mathbf{Q_D = 300 - 30P}$
- **A.** Create a demand schedule with prices of \$0, \$3, \$5, \$7 and \$9
- **B.** Create a demand curve, plotting point from your demand schedule
- **C.** Decrease the value of **a**, the autonomous element of demand, by 30 units. Create a new demand schedule, with the adjusted values for $\mathbf{Q_D}$.
- **D.** On your previous diagram, show the new demand curve
- **E.** Now change the value of the price coefficient, in the original function to – 10. Calculate the prices and quantities demanded, and list them of a demand schedule
- **F.** Create a new demand curve

Study Questions

- **1.** Use the linear demand function, $\mathbf{Q_S = -100 + 10P}$
- **A.** Create a supply schedule with prices of $10, $20, $30, $40 and $50
- **B.** Create a supply curve, plotting point from your demand schedule
- **C.** Decrease the value of **c**, the autonomous element of supply, by 50 units. Create a new supply schedule, with the adjusted values for $\mathbf{Q_S}$.
- **D.** On your previous diagram, show the new supply curve

Market Equilibrium and Linear Equations

Market Equilibrium and Linear Equations

- Linear equations can be used to solve the market equilibrium by setting the quantity supplied equal to the quantity demanded
    - The market is in equilibrium when $\mathbf{Q_d = Q_s}$
- **Example;** Suppose the market for cappuccino can be modeled by the following, $\mathbf{Q_d = 600 - 50P}$ and $\mathbf{Q_s = -200 + 150P}$

Linear supply and demand schedules: Cappuccinos		
Price of Cappuccinos (P)	**Quantity demanded (Q_D)**	**Quantity supplied (Q_S)**
10	100	1300
8	200	1000
6	300	700
4	400	400
2	500	100
0	600	-200

- The equilibrium is the point at which supply equals demand,

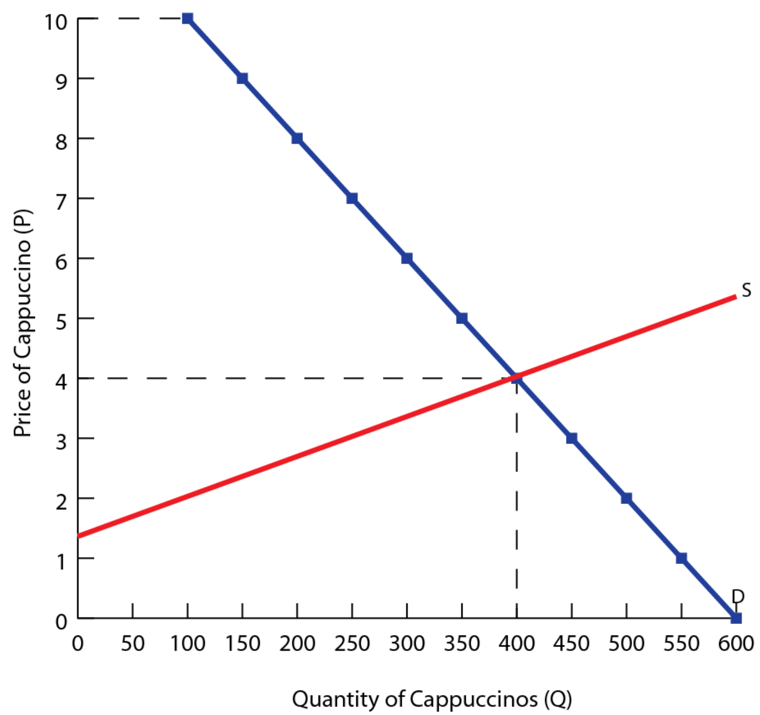
$Q_d = Q_s$

$600 – 50P = – 200 + 150P$

$200P = 800$

Therefore, **P_E= $4** and **$Q_E$= 400 units**

Therefore the equilibrium price is $4 and the quantity is 400 units



Shifts in Supply and Equilibrium

- Shifts in the supply can also be illustrated using linear functions

- **Example;** Suppose the price of coffee beans increases, adding to the costs of the production of cappuccino and reducing the supply. The new supply function is $\mathbf{Q_s = -400 + 150P}$

Linear supply schedule: Cappuccinos	
Price of Cappuccinos (P)	**Quantity supplied per day (Q_D)**
10	1100
8	800
6	500
4	200
2	-100
0	-400

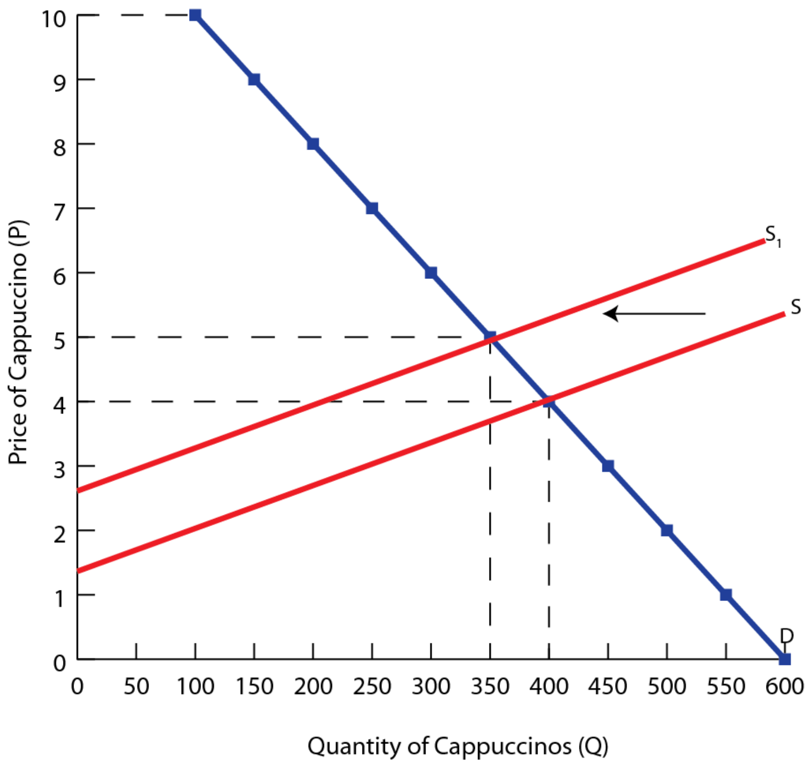
- Solving the new equilibrium,

  $\mathbf{Q_d = Q_s}$

  600 – 50P = – 400+ 150P

  200P =1000

  Therefore, $\mathbf{P_E}$**= $5** and $\mathbf{Q_E}$**= 350 units**



- The price rises until the market is cleared, with all excess demand eliminated

Shifts in Demand and Equilibrium

- Changes in demand will also effect the equilibrium price and quantity

- **Example;** Suppose a decrease in the demand for cappuccinos shifts the demand curve to the right. In addition, the demand curve becomes less elastic. The new demand function is $\mathbf{Q_d = 400 - 25P}$

  - Solving the new equilibrium algebraically,

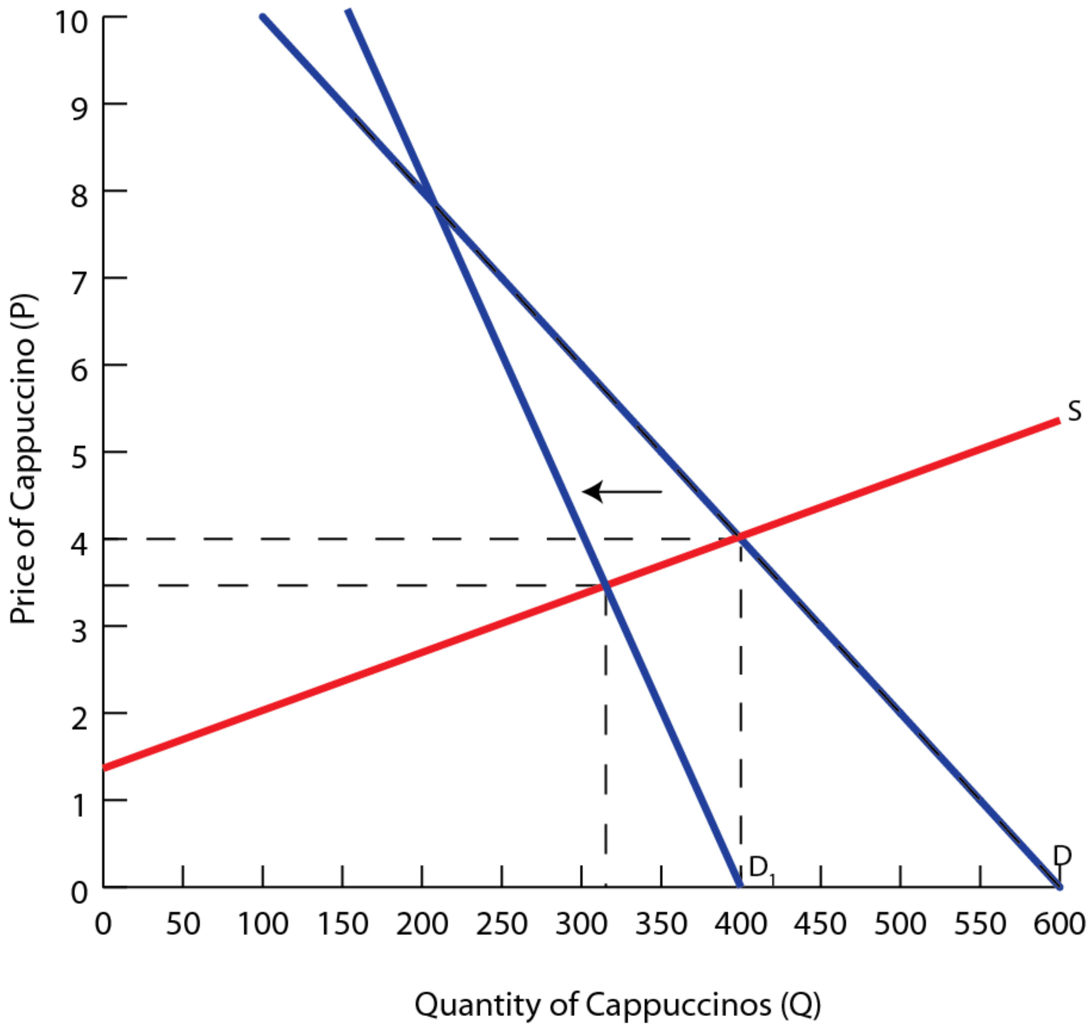
    $\mathbf{Q_d = Q_s}$

    $\mathbf{400 - 25P = - 200 + 150P}$

    $\mathbf{600P = 175}$

    Therefore, $\mathbf{P_E = \$3.43}$ and $\mathbf{Q_E = 314}$ **units**

- The decrease in demand causes the price of cappuccinos to fall from $4 to $3.43 and the equilibrium quantity to decrease from 400 to 314 drinks



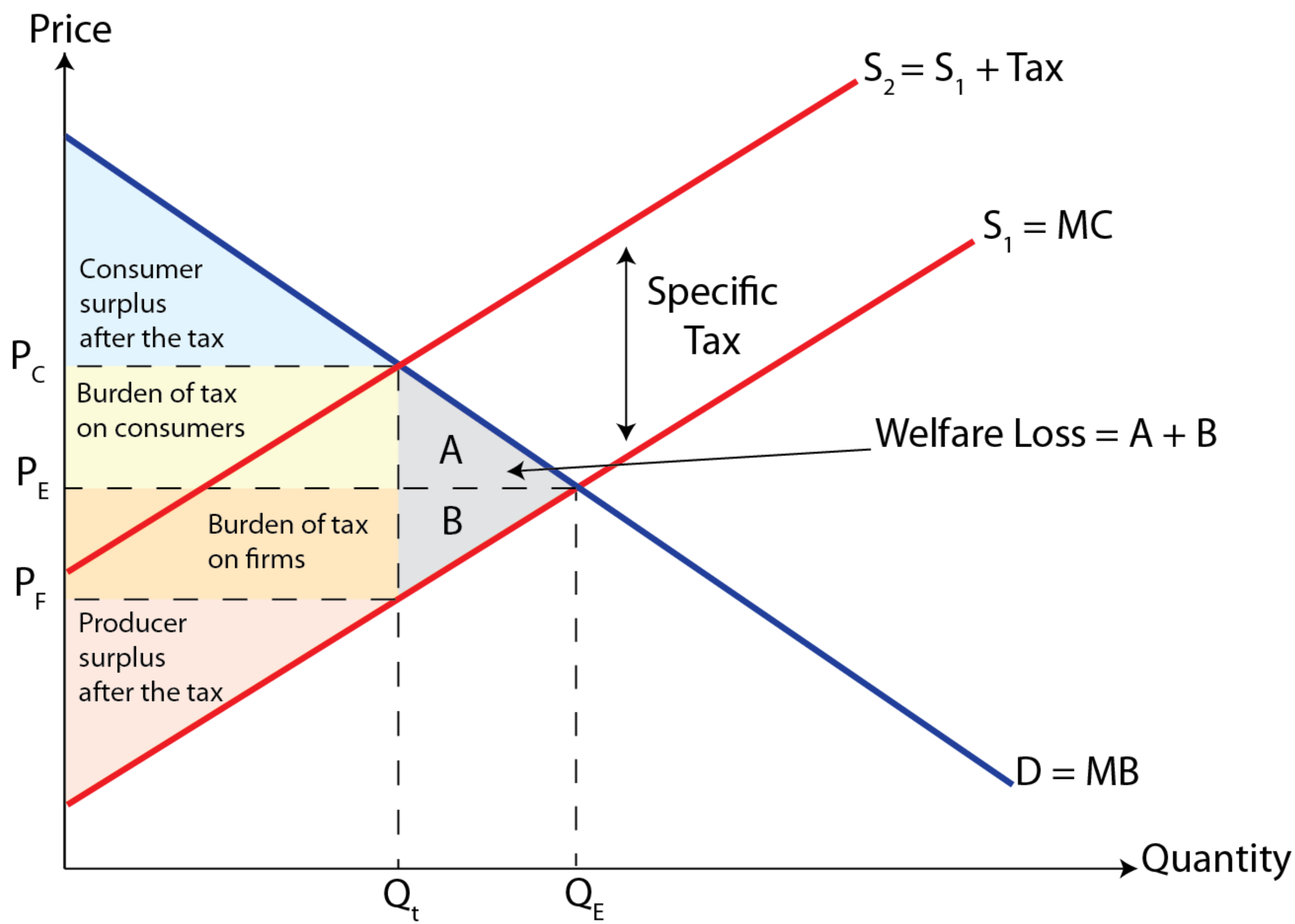
Tax & Subsidies and Linear Functions

Overview

- Given a supply function of the general form $\mathbf{Q_S = c + dP}$
  - Whenever there is a *downward shift* of the function by **s** units, where **s** is the subsidy per unit we replace **P** by **P + s**. The new supply function therefore becomes $\mathbf{Q_S = c + d(P + s)}$.
  - Whenever there is a *upward shift* of the function by **t** units, where **t** is the tax per unit we replace **P** by **P − t**. The new supply function therefore becomes $\mathbf{Q_S = c + d(P - t)}$.

	Original Function	Revised Function
Taxes (**t**)	$\mathbf{Q_s = c + dP}$	$\mathbf{Q_s = c + d(P - t)}$
Subsidy (**s**)	$\mathbf{Q_s = c + dP}$	$\mathbf{Q_s = c + d(P + s)}$

Recap- Indirect Taxes



Tax Incidence and Linear Functions

- Linear functions can be used for the analysis of tax incidence

- **Example;** Suppose the demand and supply of cigarettes can be modeled as follows, $\mathbf{Q_D = 1600 - 200P}$ and $\mathbf{Q_S = 600 + 300P}$

Linear supply and demand schedules: Cigarettes		
Price (P)	**Quantity demanded (Q_D)**	**Quantity supplied (Q_S)**
5	600	2100
4	800	1800
3	1000	1500
2	1200	1200
1	1400	900
0	1600	600

- We can determine the equilibrium price and quantity, algebraically

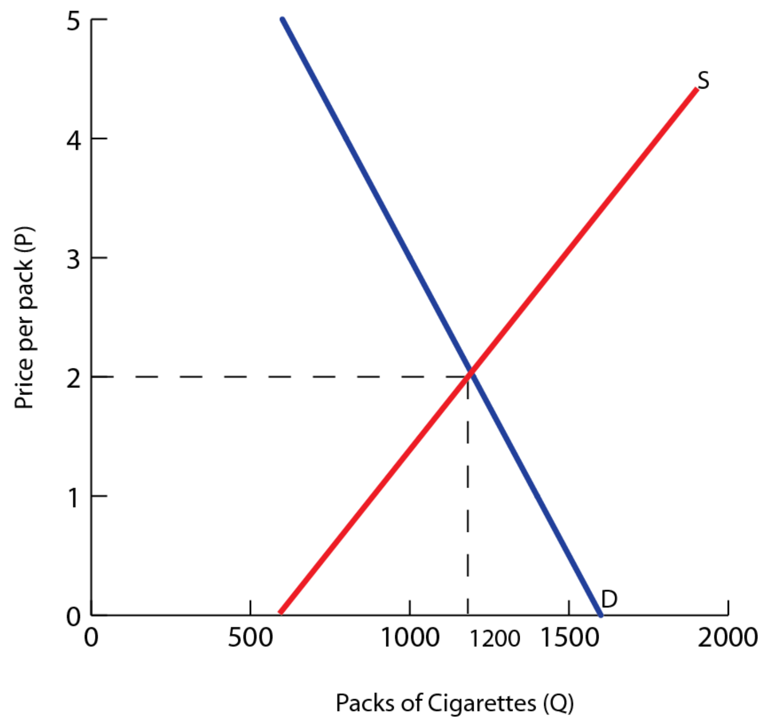
$$Q_d = Q_s$$

$$1600 - 200P = 600 + 300P$$

$$500P = 1000$$

Therefore, $P_E = \$2$ and $Q_E = 1200$ **units**

Therefore the equilibrium price is $2 and the quantity is 1200 units



Example; Tax on Cigarettes

- **Example;** Suppose the government places a $1 tax on each pack of cigarettes
  - The tax is a cost imposed on the producers of cigarettes, so whatever the price consumers pay, $1 must be given over to the government
  - Therefore, producers will receive $1 less than the new equilibrium price
  - The new supply function can be expressed as , $\mathbf{Q_S = 600 + 300(P - 1)}$ or by simplifying we get $\mathbf{Q_S = 300 + 300P}$
  - To determine the new equilibrium, we set the new supply equal to demand

$Q_d = Q_s$

300 + 300P = 1600 - 200P

500P =1300

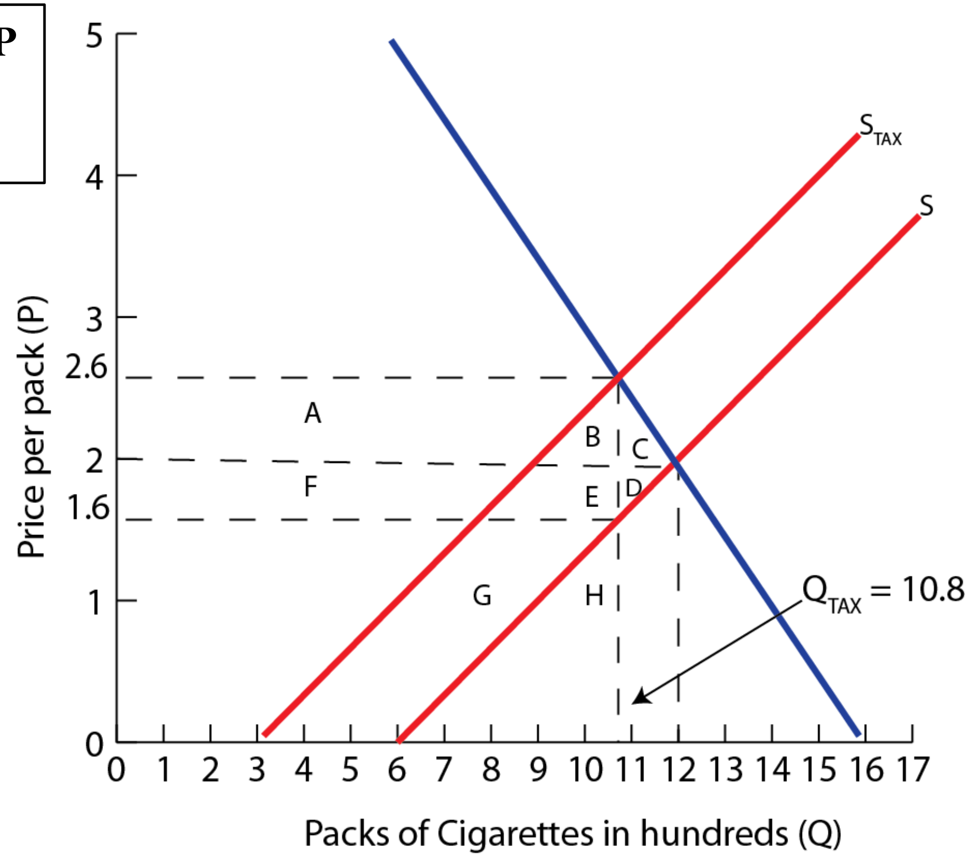
Therefore, **P_E= $2.6** and **$Q_E$= 1080 unit**

Therefore the equilibrium price is $2.6 and the quantity is 1080 units

1080 = 600 + 300P

480 = 300P

P = $1.60



<u>Calculate</u>

1) Tax Revenue
2) Consumer Tax Burden
3) Producer Tax Burden
4) Δ Consumer Surplus
5) Δ Producer Surplus
6) Welfare Loss

- Because the demand for cigarettes is relatively inelastic, the larger burden of the tax is passed on to consumers.

- We can also analyze the impact of the tax on various other factors,

- **Tax revenue:** is shown by the area **A + B + E + F** and is equal to **$1 × 1080 = $1080**

- **Consumer tax burden:** is represented by the area **A + B** and is equal to **($2.60 - $2) × 1080 = $648**

- **Producer tax burden:** is represent by the area **F + E** and is equal to **($2 - $1.60) × 1080 = $432**

- **Effect on consumer surplus:** the loss of the consumer surplus is **A + B + C** which is equal to **$648 + 0.5(72) = $684**

- **Effect on producer surplus:** the loss of producer surplus is represented by **D + E + F** and is equal to the producer burden plus the area of **D** which is **$432 + 0.5(48) = $456**

- **Welfare loss from the tax:** overall, the amount of both consumer and producer surplus in the cigarette market falls because of the tax

  - The total loss in consumer and producer surplus is $1140

  - **Net welfare loss = ΔG + ΔCS + ΔPS**

    = $1080 − $684 − $456

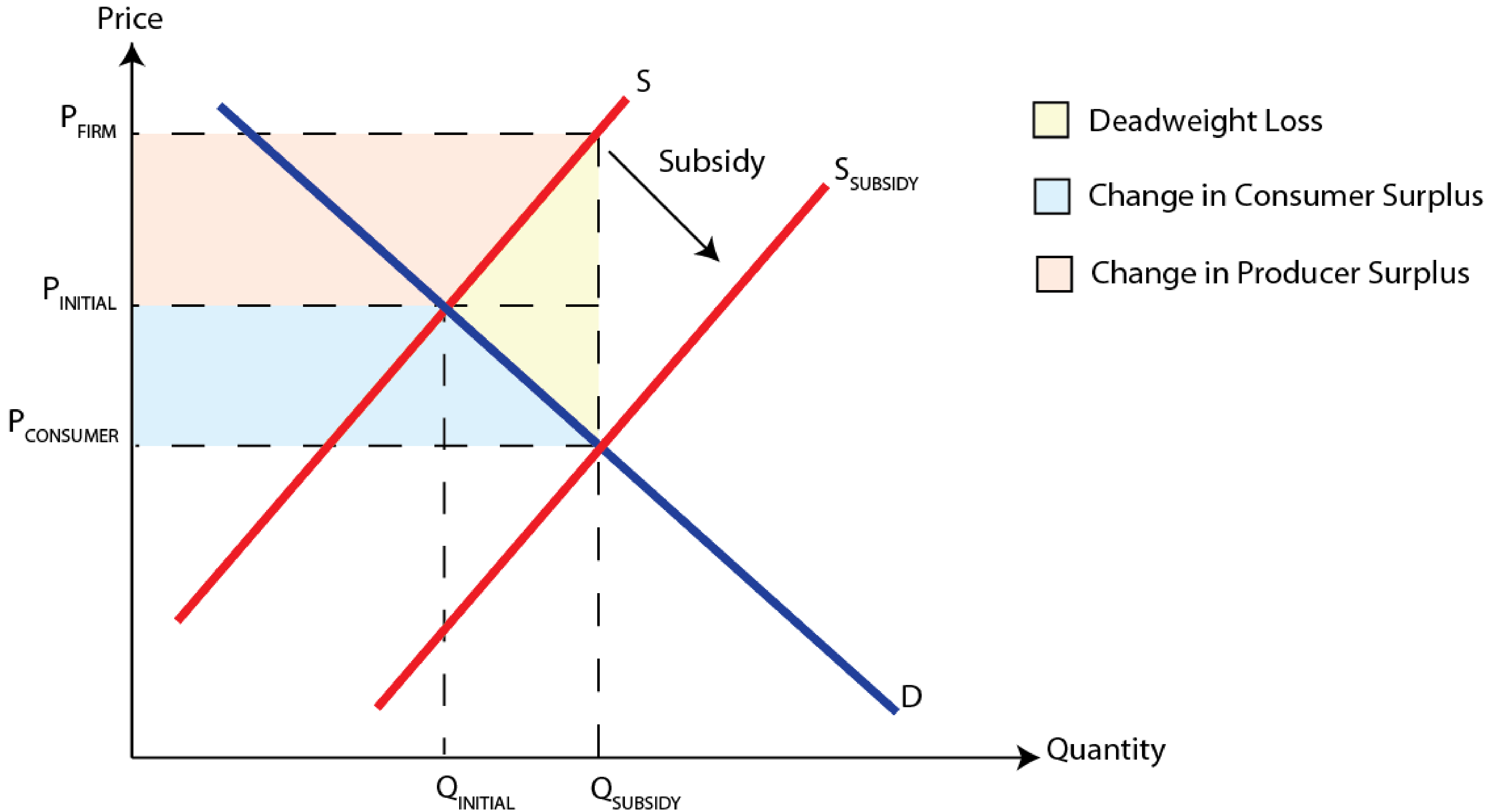
    = $60

- The tax on cigarettes creates $1080 of government revenue, but imposes a $60 welfare loss to society

  - Since consumers and producers of cigarettes lose more welfare than society gains in tax revenue

Subsidies and Linear Functions

Recap- Subsidies



Subsidies and Linear Functions

- Linear functions can be used for the analysis of subsidies
- **Example;** Suppose the demand and supply of cotton can be modeled as follows, $\mathbf{Q_D = 30 - 4P}$ and $\mathbf{Q_S = 6 + 2P}$

Linear supply and demand schedules: Cigarettes		
Price (P)	**Quantity demanded (Q_D)**	**Quantity supplied (Q_S)**
6	6	18
4	14	14
3	18	12
2	22	10
1	26	8
0	30	6

- We can determine the equilibrium price and quantity, algebraically

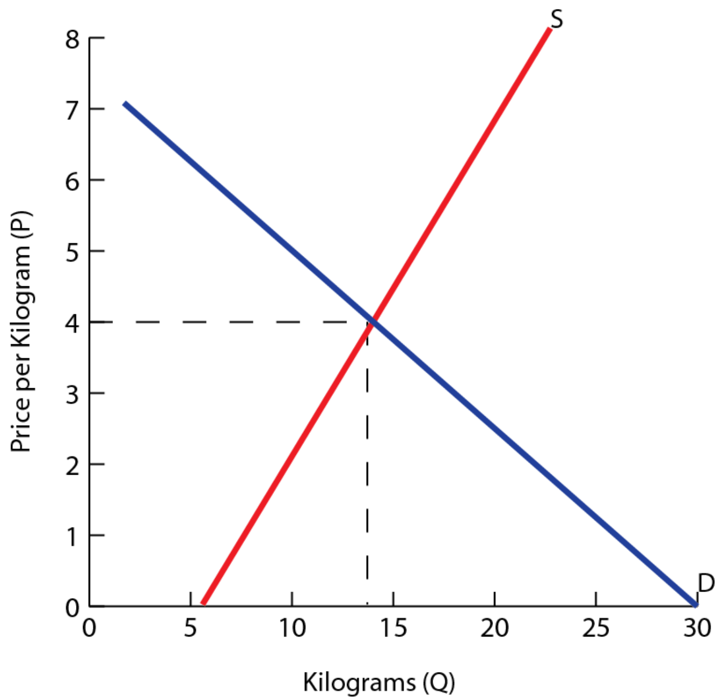
$$Q_d = Q_s$$

30 – 4P = 6+ 2P

6P =24

Therefore, $\mathbf{P_E}$**= $4** and $\mathbf{Q_E}$**= 14 units**

Therefore the equilibrium price is $4 and the quantity is 14 units



Example; Subsidy on Cotton

- **Example;** Suppose the government places a $3 subsidy on each kilogram of cotton
  - The producers will now receive $3 more per kilogram produced than the price the consumers pay
  - The new supply function can be expressed as , $\mathbf{Q_S = 6 + 2(P + 3)}$ or by simplifying we get $\mathbf{Q_S = 12 + 2P}$
  - To determine the equilibrium after the price subsidy, we set the new supply function equal to demand

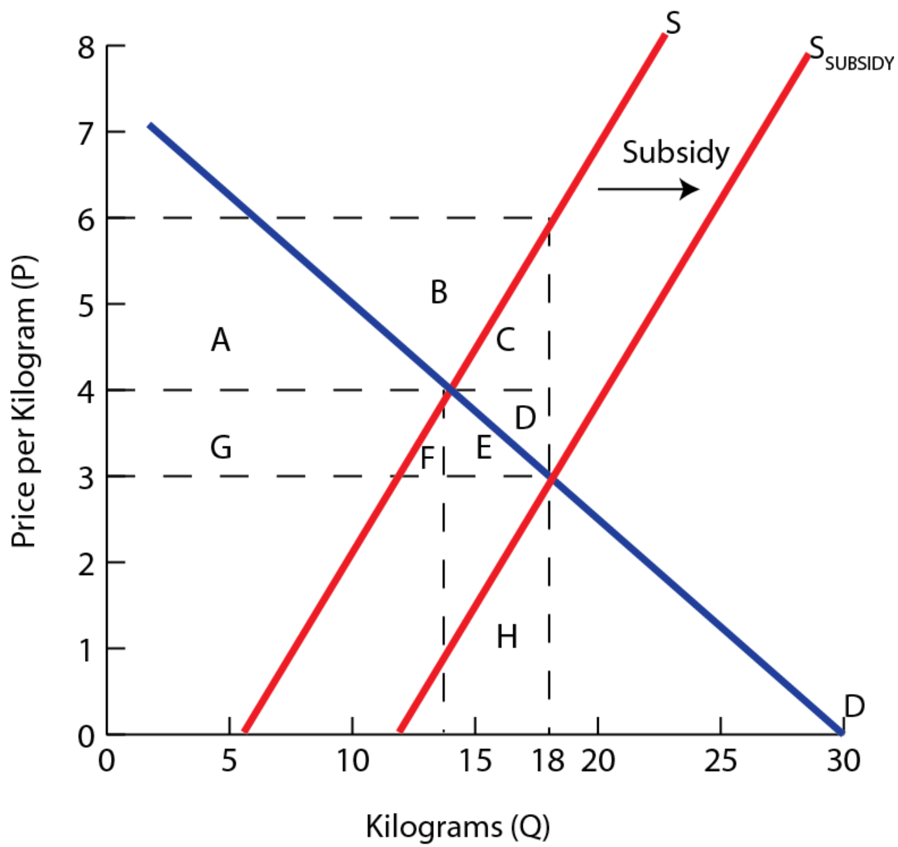
$$Q_d = Q_s$$

$$12 + 2P = 30 - 4P$$

$$6P = 18$$

Therefore, $P_E = \$3$ and $Q_E = 18$ **units**

Therefore the equilibrium price is $3 and the quantity is 18 units



Calculate

1) Government Spending
2) Δ Consumer Surplus
3) Δ Producer Surplus
4) Welfare Loss

- Both consumer and producer welfare increases as a result of a subsidy,
- **Change in consumer surplus:** the increase in the consumer surplus is **E + F + G** since consumers now enjoy a lower price and greater quantity. This is equal to **$16** million
- **Change in producer surplus:** the increase in producer surplus is **A + B** which is equal to **$32** million
- **Increase in total consumer and producer welfare:** the subsidy increases producer and consumer welfare by **$48** million

* We also need to take into the account the cost to taxpayers and society of subsidizing cotton grower
  - **Total cost of the subsidy:** is **A + B + C + D + E + F + G** and is equal to **$3 × 18 = $54** million

- **Net effect on welfare:** the cost of the subsidy was **$54** million, but the benefit was only **$48** million, so the net loss of welfare for society was **$6** million

- **Deadweight (welfare) loss:** is represented by the area of triangle **C + D** which is equal to **$6** million

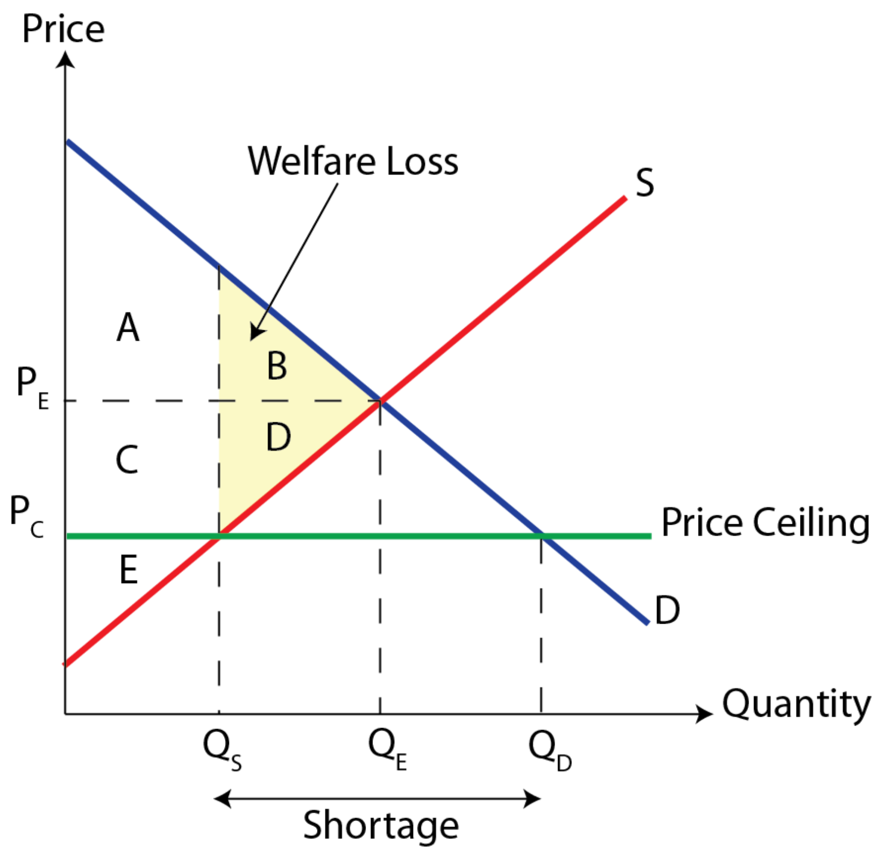
- The subsidy creates a deadweight loss for society as a whole

  - The taxpayer money used to subsidize cotton growers exceeds the increase in cotton growers and consumers welfare by **$6** million

Price Ceilings & Price Floors

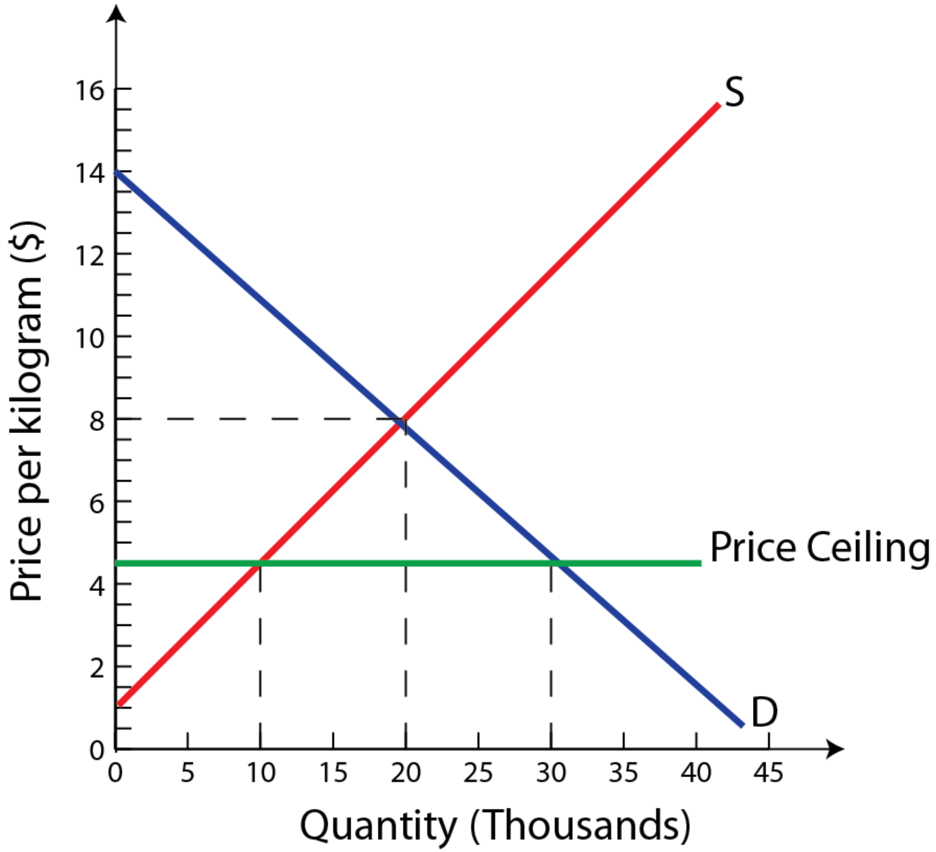
Recap- Price Ceiling

- **Price Ceiling-** is a government imposed legal maximum price set below the market equilibrium.



Price Ceiling

- **Example;** Suppose the government imposes a price ceiling on rice of $4.50 per kilogram. This may be done to make basic food staples more affordable to low-income households.



Calculate

1) Shortage (Excess demand)
2) Δ Consumer Spending
3) Δ Producer Revenue

- The original market equilibrium price was \$8.00, at which 20,000 kilograms of rice are sold.

- The price ceiling reduces the price to \$4.50, which increases the quantity demanded to 30,000 and reduces the quantity supplied to 10,000 kilograms. Thus the price-ceiling results in a shortage.

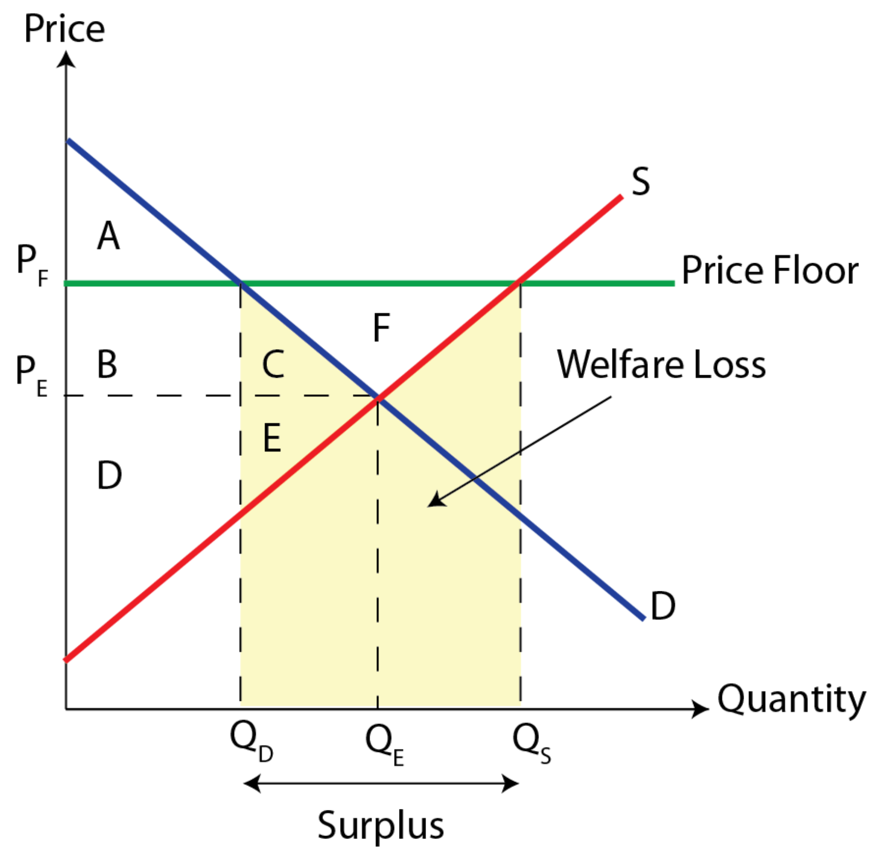
  - **Shortage:** $Q_D - Q_S = 30{,}000 - 10{,}000 = 20{,}000$ kilograms

- We can also analyze the impact of the price ceiling on the change in consumer expenditures or firm revenues.

  - $$\begin{aligned} \Delta\text{Expenditures} &= \text{Expenditures}_{New} - \text{Expenditures}_{Old} \\ &= (\$4.50 \times 10{,}000) - (\$8.00 \times 20{,}000) \\ &= \$45{,}000 - \$160{,}000 \\ &= -\$115{,}000 \end{aligned}$$

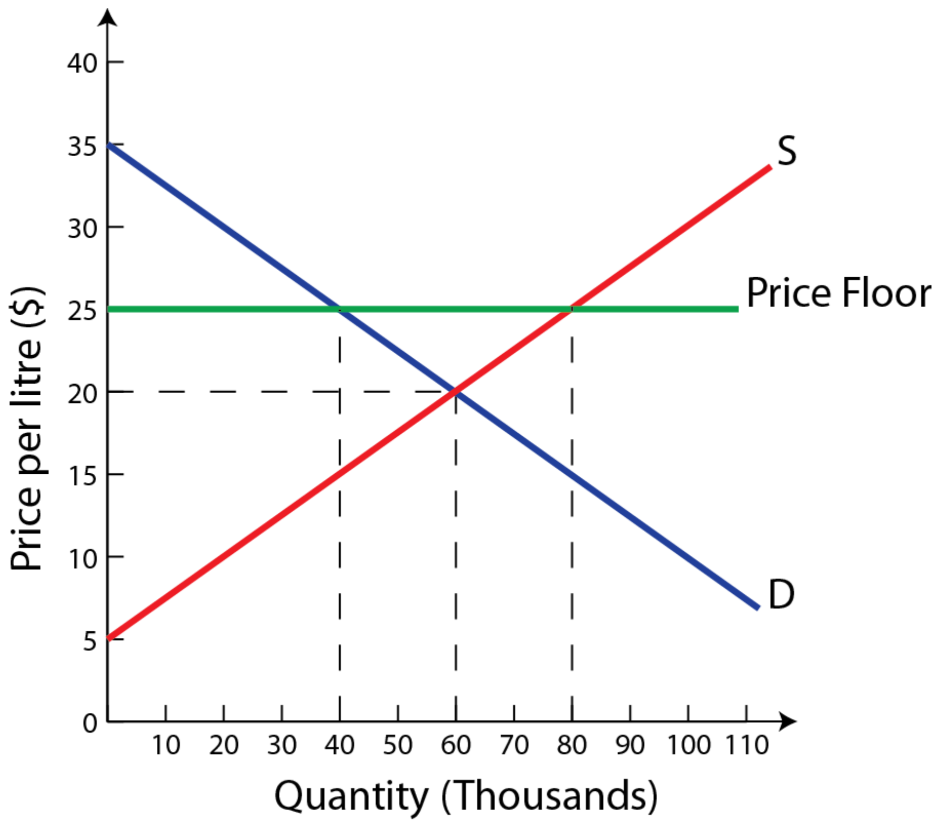
Recap- Price Floor

- **Price Floor-** is a government imposed legal minimum price set above the market equilibrium.



Price Floor

- **Example;** Suppose the government imposes a price floor for wine of $25 per liter. This may be done to protect the income and employment of the country's wine producers.



Calculate

1) Surplus (Excess supply)
2) Δ Consumer Spending
3) Δ Producer Revenue
4) Government Spending

- The original market equilibrium price was \$20, at which 60,000 liters of wine are sold.

- The price ceiling raises the price to \$25, which increases the quantity supplied to 80,000 and reduces the quantity demanded to 40,000 liters. Thus the price-floor results in a surplus.

    - **Surplus:** $\mathbf{Q_S - Q_D} = 80{,}000 - 40{,}000 = 40{,}000$ liters

- We can also analyze the impact of the price floor on various stakeholders,

    - $$\mathbf{\Delta Expenditures = Expenditures_{New} - Expenditures_{Old}}$$
      $$= (\$25 \times 40{,}000) - (\$20 \times 60{,}000)$$
      $$= \$1{,}000{,}000 - \$1{,}200{,}000$$
      $$= -\$200{,}000$$

- There is a reduction in consumer spending of \$200,000

- There is also an increase in the producers revenue of $800,000 as a result of the price floor.

  - $$\mathbf{\Delta Firm\ Revenue = Revenue_{New} - Revenue_{Old}}$$
    $$= (\$25 \times 80{,}000) - (\$20 \times 60{,}000)$$
    $$= \$2{,}000{,}000 - \$1{,}200{,}000$$
    $$= \$800{,}000$$

- The government must purchase the excess supply of wine to prevent the market from reverting back to the original equilibrium

  - $$\mathbf{Government\ Expenditure = Price \times Quantity_{Surplus}}$$
    $$= (\$25 \times 40{,}000)$$
    $$= \$1{,}000{,}000$$

Elasticities

Recap- Price Elasticity of Demand

- **Price Elasticity of Demand (PED):** is a measure of the responsiveness of the quantity of a good demanded to changes in its price.

  - **PED = $\%\Delta Q_D \div \%\Delta P$**

Value of PED	Classification	Interpretation
Frequently Encountered Cases		
$0 < PED < 1$	Inelastic demand	Price insensitive
$1 < PED < \infty$	Elastic demand	Price sensitive
Special Cases		
$PED = 1$	Unitary elastic demand	$\%\Delta Q_D = \%\Delta P$
$PED = 0$	Perfectly inelastic demand	Fixed quantity
$PED = \infty$	Perfectly elastic demand	Fixed price

- There are several factors that determine whether the demand for a good is elastic or inelastic.
  - **1) Number and closeness of substitutes**
  - **2) Necessities versus luxuries**
  - **3) Length of time**
  - **4) Proportion of income spent on a good**
- Along any *downward-sloping*, *straight-line demand curve*, the PED varies as we move along the curve.
  - Demand is price elastic at high-prices and low-quantities
  - Demand is price inelastic at low prices and large-quantities
  - At the midpoint of the demand curve, there is unit elastic demand

PED- Calculations

- **Example;** Tesla Motors Model S retails for $85,000 in Canada in August. Approximately, 100 Model S vehicles were sold in August.
- In September, the government implemented a rebate program of $5,000 for electric vehicles. Estimates indicate 110 vehicles will be sold in September.
- **PED** $= \%\Delta Q_D \div \%\Delta P$

  $= [(Q_{NEW} - Q_{OLD})/Q_{OLD}] \div [(P_{NEW} - P_{OLD})/P_{OLD}]$

  $= [(110 - 100)/100] \div [(\$80{,}000 - \$85{,}000)/\$85{,}000]$

  $= 10\% \div 5.8824\%$

  $= 1.70$
- This indicates that the demand for the Model S is *price elastic,* since the **PED > 1** and a decrease in price will increase Tesla's revenues.

Cross-Price Elasticity of Demand

- **Cross-Price Elasticity of Demand (XED):** is a measure of the responsiveness of demand for one good to a change in the price of another good.

- It involves demand curve shifts and provides information on whether demand increases or decreases, and on the size of the demand curve shifts

  - $\mathbf{XED = \%\Delta Q_X \div \%\Delta P_Y}$

Value of XED	Classification	Example
XED > 0	Substitutes	Coca-Cola & Pepsi
XED < 0	Complements	Ice-Cream & Cones

XED- Calculations

- **Example;** Suppose a convenience store decides to increase the price of a 500 mL bottle of Coca-Cola from $1.50 to $1.80.

- The store maintains their prices for Pepsi and the quantity demanded for the product increases from 1,000 to 1,140 bottles in a particular month.

  - $\mathbf{XED = \%\Delta Q_X \div \%\Delta P_Y}$

    $\mathbf{= [(Q_{NEW} - Q_{OLD})/Q_{OLD}] \div [(P_{NEW} - P_{OLD})/P_{OLD}]}$

    $= [(1{,}140 - 1{,}000)/1{,}000] \div [(\$1.80 - \$1.50)/\$1.50]$

    $= 14\% \div 20\%$

    $= 0.70$

- This indicates that Coca-Cola and Pepsi have a high degree of *substitutability* since **XED > 0** and relatively close to 1.

Income Elasticity of Demand

- **Income Elasticity of Demand (YED):** is a measure of the responsiveness of demand to changes in income.

- It involves demand curve shifts and provides information on the direction of change of demand given a change in income and on the size of the change.

  - **$YED = \%\Delta Q_D \div \%\Delta Y$**

Value of YED	Classification	Interpretation
$YED < 0$	Inferior Good	Quantity falls with income
$YED > 0$	Normal Good	Quantity increases with income
$0 < YED < 1$	Necessities	Income inelastic demand
$YED > 1$	Luxuries	Income elastic demand

YED- Calculations

- **Example;** Your income increases from £1,000 a month to £1,200 a month. As a result, the frequency that you dine-out at restaurants increases from 4 to 6 times per month.

  - $\textbf{YED} = \%\Delta Q_D \div \%\Delta Y$

    $= [(Q_{NEW} - Q_{OLD})/Q_{OLD}] \div [(Y_{NEW} - Y_{OLD})/Y_{OLD}]$

    $= [(6 - 4)/4] \div [(£1{,}200 - £1{,}000)/£1{,}000]$

    $= 50\% \div 20\%$

    $= 2.50$

- This indicates that dining-out at restaurants has *income elastic demand* and is a *normal good* since **XED > 1**

Recap- Price Elasticity of Supply

- **Price Elasticity of Supply (PES):** is a measure of the responsiveness of the quantity of a good supplied to changes in its price.
  - **PES = $\%\Delta Q_S \div \%\Delta P$**

Value of PES	Classification	Interpretation
Frequently Encountered Cases		
$0 < PES < 1$	Inelastic supply	Price insensitive
$1 < PES < \infty$	Elastic supply	Price sensitive
Special Cases		
PES = 1	Unitary elastic supply	$\%\Delta Q_S = \%\Delta P$
PES = 0	Perfectly inelastic supply	Fixed quantity
$PES = \infty$	Perfectly elastic supply	Fixed price

- There are several factors that determine whether the supply for a good is elastic or inelastic.

- **1) Length of time**
  - The amount of time firms have to adjust their inputs and the quantity supplied in response to changes in price

- **2) Mobility of the factors of production**
  - The ease and speed with which firms can shift resources and production between different products

- **3) Spare capacity of firms**
  - The greater the spare capacity the more elastic the supply

- **4) Ability to store stocks**
  - Firms that have an ability to store stocks are likely to have a more elastic supply than firms that cannot store stocks

PES- Calculations

- **Example;** Suppose that the price of oil increases from \$100 to \$110 as a result of instability in the Middle East.

- In response, the quantity of oil supplied by Canadian producers increases from 1.25 to 1.30 million barrels of oil per day.

- **PED** $= \%\Delta Q_S \div \%\Delta P$

  $= [(Q_{NEW} - Q_{OLD})/Q_{OLD}] \div [(P_{NEW} - P_{OLD})/P_{OLD}]$

  $= [(1.30 - 1.25)/1.25] \div [(\$110 - \$100)/\$100]$

  $= 4\% \div 10\%$

  $= 0.4$

- This indicates that the supply of oil from Canadian sources is *price inelastic,* since the **PES < 1**.

Summary of Key Characteristics

Elasticity	Values		Description
Price elasticity of demand $PED = \%\Delta Q_D \div \%\Delta P$ **Price elasticity of supply** $PES = \%\Delta Q_S \div \%\Delta P$	PED = 0	PES = 0	Perfectly inelastic
	PED < 1	PES < 1	Price inelastic
	PED = 1	PES = 1	Unit elastic
	PED > 1	PES > 1	Price elastic
	PED = ∞	PES = ∞	Perfectly elastic
Cross-price elasticity of demand $XED = \%\Delta Q_X \div \%\Delta P_Y$	XED < 0		Substitutes
	XED = 0		Unrelated
	XED > 0		Complements
Income elasticity of demand $YED = \%\Delta Q_D \div \%\Delta Y$	YED < 0		Inferior good
	YED > 0		Normal good
	0 < YED < 1		Income inelastic (Necessity)
	YED > 1		Income elastic (Luxury)

Study Questions

- **1.** If the XED between Coca-Cola and Pepsi is 0.7, how will the demand for Coca-Cola change if the price of Pepsi increases by 5%?

- **2.** Your income increases from £1000 a month to £1200 a month. As a result, you increase your purchases of pizza from 8 to 12 per month, and decrease your purchases of chees sandwiches from 15 to 10 per month.

- **A.** Calculate your income elasticity of demand for pizzas and for cheese sandwiches.

- **B.** What kind of goods are pizzas and cheese sandwiches for you?

- **C.** Show using diagrams the effect of your increase in income on your demand for pizzas and cheese sandwiches.

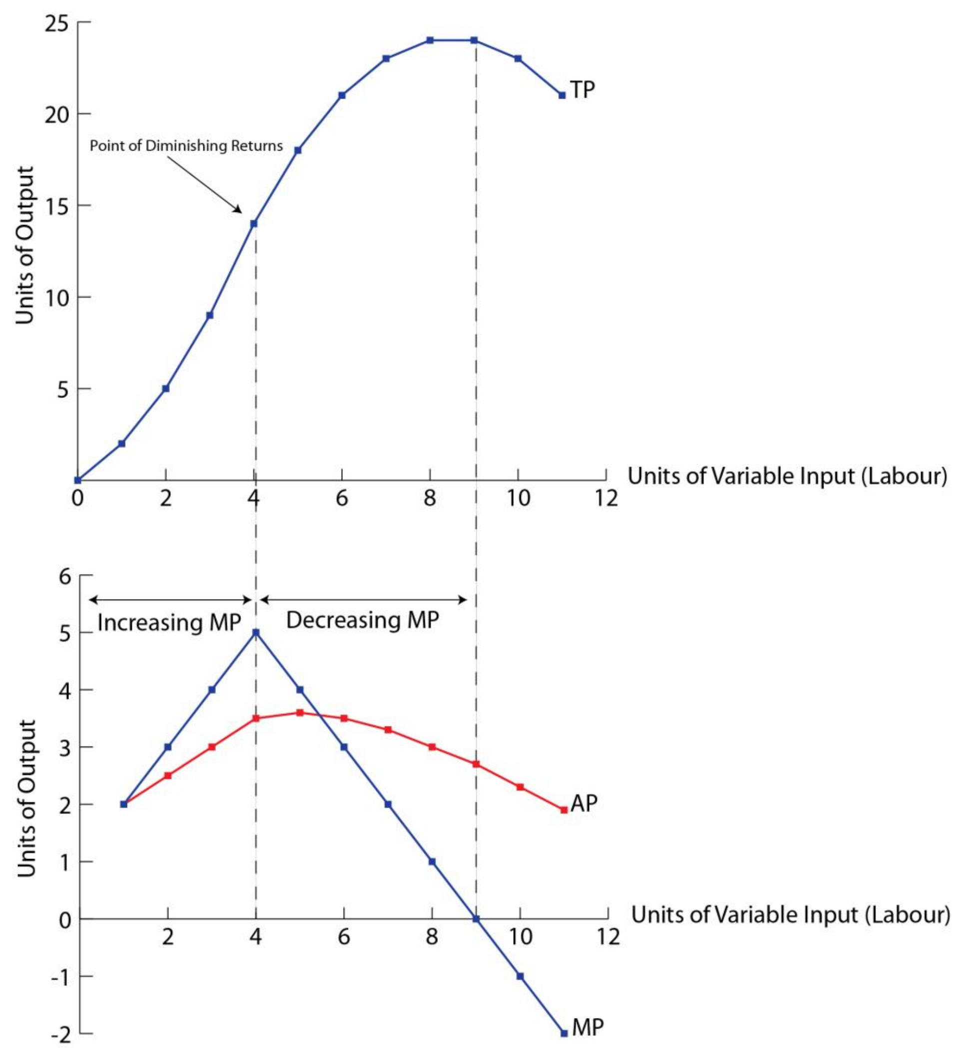
Production & Costs in the Short-run

Total, Marginal & Average Product

- **Total Product (TP):** is the total quantity of output produced by a firm
- **Marginal Product (MP):** is the extra or additional output resulting from one additional unit of the variable input
  - It tells us by how much output increases as labour increases by one worker.
  - **MP = ΔTP ÷ ΔLabour**
- **Average Product (AP)**: is the total quantity of output per unit of variable input, or labour
  - This tells us how much output each unit of labour produces on average
  - **AP = TP ÷ Labour**

Example; TP, MP and AP

Labour (L)	Total Product (TP)	Marginal Product (MP) MP = ΔTP ÷ ΔLabour	Average Product (AP) AP = TP ÷ Labour
0	0	–	–
1	2	2	2
2	5	3	2.5
3	9	4	3
4	14	5	3.5
5	18	4	3.6
6	21	3	3.5
7	23	2	3.3
8	24	1	3
9	24	0	2.7
10	23	− 1	2.3
11	21	− 2	1.9



- **Law of Diminishing Returns:** as more and more units of a variable input (such as labour) are added to one or more fixed inputs (such as land), the marginal product of the variable input at first increases, but there comes a point when it begins to decrease

Economic Costs

- **Economic Costs:** are the sum of explicit and implicit costs, or total opportunity costs incurred by a firm for its use of resources, whether purchases or self-owned.
    - **Economic Costs = Explicit Costs + Implicit Costs**
    - When economists refer to 'costs' they mean 'economic costs'
- **Explicit Costs:** payments made by a firm to outsiders to acquire resources for use in production
- **Implicit Costs:** the sacrificed income arising from the use of self-owned resources by a firm

Short-Run Costs

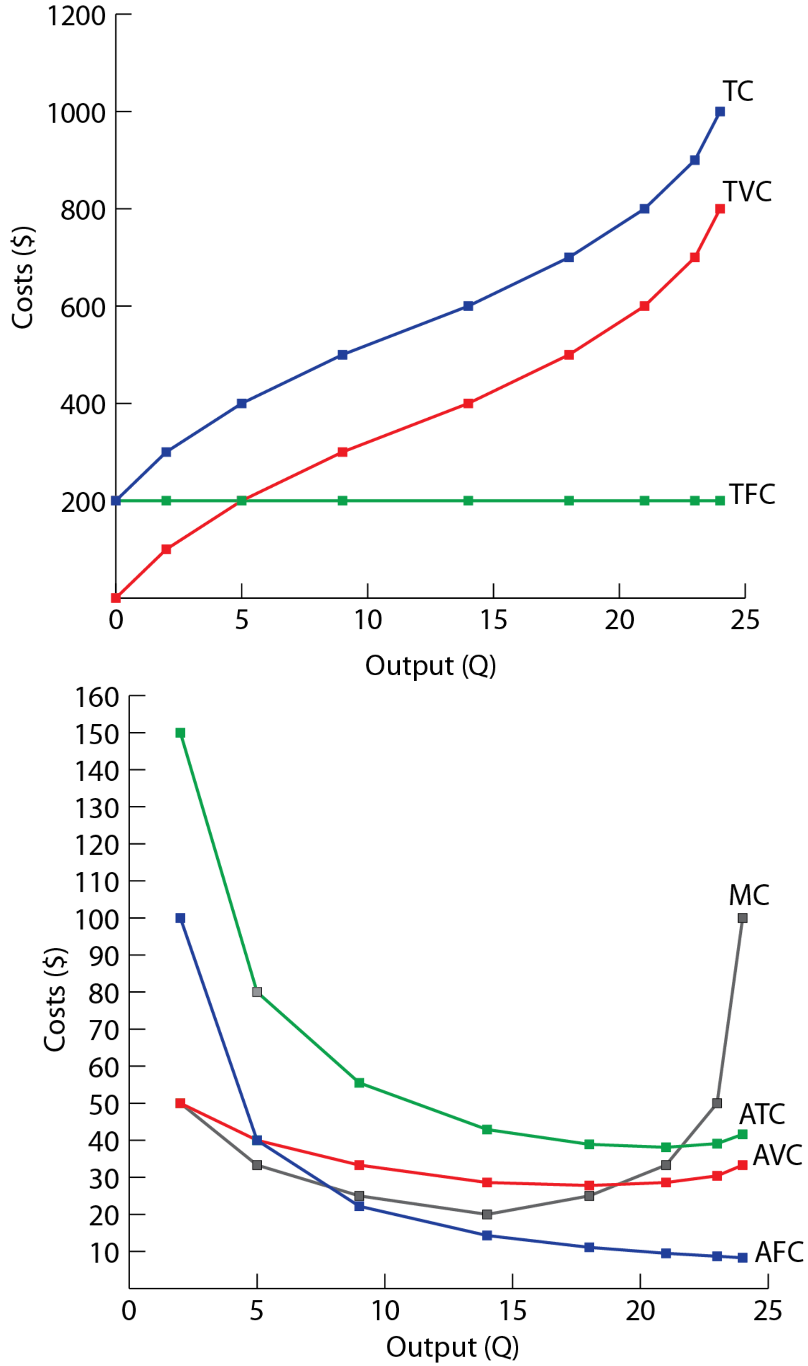
- **Fixed Costs (FC):** arise from the use of fixed inputs. Fixed costs are costs that do not change as output changes.
  - **Example;** Rental payments, property taxes, insurance premiums
- **Variable Costs (VC):** arise from the use of variable inputs. These costs change as output increases or decreases.
  - **Example;** Wage cost of labour
- **Total Costs:** in the short-run, a firm's total costs are the sum of fixed and variable costs.
  - In the long-run there are no fixed costs, therefore a firm's total costs are equal to its variable costs
  - **TC = TFC + TVC**

Average and Marginal Costs

- **Average Costs:** are costs per unit of output, or total cost divided by the number of units of output.
  - **AFC = TFC ÷ Q** (Average fixed costs)
  - **AVC = TVC ÷ Q** (Average variable costs)
  - **ATC = TC ÷ Q**
    = AFC + AVC (Average total costs)
- **Marginal Cost (MC):** is the extra or additional costs of producing one more unit of output.
  - **MC = ΔTC ÷ ΔQ**
    = ΔTVC ÷ ΔQ

Example; Cost & Product Curves

Total Product (TP)	Labour (L)	TFC	TVC	TC	AFC	AVC	ATC	MC
0	0	200	0	200	–	–	–	–
2	1	200	100	300	100	50	150	50
5	2	200	200	400	40	40	80	33.3
9	3	200	300	500	22.2	33.3	55.5	25
14	4	200	400	600	14.3	28.6	42.9	20
18	5	200	500	700	11.1	27.8	38.9	25
21	6	200	600	800	9.5	28.6	38.1	33.3
23	7	200	700	900	8.7	30.4	39.1	50
24	8	200	800	1000	8.3	33.3	41.6	100



1200
1000
800
600
400
200
Costs ($)
TC
TVC
TFC
0
5
10
15
20
25
Output (Q)
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Costs ($)
MC
ATC
AVC
AFC
0
5
10
15
20
25
Output (Q)

Summary

Concept	Definition	Equation
Product Concepts		
Total product (TP)	The total amount of output produced	
Marginal product (MP)	The additional output produced by one additional unit of variable input.	$MP = \Delta TP \div \Delta L$
Average product (AP)	Output per unit of variable input	$AP = TP \div L$
Cost Concepts		
Total cost (TC)	The sum of fixed and variable costs	$TC = TFC + TVC$
Average fixed cost (AFC)	Fixed cost per unit of output	$AFC = TFC \div Q$
Average variable cost (AVC)	Variable cost per unit of output	$AVC = TVC \div Q$
Average total cost (ATC)	Total cost per unit of output	$ATC = AFC + AVC$
Marginal cost (MC)	The change in cost arising from one additional unit of output	$MC = \Delta TC \div \Delta Q$ $= \Delta TVC \div \Delta Q$

Revenue & Economic Profit

Revenues

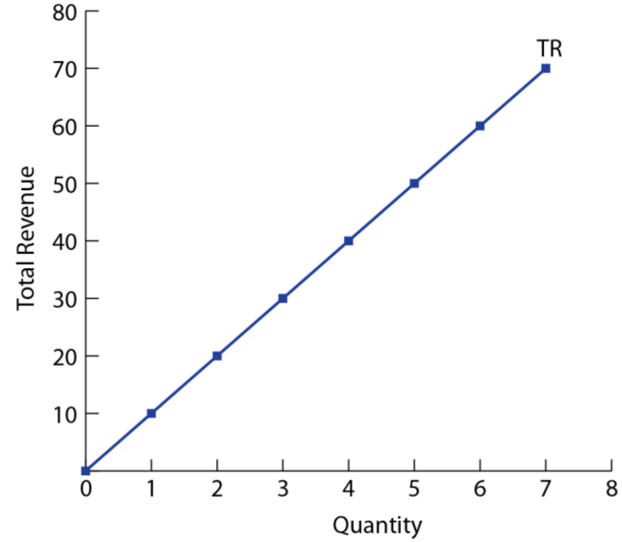
- **Total Revenue (TR):** is obtained by multiplying the price at which the good is sold (P) by the number of units of the good sold (Q)
  - **TR = P × Q**
- **Marginal Revenue (MR):** is the additional revenue arising from the sale of an additional unit of output
  - **MR = ΔTR ÷ ΔQ**
- **Average Revenue (AR):** is the revenue per unit of output sold. It is always equal to the price.
  - **AR = TR ÷ Q**
= P

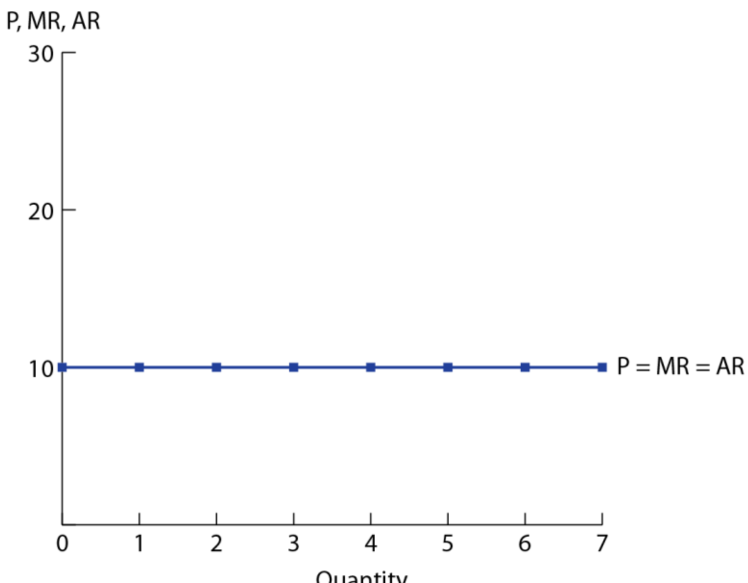
Revenues for Perfect Competition

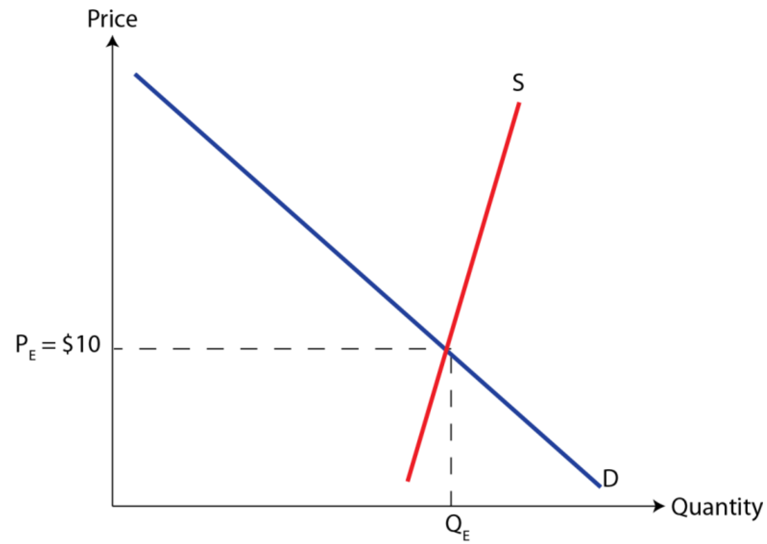
- Perfectly competitive firms compete in a market with a large number of firms each producing an identical product, and each firm's output making up a tiny fraction of the total market supply
  - It is impossible for a single firm to affect the market price, and price at which the firm sells remains unchanged regardless of output

Output (Q)	**Price (P)**	**Total Revenue** $TR = P \times Q$	**Marginal Revenue** $MR = \Delta TR \div \Delta Q$	**Average Revenue** $AR = TR \div Q$
1	10	10	10	10
2	10	20	10	10
3	10	30	10	10
4	10	40	10	10
5	10	50	10	10
6	10	60	10	10
7	10	70	10	10

- For a perfectly competitive firm, **P = D = MR = AR**



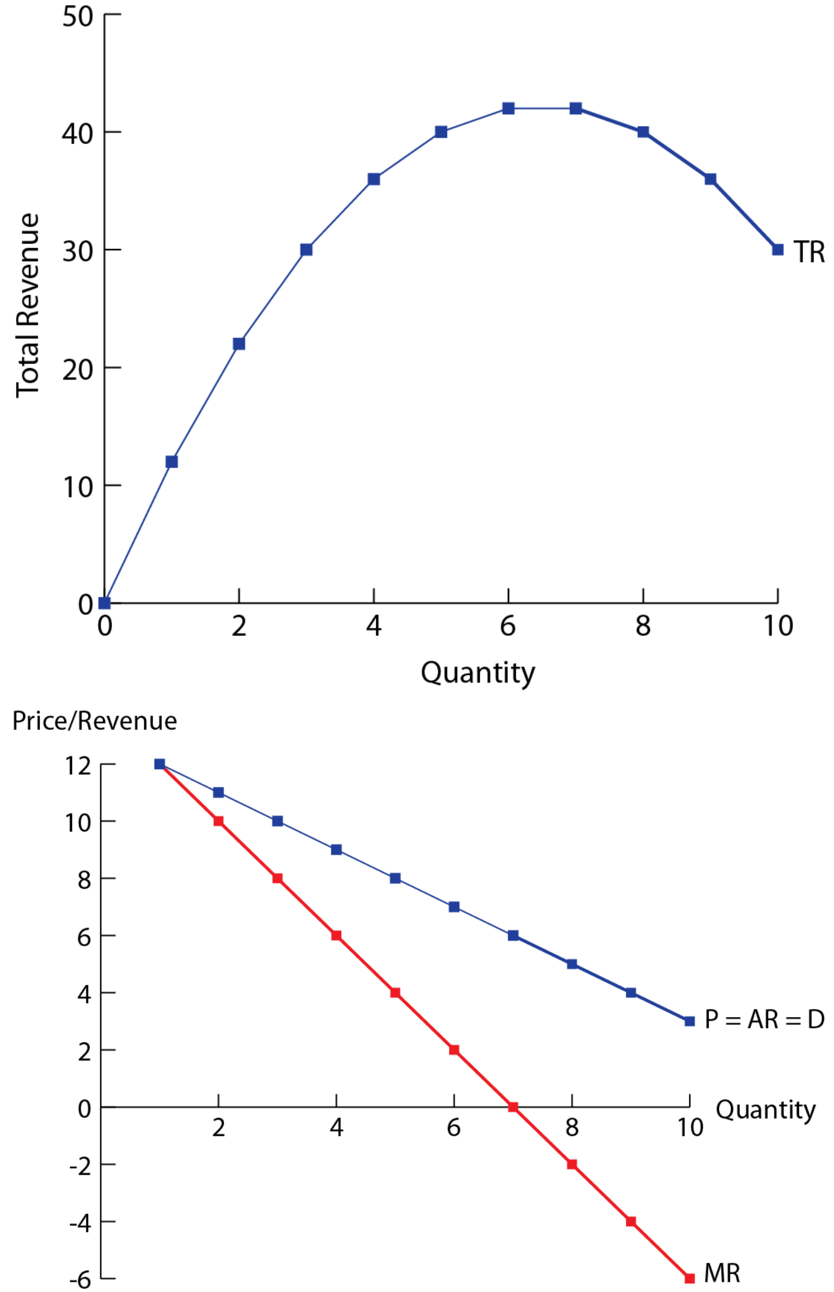




Revenues for Imperfect Competition

- Imperfectly competitive firms have some degree of control over price, and the price varies with output. Such market structures include,
  - Monopolistic competition, Oligopoly, and Monopoly

Output (Q)	**Price (P)**	**Total Revenue** $TR = P \times Q$	**Marginal Revenue** $MR = \Delta TR \div \Delta Q$	**Average Revenue** $AR = TR \div Q$
1	12	12	12	12
2	11	22	10	11
3	10	30	8	10
4	9	36	6	9
5	8	40	4	8
6	7	42	2	7
7	6	42	0	6
8	5	40	− 2	5
9	4	36	− 4	4
10	3	30	− 6	3



50
40
30
20
10
0
Total Revenue
TR
0
2
4
6
8
10
Quantity
Price/Revenue
12
10
8
6
4
2
0
-2
-4
-6
P = AR = D
2
4
6
8
10
Quantity
MR

Profit & Revenue Maximization

- Recall, **Profit = Total revenue − Total cost**
  = TR − TC
  = Total revenue − Explicit costs − Implicit costs

- Economic profit can be positive, zero or negative
  - **Supernormal profit:** TR > Economic cost (**P > AC**)
  - **Normal profit:** TR = Economic cost (**P = AC**)
  - **Loss:** TR < Economic cost (**P < AC**)

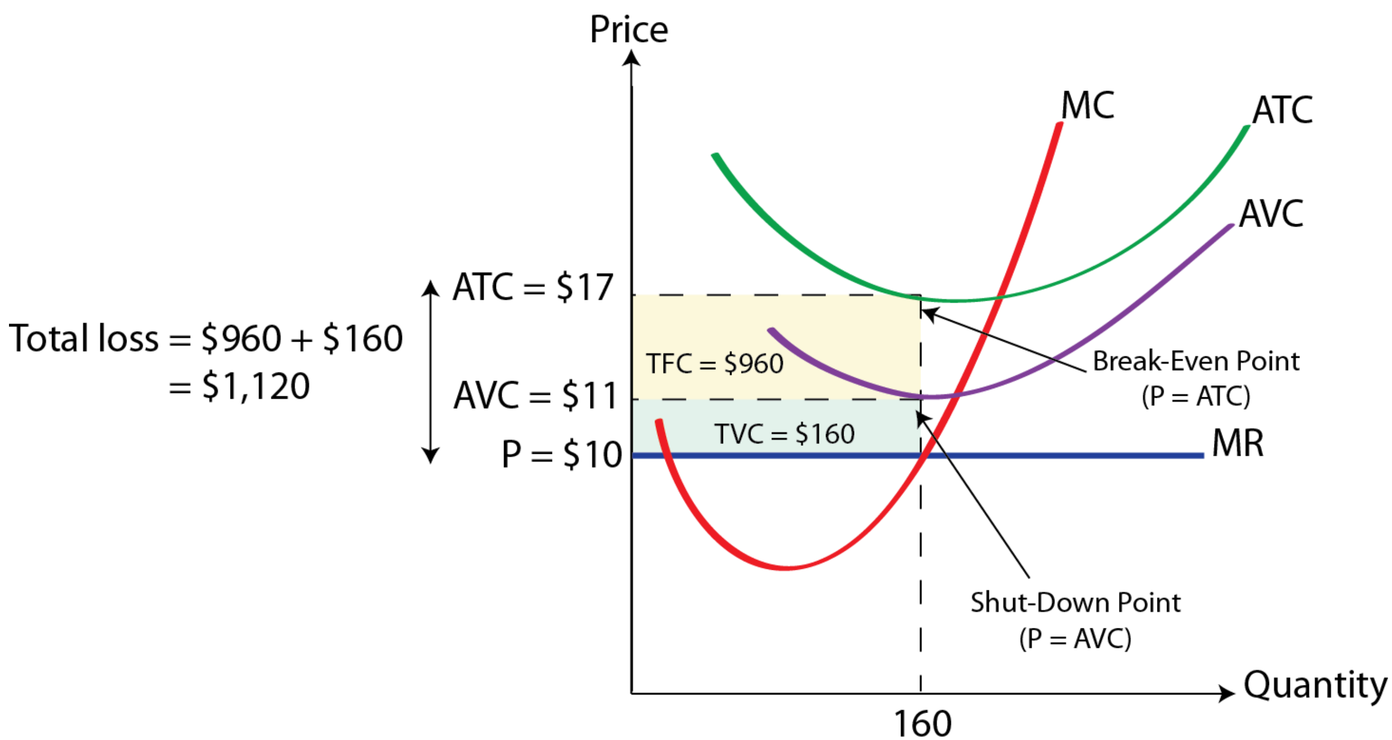
- **Profit-maximization rule:** a firm in any market structure should produce as close as possible to the point at which marginal revenue equals its marginal costs of production, where **MR = MC**

- **Revenue-maximization rule:** the revenue for a firm will be maximized at the output level in which **MR = 0**

Shut-Down & Break-Even Price

- **Break-even price:** the firm's break-even price occurs at the level of output for which the firm is earning a normal economic profit (**P = AC**)

- **Shut-down price:** a firm making an economic loss in the short-run will continue to produce a positive level of output as long as **P ≥ AVC**



Summary

Concept	Definition	Equation
Revenue Concepts		
Total revenue (TR)	The total earnings of a firm from the sale of its output.	$TR = P \times Q$
Marginal revenue (MR)	The additional revenue of a firm arising from the sale of an additional unit	$MR = \Delta TR \div \Delta Q$
Average revenue (AR)	Revenue per unit of output	$AR = TR \div Q$
Profit Concepts		
Economic profit	Total revenue minus economic costs (or total opportunity costs which is the sum of explicit and implicit costs)	$Profit = TR - TC$
Normal profit	The minimum amount of revenue required by a firm so that it will be induced to keep running.	$TR = TC$ or $P = AC$

Measures of Economic Activity

Measures of Economic Activity

- Recall, there are three ways to measure the value of aggregate output, suggested by the circular flow income model, all giving rise to the same results

- **1) Expenditure Approach:** adds up all spending to buy final goods and services produced within a country over a period.

  - **GDP = C + I + G + (X − M)**

- **2) Income Approach:** adds up all income earned by the factors of production that produce all goods and services within a country over a time period.

  - **GDP = W + I + R + P**

- **3) Output Approach:** calculates the value of all final goods and services produced in a country over a time period.

Distinction between GDP & GNP

- **Gross domestic product (GDP):** is the market value of all final goods and services produced in a country over a time period, usually a year.
  - **GDP = C + I + G + (X − M)**
- **Gross national product (GNP/GNI):** is the value of all final goods and services produced by the factors of production supplied by a country's residents regardless of where the factors are located.
  - **GNP = GDP + Income from abroad − Income sent abroad**
    = GDP + Net income from abroad
- **Green GDP:** is an adjustment of traditional GDP, deducting resource and environmental costs in economic activities.
  - **Green GDP = GDP − Value of environmental degradation**

Calculating GDP

- **Example;** The table below shows the spending components for the United States national income in 2013.

Component	***Value (in trillions)***
Consumption (C)	\$11.5
Investment (I)	\$2.67
Government Spending (G)	\$3.13
Exports (X)	\$2.10
Imports (M)	\$2.67

- **GDP = C + I + G + (X − M)**

  = \$11.5 + \$2.67 + \$3.13 + (\$2.10 − \$2.67)

  = \$16.73 trillion

Calculating GNP

- **Example;** Suppose in 2013, Canada's GDP was \$1,821 billion; Income earned abroad and sent home to Canada was \$110 billion; Income earned in Canada and sent abroad was \$29 billion. What was Canada's 2013 GNP?

  - **GNP = GDP + Net income from abroad**

    = \$1,821 + (\$110 − \$29)

    = \$1,902 billion

- Since **GNP > GDP** it indicates that Canada has significant foreign presence, in either workers or companies.

Real GDP & Nominal GDP

- **Nominal GDP:** is measured in terms of current output valued at current prices, which does not account for changes in prices.

- **Real GDP:** is a measure of economic activity that has eliminated the influence of changes in prices.

  - It measures the value of current output valued at constant prices so a relative comparison can be made to the base year

  - It is important to use real values when GDP is being compared over time

Example; Real GDP & Nominal GDP

Calculating Nominal GDP

	2001			2002			2003		
Item	Quantity	Price	Value	Quantity	Price	Value	Quantity	Price	Value
Burgers	37	$3	$111	40	$4	$160	39	$5	$195
Haircuts	15	$18	$270	17	$20	$340	18	$21	$378
Tractors	10	$50	$500	11	$60	$660	10	$65	$650
Nominal GDP			$881			$1160			$1223

Calculating Real GDP (Base year- 2001)

	2001			2002			2003		
Item	Quantity	Price	Value	Quantity	Price	Value	Quantity	Price	Value
Burgers	37	$3	$111	40	$3	$120	39	$3	$117
Haircuts	15	$18	$270	17	$18	$306	18	$18	$324
Tractors	10	$50	$500	11	$50	$550	10	$50	$500
Real GDP			$881			$976			$941

GDP Deflator

- The GDP deflator is a price index that is an indicator of price changes for all good and services produced in the economy
  - **GDP Deflator = (Nominal GDP ÷ Real GDP) × 100**
  - The index number for the base year is always 100, for all indices
  - An increasing GDP deflator indicates rising prices on average, while a decreasing GDP deflator indicates falling prices.

Year	Nominal GDP	Real GDP	GDP Deflator
2001	$881	$881	100
2002	$1160	$976	118.8
2003	$1223	$941	130

GDP Deflator & Real GDP

- The GDP deflator is a price index that is commonly used to covert nominal GDP to real GDP.

  - **Real GDP = (Nominal GDP ÷ GDP Deflator) × 100**
    = (Nominal GDP ÷ CPI) × 100

- **Example;** Suppose the nominal GDP was $7,850 billion in 2001; $9,237 billion in 2002; and $10,732 billion in 2003. The GDP deflator was 100 in 2001; 118.8 in 2002; and 130 in 2003.

  - **Real GDP$_{2001}$ = ($7,850 ÷ 100) × 100**
    = $7,850 billion

  - **Real GDP$_{2002}$ = ($9,237÷ 118.8) × 100**
    = $7,775 billion

  - **Real GDP$_{2003}$ = ($10,732 ÷ 130) × 100**
    = $8,255 billion

Calculating Economic Growth

- Recall, economic growth refers to an increase in real GDP over time.
  - It is usually expressed as a percentage change in real GDP over a specified period of time.
  - $\%\Delta GDP = (GDP_{NEW} - GDP_{OLD}) \div GDP_{OLD}$
- It is important to distinguish between a decrease in GDP and a decrease in GDP growth
  - A decrease in GDP involves a fall in the value of output produced, which gives rise to a negative growth rate
  - A decrease in GDP growth, involves falling rates of growth, but the rates may be positive

Example; Economic Growth

- **Example;** Given the values for real GDP we can calculate the growth rates between successive years.

Year	Real GDP ($ Billion)	Growth Rate	Description
2010	210	–	–
2011	215.5	2.6%	Increasing GDP
2012	219.5	1.9%	Falling GDP growth
2013	223.1	1.6%	Falling GDP growth
2014	217.0	−2.7%	Negative GDP growth

Keynesian Multiplier

- **Keynesian Multiplier (k):** tells us the amount by which a particular injection of government spending, investment, or export spending will increase the nation's total GDP

- The spending multiplier is a function of the marginal propensity to consume and is determined from the formula,

  - **k = Change in Real GDP ÷ Initial Change in Expenditure**
    = 1 ÷ (1 − MPC)
    = 1 ÷ (MPS + MPT + MPM)

- Recall, that **MPC + MPS + MPT + MPM = 1** since if national income increases fractions of the funds will be consumed, saved, taxed and spent on imports

- The larger the **MPC** and the smaller the leakages from the spending stream, the greater the value of the multiplier

- The change in GDP (**ΔGDP**) resulting from an initial change in expenditures (**ΔE**) is,

  - **$\Delta GDP = k \times \Delta E$**

- **Example;** Suppose the economy is in a recession and the government increases expenditures by \$8 million. Assuming the MPC = 0.75 we can determine the value of the multiplier and change in real GDP.

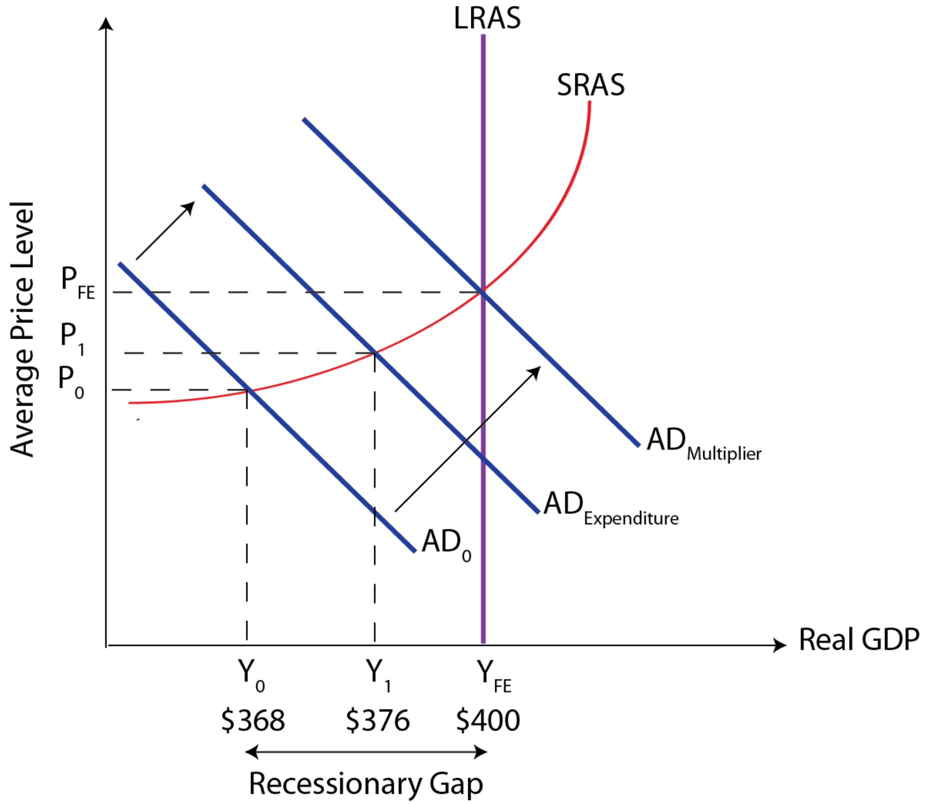
Round	ΔGDP (\$ million)	ΔConsumption (\$ million)
1	8	$0.75 \times 8 = 6$
2	6	$0.75 \times 6 = 4.5$
3	4.5	$0.75 \times 4.5 = 3.38$
4	3.38	$0.75 \times 3.38 = 2.5$
Total	32	$0.75 \times 32 = 24$

- The Keynesian multiplier, $\mathbf{k = 1 \div (1 - MPC)}$

$$= 1 \div (1 - 0.75)$$

$$= 4$$

- Real GDP increases more than proportionally and the government expenditure of \$8 million increases real GDP by \$32 million.



$$\Delta GDP = k \times \Delta E$$
$$= 4 \times \$8$$
$$= \$32 \text{ million}$$

Study Questions

- **1.** You are given the following information on an imaginary country called Lakeland.

Year	2006	2007	2008	2009	2010
Nominal GDP	19.9	20.7	21.9	22.6	22.3
GDP Deflator	98.5	100	102.3	107.6	103.7

- **A.** Which year is the base year
- **B.** Calculate real GDP for each of the five years in the table

- **2.** Calculate nominal GDP, given the following information from the national accounts of Flatland (all figures are in billions). Consumer spending $125; Government spending $46; Exports of $12 and imports of $17.

Macroeconomic Objectives

Unemployment

- **Unemployment:** refers to people of working age who are actively seeking employment but are not employed
  - **Unemployment Rate = (Unemployed ÷ Labour Force) × 100**
- **Labour force:** is the number of people who are employed plus the number of people of working age that are not employed.
  - **Labour Force = Employed + Unemployed**
- **Labor force participation rate (LFPR):** is the ratio of the number of people in the labour force to the entire working age population of a nation
  - **LFPR =[Labor Force ÷ Labor Force Population] × 100**

Inflation & Deflation

- **Inflation:** is a sustained increase in the general price level
- **Disinflation:** refers to a decrease in the rate of inflation
- **Deflation**: is a sustained decrease in the general price level
- **Consumer price index (CPI):** is a measure of the cost of living for the typical household and compares the value of a basket of goods and services in one year with the value of the same basket in a base year
  - Inflation and deflation are measured as a percentage change in the value of the basket from one year to another
  - $\%\Delta CPI = (CPI_{NEW} - CPI_{OLD}) \div CPI_{OLD}$

Constructing a Weighted Price Index

- **Weighted price index:** is a measure of average price in one period relative to a reference period called a base year.
  - It is a price index that weighs the various goods and services according to their relative importance in consumer spending.
  - $\textbf{Price Index}_{\textbf{Current Year}} = [\textbf{Value}_{\textbf{Current Year}} \div \textbf{Value}_{\textbf{Base Year}}] \times 100$
- To construct a weighted price index,
  - **1)** Find the value of the basket in current prices for each year
  - **2)** Use the formula to find the price index number for each year

Example; Consumer Price Index

- **Example;** For a simple economy producing only three items we can create the consumer price index and calculate the rate of inflation. Assume that 2012 is the base year.

	2012			2013		2014	
Item	Quantity	Price	Value	Price	Value	Price	Value
Burgers	37	\$3	\$111	\$4	\$148	\$5	\$185
DVDs	25	\$15	\$375	\$14	\$350	\$16	\$400
Haircuts	15	\$18	\$270	\$20	\$300	\$21	\$315
Total Value			\$756		\$798		\$900

- **Price Index**$_{2012}$ $= (756 \div 756) \times 100 = 100$
- **Price Index**$_{2013}$ $= (798 \div 756) \times 100 = 105.5$
- **Price Index**$_{2014}$ $= (900 \div 756) \times 100 = 119$

Year	CPI
2012	100
2013	105.5
2014	119

Example; Calculating Inflation

- **Example;** Given the values for CPI we can calculate the inflation rate between any two years.
  - **Inflation Rate = %ΔCPI**

$$= (CPI_{NEW} - CPI_{OLD}) \div CPI_{OLD}$$

Year	CPI	Inflation Rate	Description
2010	97.5	–	–
2011	100	2.6%	Inflation
2012	107.3	7.3%	Inflation
2013	109.7	2.2%	Disinflation
2014	107.8	−1.7%	Deflation

Taxation

- **Proportional taxation:** as income increases, the fraction of income paid as taxes remains constant; there is a constant tax rate.

- **Progressive taxation:** as income increases, the fraction of income paid as taxes increases, there is an increasing tax rate.

- **Regressive taxation:** as income increases, the fraction of income paid as taxes decreases, there is a decreasing tax rate.

- **Average tax rate (ART):** at a particular level of income is found by dividing the amount of tax paid (**Tax**) by the individual's gross income (**Y**)

  - **ART = (Tax ÷ Y) × 100**

- **Marginal rate of taxation (MRT):** is the tax rate paid on additional income. It is the change in tax (**ΔTax**) divided by the change in gross income (**ΔY**)

  - **MRT = (ΔTax ÷ ΔY) × 100**

Example; Taxation

- **Example;** The following table shows the annual income and marginal income tax rates for Australia. Calculate the annual tax paid, the average tax rate, and the marginal tax rate for an individual earning $59,000

Annual income ($)	Marginal income tax rate (%)
0 – $10,000	0%
$10,001 – $25,000	9%
$25,001 – $55,000	22%
$55,001 – $115,000	40%
$115,001+	55%

- **Total tax paid =** (0.09 × $15,000) + (0.22 × $30,000) + (0.4 × $4000)
  = $9,550

- **Average tax rate = (Tax ÷ Y) × 100**
  = ($9,550 ÷ $59,000) × 100
  = 16.2%

Study Questions

- **1.** Using the data below construct a price index using 2011 as the base year.

		2010	**2011**	**2012**	**2013**
Item	Quantity	Price	Price	Price	Price
Pizzas	35	$7	$5	$7	$6
DVDs	9	$15	$17	$18	$18
Bus rides	47	$2	$4	$4	$3

- **A.** Identify the rates of inflation and deflation for consecutive years.

Absolute & Comparative Advantage

Absolute & Comparative Advantage

- **Absolute advantage:** refers to the ability of a country to produce a good using fewer resources than another country

- **Comparative advantage:** arises when a country has a lower relative cost, or opportunity cost, in the production of a good than another country.

- **Theory of absolute advantage:** if countries specialize in and export the good in which they have an absolute advantage, the result is increased production and consumption in each country.

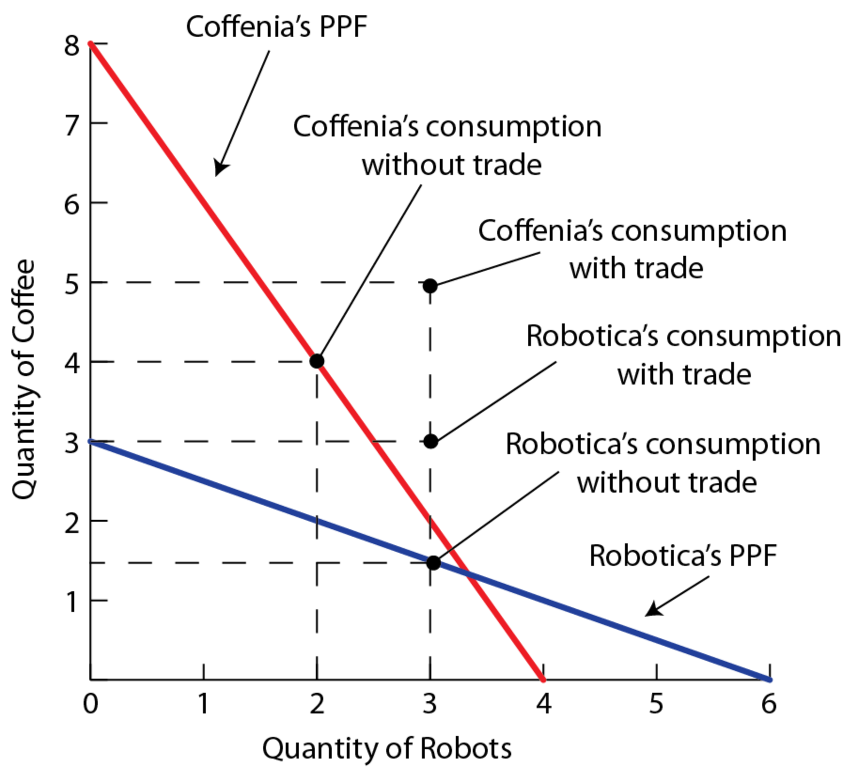
- **Theory of comparative advantage:** as long as opportunity costs in two or more countries differ, it is possible for all countries to gain from specialization and trade according to their comparative advantage.

Law of Absolute Advantage

- **Example;** Consider a simple world economy of two countries Coffenia and Robotica, that produce coffee and robots
  - Under autarky, assume that each worker in Coffenia and Robotica allocate their time evenly between production of robots and coffee
  - Suppose that the countries would trade **1 coffee: 1 robot** and that 3 units are traded

	Coffee or Robots (Production)		**Autarky (Production)**		**Specialization (Production)**		**Specialization (Consumption)**	
	Coffee	Robots	Coffee	Robots	Coffee	Robots	Coffee	Robots
Coffenia	8	4	4	2	8	0	5	3
Robotica	3	6	1.5	3	0	6	3	3
Total	–	–	5.5	5	8	6	8	6

- Originally, both countries were producing on their PPF
    - Trade allows countries to consume at a point outside of their PPF
    - Specialization increases production by 2.5 units of coffee and 1 robot
- Specialization according to absolute advantage leads to a global reallocation of resources where production takes place by the most efficient producers



Law of Comparative Advantage

- **Example;** Consider a simple world economy of two countries Cottonia and Microchippia, producing cotton and microchips.

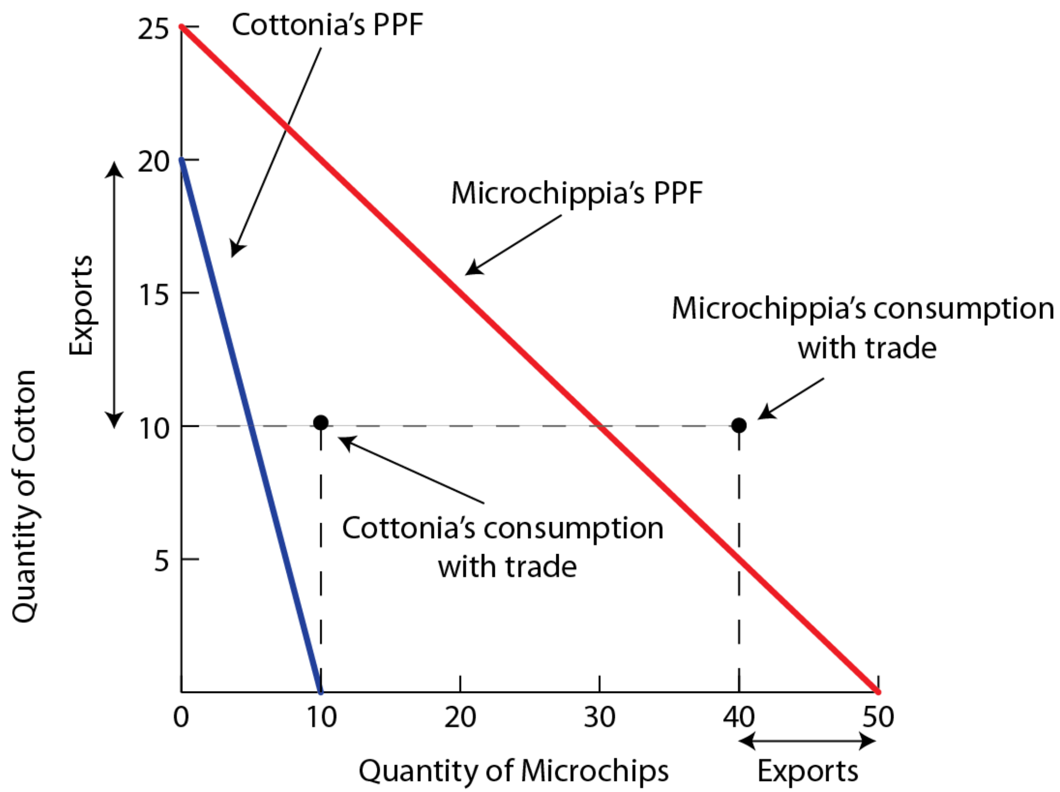
	Cotton or Microchips (Production)		**Cotton (Opportunity Cost)**	**Microchips (Opportunity Cost)**
	Cotton	Microchips		
Cottonia	20	10	10 ÷ 20 = 0.5	20 ÷ 10 = 2
Microchippia	25	50	50 ÷ 25 = 2	25 ÷ 50 = 0.5

- Suppose that the countries trade **1 cotton: 1 microchip** and that 10 units are traded

- Since Cottonia has a lower opportunity cost in the production of cotton the country would specialize in cotton production

    - Cottonia would export cotton and import microchips

- Microchippia has a lower opportunity cost in the production of microchips and would specialize in microchip production
    - Microchippia would export microchips and import cotton
- Trade allows both countries to consume at a point outside of their PPF



Summary

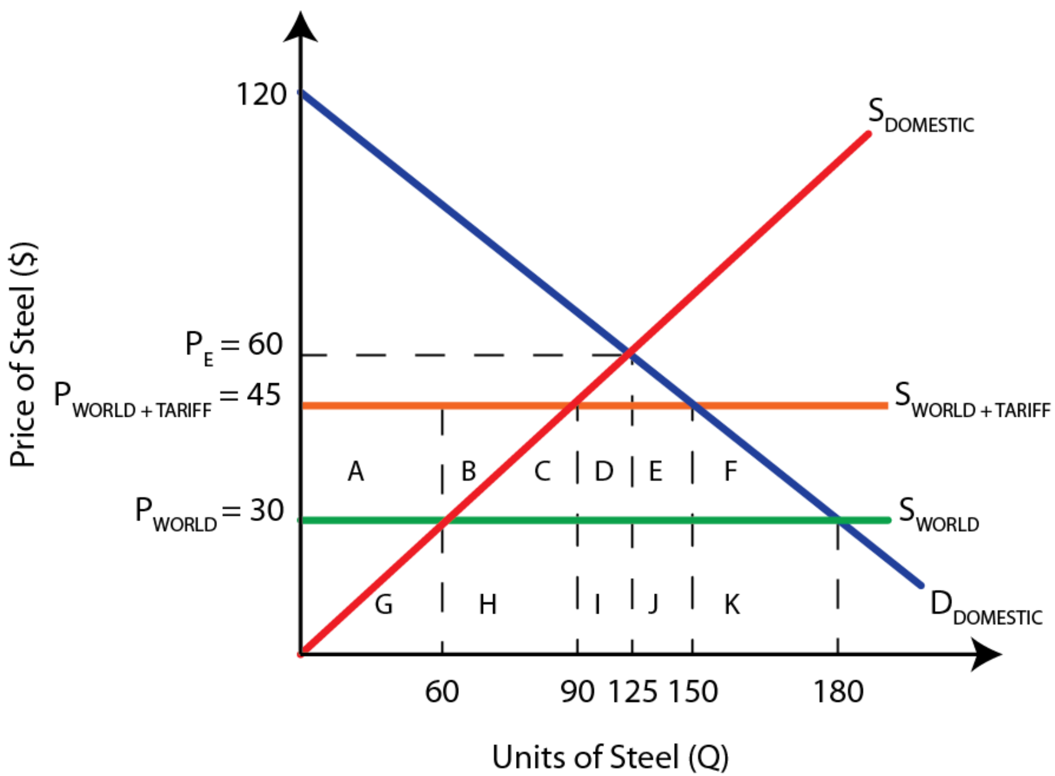
- The country that has the *flatter* PPF has a comparative advantage in the good measured on the horizontal axis
- The country that has the *steeper* PFF has a comparative advantage in the good measured on the vertical axis

Calculating the Effects of Protectionist Policies

Tariffs

- When given specific values for price and quantity, we can calculate the effects of protectionist policies on all relevant stakeholders: domestic and foreign producers, consumers, and the government

- **Example;** The diagram below shows a tariff of $15 per unit placed on steel. Calculate the following before and after the tariff was implemented.



Calculate

1) Domestic revenue
2) Foreign revenue
3) Consumer surplus
4) Government revenue
5) Welfare loss

- **1)** Domestic revenue
  - **Before:** $P_{WORLD} \times Q_{DOMESTIC} = \$30 \times 60 = \$1800$
  - **After:** $P_{TARRIF} \times Q_{NEW\ DOMESTIC} = \$45 \times 90 = \$4050$

- **2)** Foreign revenue
  - **Before:** $P_{WORLD} \times Q_{IMPORTS} = \$30 \times (180 - 60) = \$3600$
  - **After:** $P_{WORLD} \times Q_{NEW\ IMPORTS} = \$30 \times (150 - 90) = \$1800$

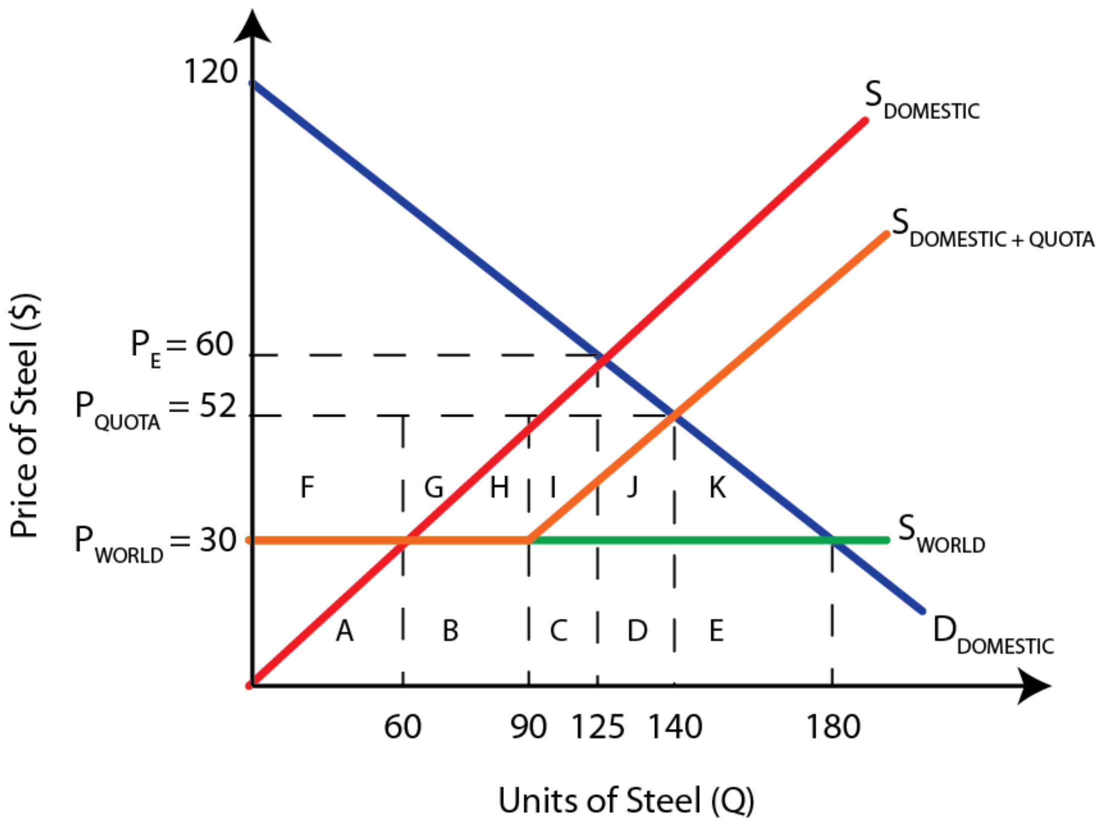
- **3)** Consumer surplus
  - **Before:** ½(Highest price – P_{WORLD}) × Q_{WORLD} = 0.5(120 – 30) × 180 = \$8100
  - **After:** ½(Highest price – P_{TARIFF}) × Q_{TARIFF} = 0.5(120 – 45) × 150 = \$5625

- **4)** Government revenue
  - **Before:** \$0 = No tax collected
  - **After:** $(P_{TARIFF} \times P_{WORLD}) \times Q_{NEW\ IMPORTS} = (\$45 - \$30) \times (150 - 90) = \$900$

- **5)** Welfare loss: (Area **C + F**)
  - **After:** $2(0.5(30 \times 15)) = 2 \times 225 = \$450$

Quotas

- **Example;** The diagram below shows a quota of 30 imported units of steel. Domestic producers previously sold 60 units at the world price of $30. After the quota, they are paid $52 and sell 110.
  - Calculate the following before and after the quota was implemented.



Calculate

1) Domestic revenue
2) Foreign revenue
3) Consumer surplus
4) Government revenue
5) Welfare loss

- **1)** Domestic revenue
  - **Before:** $P_{WORLD} \times Q_{DOMESTIC} = \$30 \times 60 = \$1800$
  - **After:** $P_{QUOTA} \times Q_{NEW\ DOMESTIC} = \$52 \times ((60 - 0) + (140 - 90)) = \$5720$

- **2)** Foreign revenue
  - **Before:** $P_{WORLD} \times Q_{IMPORTS} = \$30 \times (180 - 60) = \$3600$
  - **After:** $P_{WORLD} \times Q_{NEW\ IMPORTS} = \$52 \times (90 - 60) = \$1560$

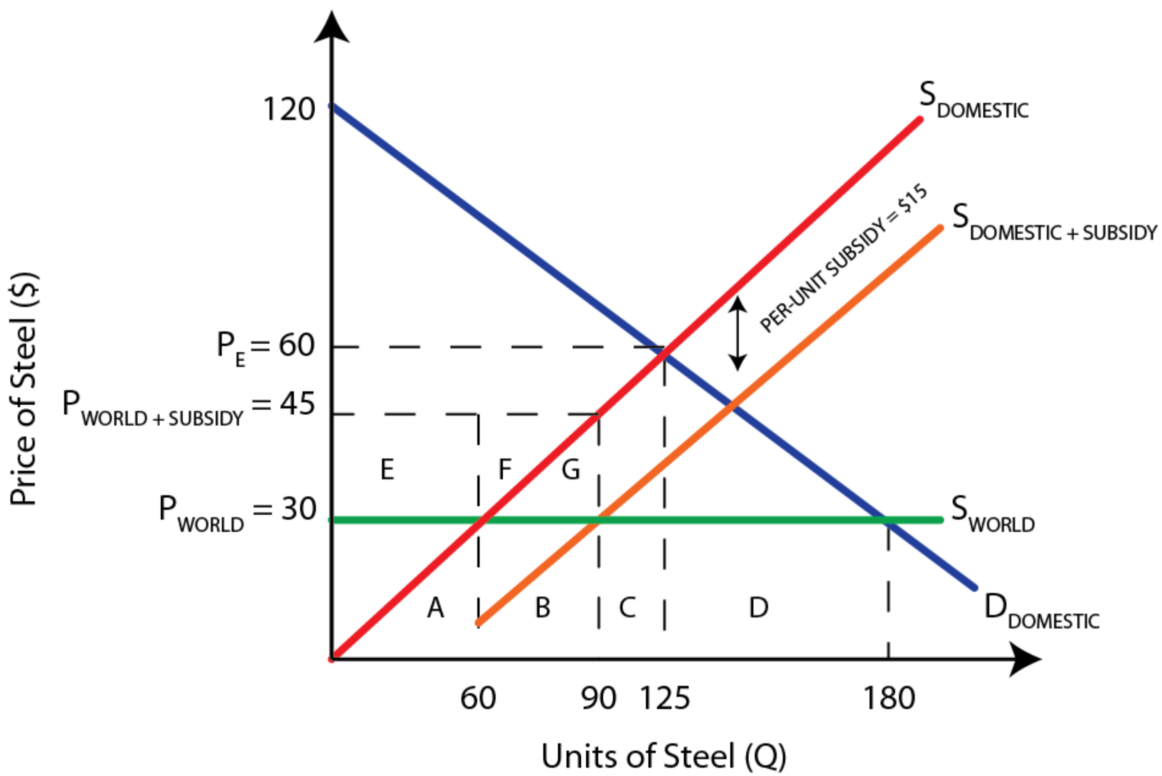
- **3)** Consumer surplus
  - **Before:** $\frac{1}{2}(\text{Highest price} - P_{WORLD}) \times Q_{WORLD} = 0.5(120 - 30) \times 180 = \$8100$
  - **After:** $\frac{1}{2}(\text{Highest price} - P_{QUOTA}) \times Q_{QUOTA} = 0.5(120 - 52) \times 140 = \$4760$

- **4)** Government revenue
  - **Before:** $0 = No tax collected
  - **After:** $0 = No tax collected

- **5)** Welfare loss: (Area **J** + **K**)
  - **After:** $0.5(50 \times 22) + 0.5(40 \times 22) = \$990$

Subsidy

- **Example;** The diagram below shows a per-unit subsidy of $15, the same value as the per unit tariff above. The subsidy is designed to reduce the number of imports
  - Calculate the following before and after the subsidy was implemented.



Calculate

1) Domestic revenue
2) Foreign revenue
3) Consumer surplus
4) Government revenue
5) Welfare loss

- **1)** Domestic revenue
  - **Before:** $P_{WORLD} \times Q_{DOMESTIC} = \$30 \times 60 = \$1800$
  - **After:** $P_{SUBSIDY} \times Q_{NEW\ DOMESTIC} = \$45 \times 90 = \$4050$

- **2)** Foreign revenue
  - **Before:** $P_{WORLD} \times Q_{IMPORTS} = \$30 \times (180 - 60) = \$3600$
  - **After:** $P_{WORLD} \times Q_{NEW\ IMPORTS} = \$30 \times (180 - 90) = \$2700$

- **3)** Consumer surplus
  - **Before:** $\frac{1}{2}(\text{Highest price} - P_{WORLD}) \times Q_{WORLD} = 0.5(120 - 30) \times 180 = \$8100$
  - **After:** $\frac{1}{2}(\text{Highest price} - P_{WORLD}) \times Q_{WORLD} = 0.5(120 - 30) \times 180 = \$8100$

- **4)** Government revenue
  - **Before:** $0 = No subsidy paid
  - **After:** $\text{Per-unit subsidy} \times Q_{DOMESTIC} = \$15 \times 90 = \$1350$

- **5)** Welfare loss: (Area **G**)
  - **After:** $0.5(15 \times 30) = \$225$

Study Questions

- **1.** Create a free trade diagram that has the following values
  - A supply curve with quantities 45 units at $15 and 30 units at $10
  - A demand curve with quantities 15 units at $15 and 30 units at $10
  - World price of $5 and domestic price of $10
  - At the world price, domestic quantity of 15
  - At the world price, foreign imports of 30
- **1b.** Impose a tariff of $3. Draw the expected results for domestic/import quantities on your diagram. Based on your diagram calculate the following
  - Domestic producer revenue before & after the tariff
  - Foreign revenue before and after the tariff
  - Total tariff amount
  - Areas of inefficiency and welfare loss

Exchange Rate Calculations

Supply and Demand for Currency

- Foreign exchange is traded in much the same way as any other product
  - The supply and demand can be calculated using linear functions
- The linear demand equation format is, $\mathbf{Q_D = a - bP}$
  - In this context, P stands for the exchange rate of the currency, in terms of another currency
- The linear supply equation format is, $\mathbf{Q_S = c + dP}$
- When given a supply and demand schedule we can derive these equations and determine the equilibrium

Example; Determining Equilibrium

- Suppose the supply function is $\mathbf{Q_{S\ EURO} = 55 + 20P}$ and the demand function is $\mathbf{Q_{D\ EURO} = 100 - 10P}$
  - The supply and demand schedules are given in the tables below,

Exchange Rate Demand Schedule	
Exchange Rate (USD per Euro)	**Quantity of Euros Demanded (Billions)**
2	80
1.75	82.5
1.5	85
1.25	87.5
1	90

Exchange Rate Supply Schedule	
Exchange Rate (USD per Euro)	**Quantity of Euros Supplied (Billions)**
2	95
1.75	90
1.5	85
1.25	80
1	75

- We can determine the equilibrium exchange rate (P) and quantity (Q) by setting supply equal to demand

- Setting demand equal to supply,

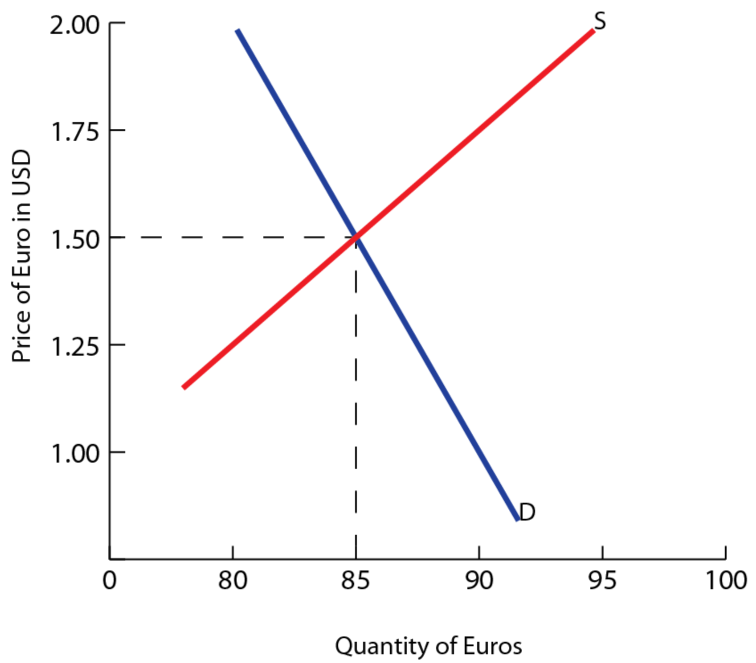
$$Q_{D\ EURO} = Q_{S\ EURO}$$

$$100 - 10P = 55 + 20P$$

$$30P = 45$$

$$P = 1.5$$

- So, the equilibrium exchange rate is $1.50 per euro and the equilibrium quantity is 85 billion Euros



Changes in Foreign Exchange Equilibrium

- Free floating exchange rates are subject to change, and these changes can be expressed using linear functions
- In linear demand functions, **a** represents the autonomous demand
  - When this amount changes, demand has changed, and a new curve representing a new set of prices and quantities must be created
- The same is true for **c** in linear supply functions
  - A change in **c** is a change in supply, requiring a new supply schedule and curve

Changes in Demand for Currency

- Suppose the **a** variable of demand in the previous example has increased by 7.5 from 100 to 107.5
  - The new demand function is $\mathbf{Q_{D\ EURO} = 107.5 - 10P}$
  - This increases demand at all prices and results in a new demand schedule.

Exchange Rate Market Schedule		
Exchange Rate (USD per Euro)	**Quantity of Euros Demanded (Billions)**	**Quantity of Euros Supplied (Billions)**
2	87.5	95
1.75	90	90
1.5	92.5	85
1.25	95	80
1	97.5	75

- Setting demand equal to supply,

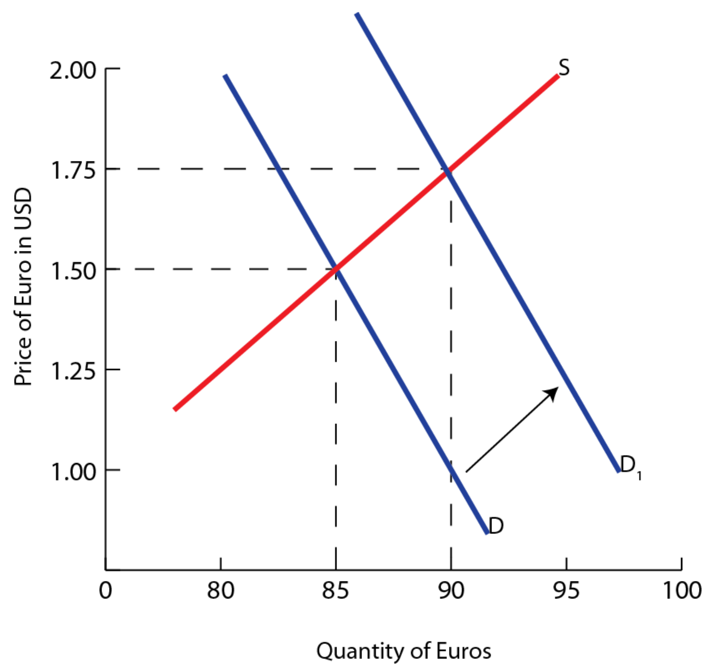
$$Q_{D\ EURO} = Q_{S\ EURO}$$

$$107.5 - 10P = 55 + 20P$$

$$30P = 52.5$$

$$P = 1.75$$

- So, the equilibrium exchange rate is $1.75 per euro and 90 billion Euros are bought and sold



Changes in Supply of the Currency

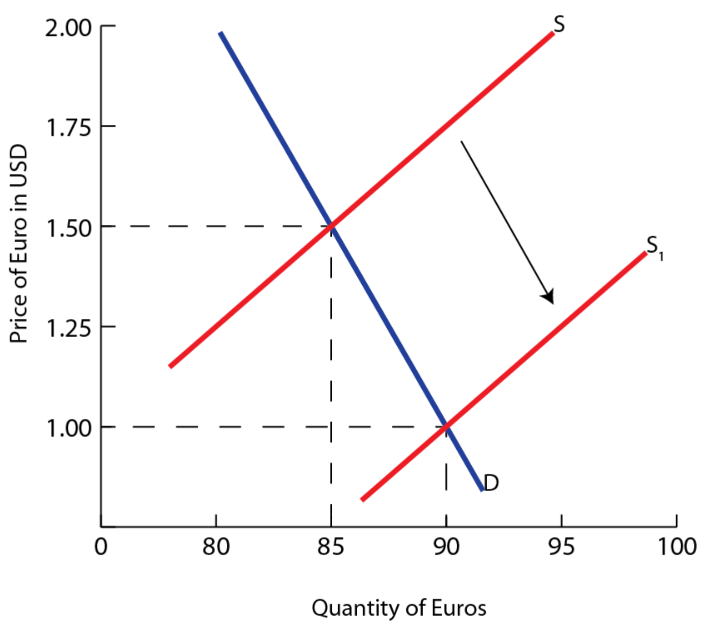
- Suppose the **c** variable of supply in the original example has increased by 15 units from 55 to 70
  - The new supply function is $\mathbf{Q_{S\ EURO} = 70 + 20P}$
  - All supply quantities have increased by 15 units. This represents an increased supply at all prices and a parallel shift of the supply curve

Exchange Rate Market Schedule		
Exchange Rate (USD per Euro)	**Quantity of Euros Demanded (Billions)**	**Quantity of Euros Supplied (Billions)**
2	80	110
1.75	82.5	105
1.5	85	100
1.25	87.5	95
1	90	90

- Setting demand equal to supply,

$$Q_{D\ EURO} = Q_{S\ EURO}$$
$$100 - 10P = 70 + 20P$$
$$30P = 30$$
$$P = 1$$

- So, the equilibrium exchange rate is $1 per euro and 90 billion Euros are bought and sold



Calculating Exchange Rates from Data

- Currency information is reported in many forms and can be deduced from various sources of information
  - You need to be able to calculate exchange rates from different types of data
- **Example;** Last year, Japan could import athletic jerseys from China costing 60 RMB, which cost 720 JPY at current exchange rates. Now the same 60 RMB jersey costs 780 JPY. What is the current exchange rate?
  - The exchange rate of RMB last year was 12 JPY (1 RMB: 12 JPY)
  - The exchange rate of RMB this year is 13 JPY (1 RMB: 13 JPY)
  - The Japanese Yen has depreciated relative to the Chinese Yuan

Study Questions

- **1.** Given the following linear demand and supply functions for USD in terms of Chinese RMB
  - $\mathbf{Q_S = 10 + 3P}$ and $\mathbf{Q_D = 50 - 2P}$
  - Calculate the exchange rate for USD in terms of RMB
  - Plot the linear supply and demand curves on a diagram indicating the equilibrium price and quantity
- **2.** Assume the exchange rate for British pounds and USD is 1.60 USD per GBP
  - Calculate the value in GBP for 1 USD
  - Calculate in USD the price of a Manchester United football jersey that costs 45 GBP

Balance of Payments

Balance of Payments

- **Balance of payments:** of a country is a record (usually for a year) of all transactions between the residents of the country and the residents of all other countries

Current Account + Financial Account + Capital Account = 0

- **Current account:** consists of the balance of trade in goods and services, net change income and the net change in current transfers

Current Account = Balance of trade + ΔIncome + ΔCurrent transfers

  - **Income:** refers to inflows of wages, rent, interest and profits from abroad minus outflows to foreign countries.

  - **ΔIncome = Inflows − Outflows**

- **Current transfers:** refers to inflows and outflows of funds for items such as gifts, foreign aid and pensions from government or private citizens

  - **ΔCurrent transfers = Inflows − Outflows**

Current Account	
(1) Exports of goods	+ 40
(2) Imports of goods	− 65
Balance of trade in goods (1) + (2)	− 25
(3) Exports of services	+ 25
(4) Imports of services	− 25
Balance of trade in services (3) + (4)	+ 10
Balance of trade in goods & services	− 15
(5) Income (*inflows minus outflows*)	− 6
(6) Current transfers (*inflows minus outflows*)	+ 1
Balance on Current Account	− 20

- **Capital Account:** records the transactions involving ownership of capital, forgiveness of debt, or the acquisition and disposal of intangible assets between a nation and all other nations

- **Capital Account = ΔCapital Transfers + ΔIntangible Assets**

  - **Capital Transfers:** when a nation's government or private sector gives money to another nation for the purchase of fixed assets or directly donates capital goods to the residents of another country

  - **ΔCapital Transfers = Inflows − Outflows**

Capital Account	
(7) Capital transfers (*inflows minus outflows*)	+ 0.7
(8) Intangible Assets (*inflows minus outflows*)	+ 0.3
Balance on Capital Account	+ 1

- **Financial Account:** measures the exchanges between a nation and the rest of the world involving ownership of financial and real assets

- **Financial Account = ΔFDI + ΔPortfolio Investment + ΔReserves**

  - **Reserves:** refer to foreign currency reserves that a central bank can buy or sell to influence the value of the country's currency

  - Buying domestic currency and selling foreign currency is an inflow

  - **ΔReserves = Inflows − Outflows**

Financial Account	
(9) Direct investment (*inflows minus outflows*)	+ 23
(10) Portfolio investment (*inflows minus outflows*)	− 4
(11) Reserve assets	+ 1
Balance on Financial Account	+ 20

- The current account balance is matched by the sum of the capital account balance and the financial account balance.
- **Current Account + Financial Account + Capital Account = 0**
- **Current Account = − (Capital Account + Financial Account)**

Balance of Payments	
Balance on Current Account	− 20
Balance on Capital Account	+ 1
Balance on Financial Account	+ 20
Errors and omissions	− 1
Balance of Payments	0

Marshall-Lerner Condition

- Recall, the Marshall-Lerner condition states the following.
- If $\mathbf{PED_M + PED_X > 1}$ then devaluation or depreciation of the currency will improve the trade balance (*smaller trade deficit*)
- If $\mathbf{PED_M + PED_X = 1}$ then devaluation or depreciation of the currency will leave the trade balance unchanged
- If $\mathbf{PED_M + PED_X < 1}$ then devaluation or depreciation of the currency will worse the trade balance (*larger trade deficit*)

Terms of Trade

Terms of Trade

- **Terms of trade:** refers to the ratio of a country's average price of exports to the country's average price of imports

Terms of Trade = (Index of Export Prices ÷ Index of Import Prices) × 100

- The terms of trade are set to 100 in the base year, the reference point for future changes.

Condition	Impact on Terms of Trade
Terms of trade < 100	Deterioration
Term of trade $= 100$	Unchanged (Base level)
Terms of trade > 100	Improved

- An improvement in the terms of trade, represents an increase in the value of average export prices to average import prices. It involves a fall in the opportunity cost of imports

Example; Terms of Trade

- The table below shows the average export and import prices over a period of six years. Calculate the terms of trade for each year

Year	Index of Average export prices	Index of Average import prices	Calculation of terms of trade	Terms of trade	Change
Year 1	100	100	(100÷100)×100	100	Base year
Year 2	100	105	(100÷105)×100	95.2	Deterioration
Year 3	109	105	(109÷105)×100	103.8	Improvement
Year 4	116	112	(116÷112)×100	103.5	Deterioration
Year 5	120	110	(120÷110)×100	109.1	Improvement
Year 6	120	125	(120÷125)×100	96	Deterioration

Example; Terms of Trade

- **Example;** Suppose Morocco exports only tangerines (40% of exports) and carpets (60% of exports) and imports only cars (30% of imports) and industrial equipment (70% of imports).

- The prices of these things in Moroccan dirhams in various years are listed below:

	2011	**2012**	**2013**
Tangerines (Dh/kg)	10	13	12
Carpets (Dh/m^2)	110	110	110
Cars (Dh/unit)	100,000	100,000	100,000
Industrial Equipment (Dh/unit)	10,000	9,000	8,000

- If we want to set up 2011 as the 'base' year, then we accept that the prices in 2011 are the starting point. Thus, the terms of trade in 2011 are '100'

- First, calculate the index of export prices for 2012 and 2013

- **Price Index = ∑[Weight × (New Price ÷ Old Price) × 100]**

- $\text{Export Price Index}_{2012} = [0.4\ (13 \div 10) \times 100] + [0.6\ (110 \div 110) \times 100]$
  $= 52 + 60$
  $= 112$

- $\text{Export Price Index}_{2013} = [0.4\ (12 \div 10) \times 100] + [0.6\ (110 \div 110) \times 100]$
  $= 48 + 60$
  $= 108$

- Next, calculate the index of import prices for 2012 and 2013

- $\text{Import Price Index}_{2012} = [0.3\ (10 \div 10) \times 100] + [0.7\ (9 \div 10) \times 100]$
  $= 30 + 63$
  $= 93$

- Import Price Index_{2013} $= [0.3\ (10 \div 10) \times 100] + [0.7\ (8 \div 10) \times 100]$

  $= 30 + 56$

  $= 86$

- Now, having both the import and export price indexes, we can calculate the terms of trade

Year	Index of Export prices	Index of Import prices	Terms of trade
2011	100	100	100
2012	112	93	120.4
2013	108	86	125.6

- This increase shows that Morocco's terms of trade improved in 2012 and 2013 as export prices (for tangerines) rose in 2012 and import prices (for industrial equipment) fell both years