GENERAL EQUILIBRIUM

1

Perfectly Competitive Price System

- We will assume that all markets are perfectly competitive
  - there is some large number of homogeneous goods in the economy
    - both consumption goods and factors of production
  - each good has an equilibrium price
  - there are no transaction or transportation costs
  - individuals and firms have perfect information

2

Law of One Price

- A homogeneous good trades at the same price no matter who buys it or who sells it
  - if one good traded at two different prices, demanders would rush to buy the good where it was cheaper and firms would try to sell their output where the price was higher
    - these actions would tend to equalize the price of the good

3

Assumptions of Perfect Competition

- There are a large number of people buying any one good
  - each person takes all prices as given and seeks to maximize utility given his budget constraint
- There are a large number of firms producing each good
  - each firm takes all prices as given and attempts to maximize profits

4

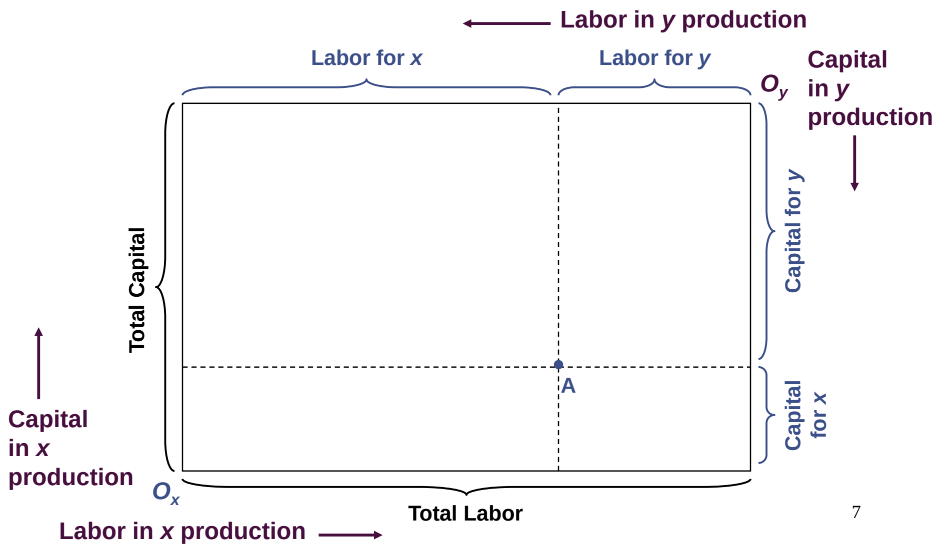
General Equilibrium

- Assume that there are only two goods, *x* and *y*
- All individuals are assumed to have identical preferences
  - represented by an indifference map
- The production possibility curve can be used to show how outputs and inputs are related

Edgeworth Box Diagram

- Construction of the production possibility curve for *x* and *y* starts with the assumption that the amounts of *k* and *l* are fixed
- An Edgeworth box shows every possible way the existing *k* and *l* might be used to produce *x* and *y*
  - any point in the box represents a fully employed allocation of the available resources to *x* and *y*

Edgeworth Box Diagram



Edgeworth Box Diagram

- Many of the allocations in the Edgeworth box are technically inefficient
  - it is possible to produce more *x* and more *y* by shifting capital and labor around
- We will assume that competitive markets will not exhibit inefficient input choices
- We want to find the efficient allocations
  - they illustrate the actual production outcomes

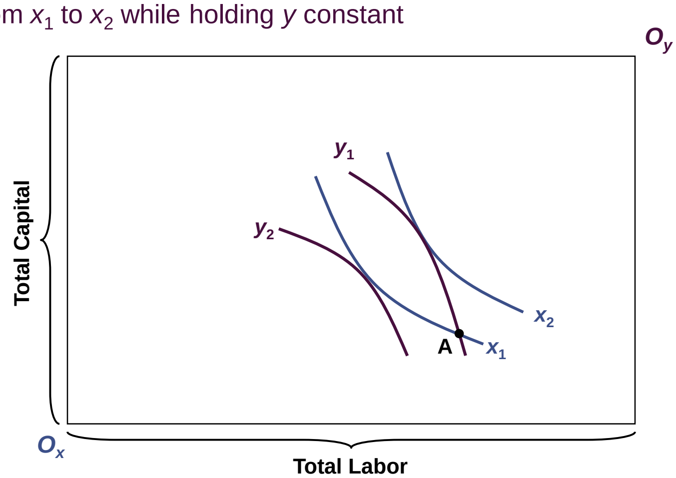
Edgeworth Box Diagram

- We will use isoquant maps for the two goods
  - the isoquant map for good *x* uses O_x as the origin
  - the isoquant map for good *y* uses O_y as the origin
- The efficient allocations will occur where the isoquants are tangent to one another

9

Edgeworth Box Diagram

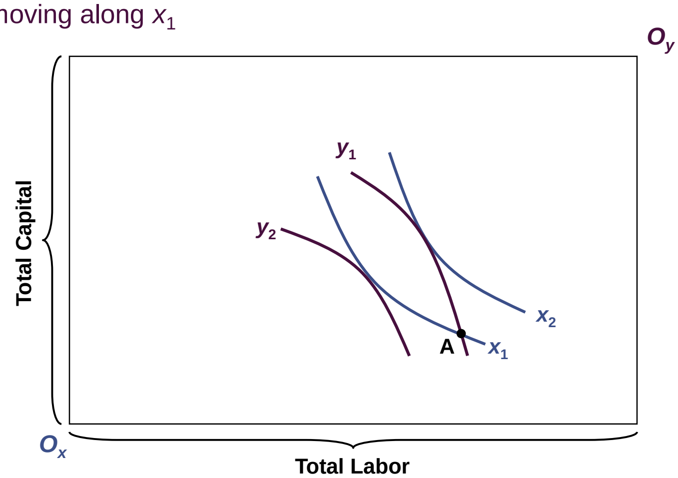
Point *A* is inefficient because, by moving along y_1, we can increase x from x_1 to x_2 while holding y constant



10

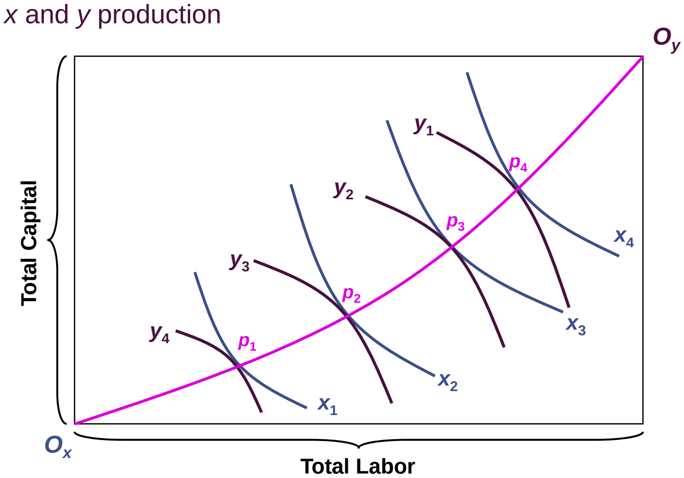
Edgeworth Box Diagram

We could also increase y from y_1 to y_2 while holding x constant by moving along x_1



Edgeworth Box Diagram

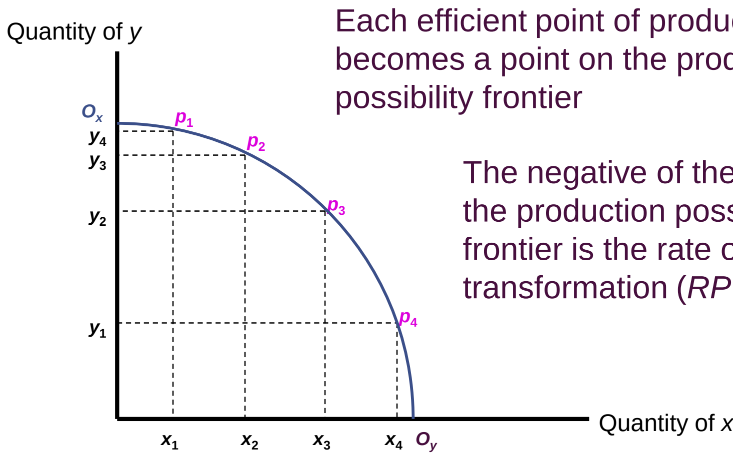
At each efficient point, the *RTS* (of k for l) is equal in both x and y production



Production Possibility Frontier

- The locus of efficient points shows the maximum output of *y* that can be produced for any level of *x*
  - we can use this information to construct a production possibility frontier
    - shows the alternative outputs of *x* and *y* that can be produced with the fixed capital and labor inputs that are employed efficiently

Production Possibility Frontier



Each efficient point of production becomes a point on the production possibility frontier

The negative of the slope of the production possibility frontier is the rate of product transformation (*RPT*)

Rate of Product Transformation

- The <u>rate of product transformation</u> (*RPT*) between two outputs is the negative of the slope of the production possibility frontier

$$RPT \text{ (of } x \text{ for } y) = -\text{ slope of production possibility frontier}$$

$$RPT \text{ (of } x \text{ for } y) = -\frac{dy}{dx} \text{ (along } O_x O_y)$$

Rate of Product Transformation

- The rate of product transformation shows how *x* can be technically traded for *y* while continuing to keep the available productive inputs efficiently employed

Shape of the Production Possibility Frontier

- The production possibility frontier shown earlier exhibited an increasing *RPT (in absolute value)*
  - this concave shape will characterize most production situations
- *RPT* is equal to the ratio of MC_x to MC_y

17

Shape of the Production Possibility Frontier

- Suppose that the costs of any output combination are $C(x,y)$
  - along the production possibility frontier, $C(x,y)$ is constant
- We can write the total differential of the cost function as

$$dC = \frac{\partial C}{\partial x} \cdot dx + \frac{\partial C}{\partial y} \cdot dy = 0$$

18

Shape of the Production Possibility Frontier

- Rewriting, we get

$$RPT = -\frac{dy}{dx}(\text{along } O_xO_y) = \frac{\partial C / \partial x}{\partial C / \partial y} = \frac{MC_x}{MC_y}$$

- The *RPT* is a measure of the relative marginal costs of the two goods

Shape of the Production Possibility Frontier

- As production of *x* rises and production of *y* falls, the ratio of MC_x to MC_y rises
  - this occurs if both goods are produced under diminishing returns
    - increasing the production of *x* raises MC_x, while reducing the production of *y* lowers MC_y
  - this could also occur if some inputs were more suited for *x* production than for *y* production

Shape of the Production Possibility Frontier

- But we have assumed that inputs are homogeneous
- We need an explanation that allows homogeneous inputs and constant returns to scale
- The production possibility frontier will be concave if goods *x* and *y* use inputs in different proportions

Opportunity Cost

- The production possibility frontier demonstrates that there are many possible efficient combinations of two goods
- Producing more of one good necessitates lowering the production of the other good
  - this is what economists mean by <u>opportunity cost</u>

Opportunity Cost

- The opportunity cost of one more unit of *x* is the reduction in *y* that this entails
- Thus, the opportunity cost is best measured as the *RPT* (of *x* for *y*) at the prevailing point on the production possibility frontier
  - this opportunity cost rises as more *x* is produced

23

Concavity of the Production Possibility Frontier

- Suppose that the production of *x* and *y* depends only on labor and the production functions are

$$x = f(l_x) = l_x^{0.5} \qquad y = f(l_y) = l_y^{0.5}$$

- If labor supply is fixed at 100, then

$$l_x + l_y = 100$$

- The production possibility frontier is

$$x^2 + y^2 = 100 \qquad \text{for } x,y \geq 0$$

24

Concavity of the Production Possibility Frontier

- The *RPT* can be calculated by taking the total differential:

$$2xdx + 2ydy = 0 \quad \text{or} \quad RPT = \frac{-dy}{dx} = \frac{-(-2x)}{2y} = \frac{x}{y}$$

- The slope of the production possibility frontier decreases as *x* output increases
  - the frontier is concave
  - Note: RPT increases as *x* output increases

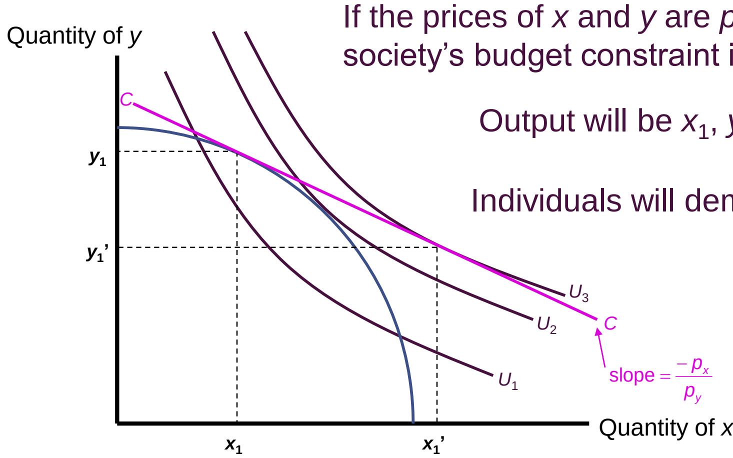
25

Determination of Equilibrium Prices

- We can use the production possibility frontier along with a set of indifference curves to show how equilibrium prices are determined
  - the indifference curves represent individuals' preferences for the two goods

26

Determination of Equilibrium Prices



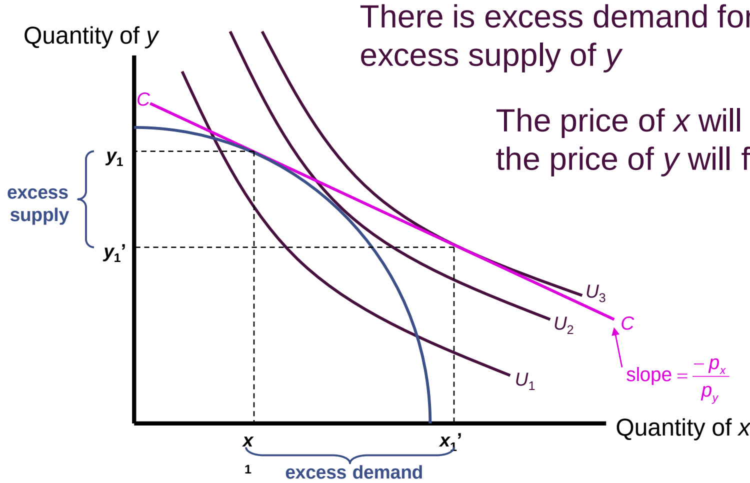
If the prices of x and y are p_x and p_y, society's budget constraint is C

Output will be x_1, y_1

Individuals will demand x_1', y_1'

27

Determination of Equilibrium Prices



There is excess demand for x and excess supply of y

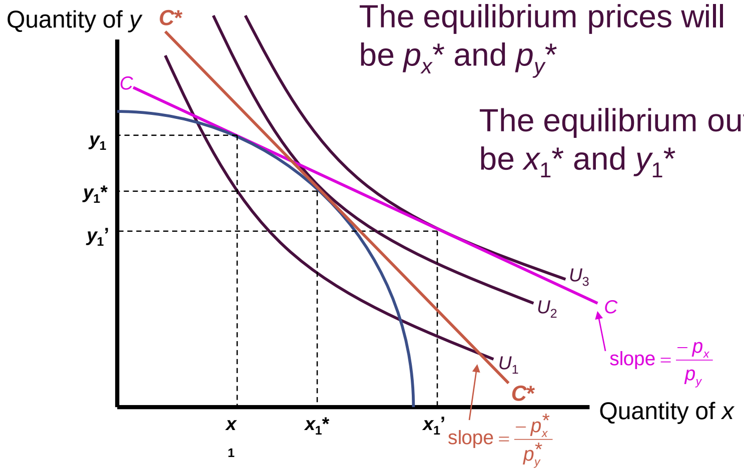
The price of x will rise and the price of y will fall

28

Determination of Equilibrium Prices

The equilibrium prices will be p_x^* and p_y^*

The equilibrium output will be x_1^* and y_1^*



29

Comparative Statics Analysis

- The equilibrium price ratio will tend to persist until either preferences or production technologies change
- If preferences were to shift toward good x, p_x/p_y would rise and more x and less y would be produced
  - we would move in a clockwise direction along the production possibility frontier

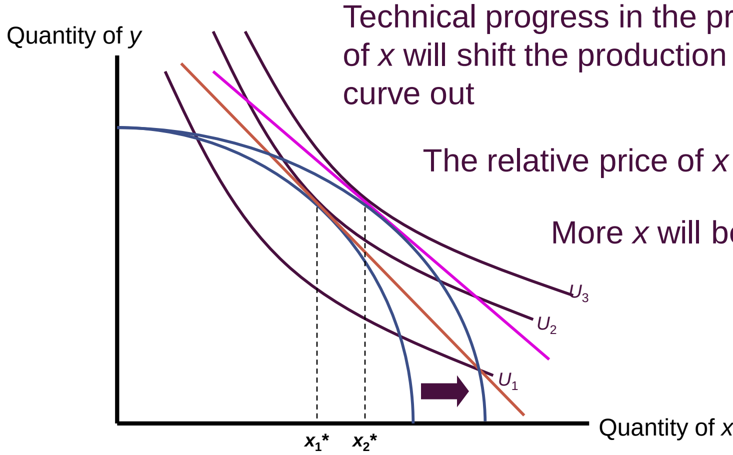
30

Comparative Statics Analysis

- Technical progress in the production of good *x* will shift the production possibility curve outward
  - this will lower the relative price of *x*
  - more *x* will be consumed
    - if *x* is a normal good
  - the effect on *y* is ambiguous

31

Technical Progress in the Production of x



Technical progress in the production of *x* will shift the production possibility curve out

The relative price of *x* will fall

More *x* will be consumed

32

General Equilibrium Pricing

- Suppose that the production possibility frontier can be represented by

$$x^2 + y^2 = 100$$

- Suppose also that the community's preferences can be represented by

$$U(x,y) = x^{0.5}y^{0.5}$$

33

General Equilibrium Pricing

- Profit-maximizing firms will equate *RPT* and the ratio of p_x / p_y

$$RPT = \frac{x}{y} = \frac{p_x}{p_y}$$

- Utility maximization requires that

$$MRS = \frac{y}{x} = \frac{p_x}{p_y}$$

34

General Equilibrium Pricing

- Equilibrium requires that firms and individuals face the same price ratio

$$RPT = \frac{x}{y} = \frac{p_x}{p_y} = \frac{y}{x} = MRS$$

or

$$x^* = y^*$$

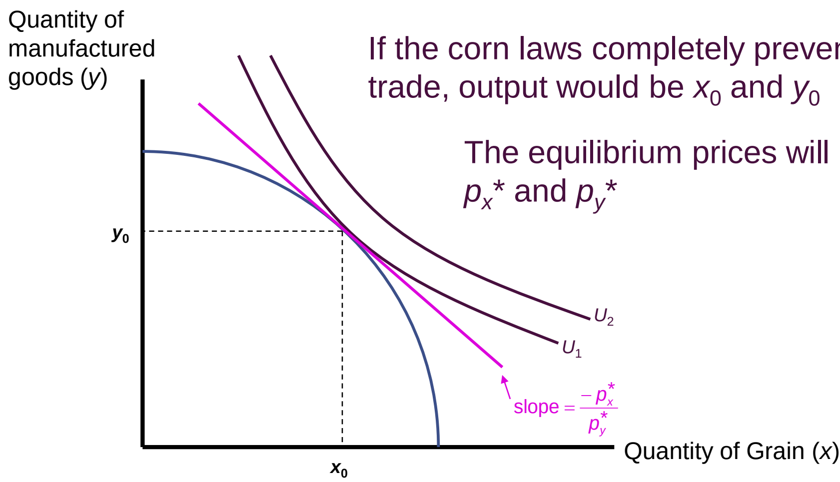
35

The Gains from Free Trade: The Corn Laws Debate

- High tariffs on grain imports were imposed by the British government after the Napoleonic wars
- Economists debated the effects of these “corn laws” between 1829 and 1845
  - what effect would the elimination of these tariffs have on factor prices?

36

The Gains from Free Trade: The Corn Laws Debate

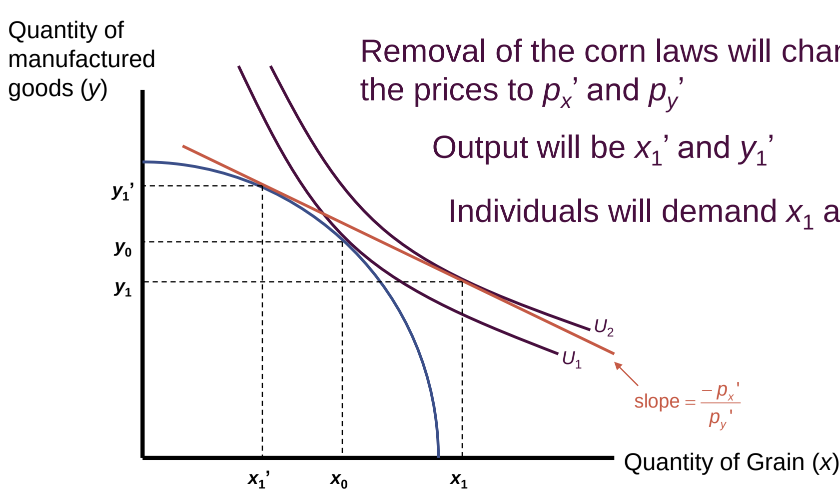


If the corn laws completely prevented trade, output would be x_0 and y_0

The equilibrium prices will be p_x* and p_y*

37

The Gains from Free Trade: The Corn Laws Debate



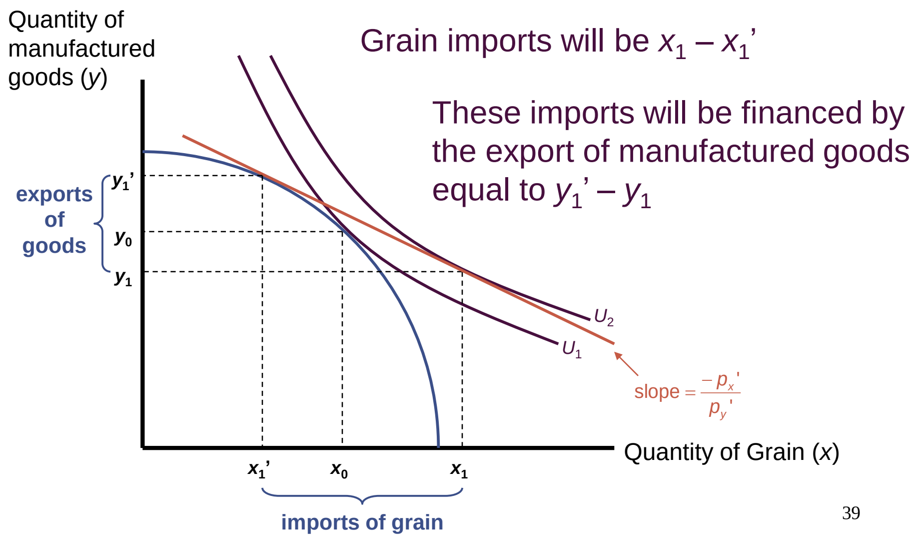
Removal of the corn laws will change the prices to p_x' and p_y'

Output will be x_1' and y_1'

Individuals will demand x_1 and y_1

38

The Gains from Free Trade: The Corn Laws Debate



39

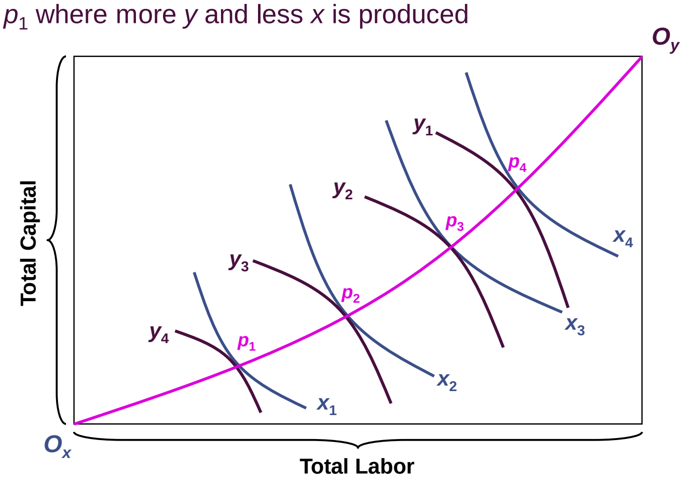
The Gains from Free Trade: The Corn Laws Debate

- We can use an Edgeworth box diagram to see the effects of tariff reduction on the use of labor and capital
- If the corn laws were repealed, there would be an increase in the production of manufactured goods and a decline in the production of grain

40

The Gains from Free Trade: The Corn Laws Debate

A repeal of the corn laws would result in a movement from p_3 to p_1 where more y and less x is produced



41

The Gains from Free Trade: The Corn Laws Debate

- If we assume that grain production is relatively capital intensive, the movement from p_3 to p_1 causes the ratio of k to l to rise in both industries
  - the relative price of capital will fall
  - the relative price of labor will rise
- The repeal of the corn laws will be harmful to capital owners and helpful to laborers

42

Existence of General Equilibrium Prices

- Beginning with 19th century investigations by Leon Walras, economists have examined whether there exists a set of prices that equilibrates all markets simultaneously
  - if this set of prices exists, how can it be found?

43

Existence of General Equilibrium Prices

- Suppose that there are n goods in fixed supply in this economy
  - let S_i (i =1,…,n) be the total supply of good i available
  - let p_i (i =1,…n) be the price of good i
- The total demand for good i depends on all prices

$$D_i\,(p_1,\ldots,p_n) \text{ for } i = 1,\ldots,n$$

44

Existence of General Equilibrium Prices

- We will write this demand function as dependent on the whole set of prices (P)

$$D_i(P)$$

- Walras' problem: Does there exist an equilibrium set of prices such that

$$D_i(P^*) = S_i$$

for all values of i?

45

Excess Demand Functions

- The <u>excess demand function</u> for any good i at any set of prices (P) is defined to be

$$ED_i(P) = D_i(P) - S_i$$

- This means that the equilibrium condition can be rewritten as

$$ED_i(P^*) = D_i(P^*) - S_i = 0$$

46

Excess Demand Functions

- Demand functions are homogeneous of degree zero
  - this implies that we can only establish equilibrium relative prices in a Walrasian-type model
- Walras also assumed that demand functions are continuous
  - small changes in price lead to small changes in quantity demanded

Walras' Law

- A final observation that Walras made was that the *n* excess demand equations are not independent of one another
- Walras' law shows that the total value of excess demand is zero at any set of prices

$$\sum_{i=1}^{n} P_i \cdot ED_i(P) = 0$$

Walras' Law

- Walras' law holds for any set of prices (not just equilibrium prices)
- There can be neither excess demand for all goods together nor excess supply

49

A General Equilibrium with Three Goods

- The economy of Oz is composed only of three precious metals: (1) silver, (2) gold, and (3) platinum
  - there are 10 (thousand) ounces of each metal available
- The demands for gold and platinum are

$$D_2 = -2\frac{p_2}{p_1} + \frac{p_3}{p_1} + 11 \qquad D_3 = -\frac{p_2}{p_1} - 2\frac{p_3}{p_1} + 18$$

50

A General Equilibrium with Three Goods

- Equilibrium in the gold and platinum markets requires that demand equal supply in both markets simultaneously

$$-2\frac{p_2}{p_1}+\frac{p_3}{p_1}+11=10$$

$$-\frac{p_2}{p_1}-2\frac{p_3}{p_1}+18=10$$

51

A General Equilibrium with Three Goods

- This system of simultaneous equations can be solved as

$p_2/p_1 = 2$ $\qquad$ $p_3/p_1 = 3$

- In equilibrium:
  - gold will have a price twice that of silver
  - platinum will have a price three times that of silver
  - the price of platinum will be 1.5 times that of gold

52

A General Equilibrium with Three Goods

- Because Walras' law must hold, we know

$$p_1 ED_1 = -p_2 ED_2 - p_3 ED_3$$

- Substituting the excess demand functions for gold and silver and substituting, we get

$$p_1 ED_1 = 2\frac{p_2^2}{p_1} - \frac{p_2 p_3}{p_1} - p_2 + \frac{p_2 p_3}{p_1} + 2\frac{p_3^2}{p_1} - 8p_3$$

$$ED_1 = 2\frac{p_2^2}{p_1^2} + 2\frac{p_3^2}{p_1^2} - \frac{p_2}{p_1} - 8\frac{p_3}{p_1}$$

53

Smith's Invisible Hand Hypothesis

- Adam Smith believed that the competitive market system provided a powerful "invisible hand" that ensured resources would find their way to where they were most valued
- Reliance on the economic self-interest of individuals and firms would result in a desirable social outcome

54

Smith's Invisible Hand Hypothesis

- Smith's insights gave rise to modern welfare economics
- The "First Theorem of Welfare Economics" suggests that there is an exact correspondence between the efficient allocation of resources and the competitive pricing of these resources

55

Pareto Efficiency

- An allocation of resources is Pareto efficient if it is not possible (through further reallocations) to make one person better off without making someone else worse off
- The Pareto definition identifies allocations as being "inefficient" if unambiguous improvements are possible

56

Efficiency in Production

- An allocation of resources is efficient in production (or "technically efficient") if no further reallocation would permit more of one good to be produced without necessarily reducing the output of some other good
- Technical efficiency is a precondition for Pareto efficiency but does not guarantee Pareto efficiency

57

Competitive Prices and Efficiency

- Attaining a Pareto efficient allocation of resources requires that the rate of trade-off between any two goods be the same for all economic agents
- In a perfectly competitive economy, the ratio of the prices of the two goods provides the common rate of trade-off to which all agents will adjust

58

Competitive Prices and Efficiency

- Because all agents face the same prices, all trade-off rates will be equalized and an efficient allocation will be achieved
- This is the “First Theorem of Welfare Economics”

59

Distribution

- Although the First Theorem of Welfare Economics ensures that competitive markets will achieve efficient allocations, there are no guarantees that these allocations will exhibit desirable distributions of welfare among individuals

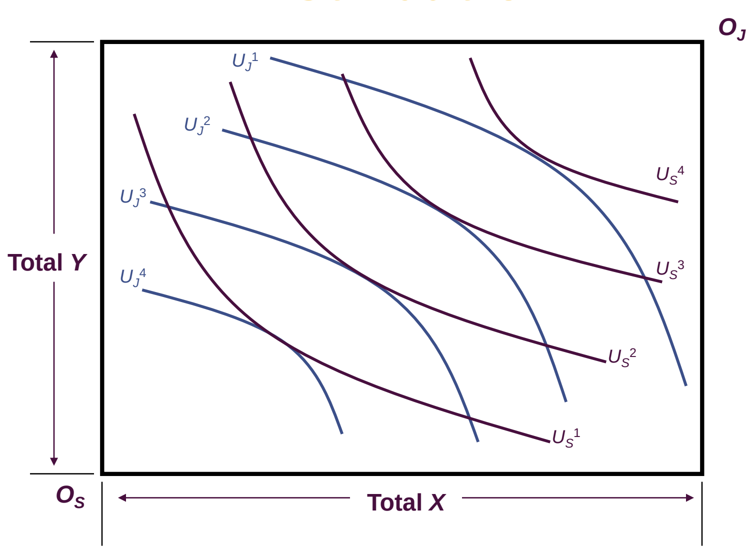
60

Distribution

- Assume that there are only two people in society (Smith and Jones)
- The quantities of two goods (*x* and *y*) to be distributed among these two people are fixed in supply
- We can use an Edgeworth box diagram to show all possible allocations of these goods between Smith and Jones

61

Distribution



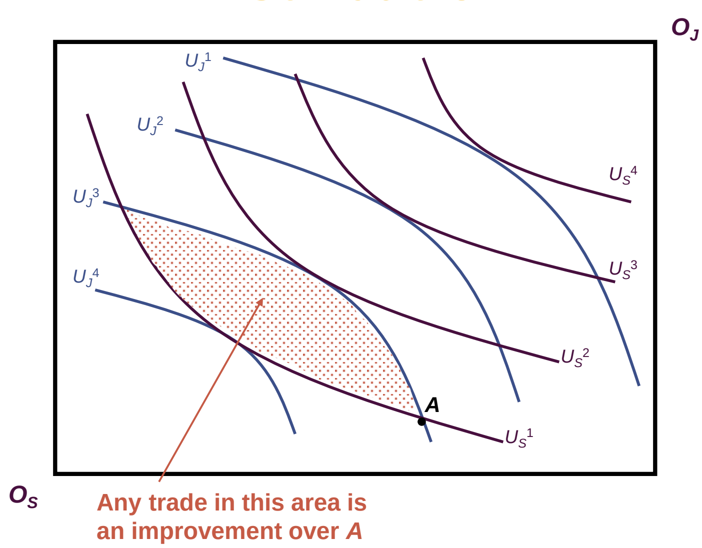
62

Distribution

- Any point within the Edgeworth box in which the *MRS* for Smith is unequal to that for Jones offers an opportunity for Pareto improvements
  - both can move to higher levels of utility through trade

63

Distribution



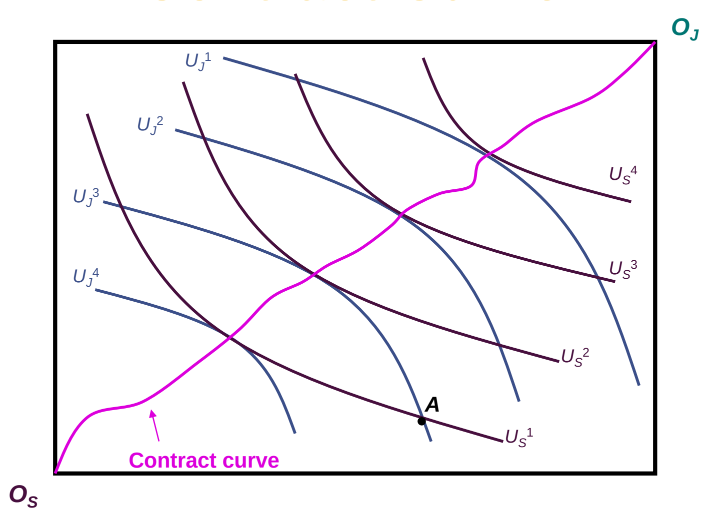
64

Contract Curve

- In an exchange economy, all efficient allocations lie along a <u>contract curve</u>
  - points off the curve are necessarily inefficient
    - individuals can be made better off by moving to the curve
- Along the contract curve, individuals' preferences are rivals
  - one may be made better off only by making the other worse off

65

Contract Curve



66

Exchange with Initial Endowments

- Suppose that the two individuals possess different quantities of the two goods at the start
  - it is possible that the two individuals could both benefit from trade if the initial allocations were inefficient

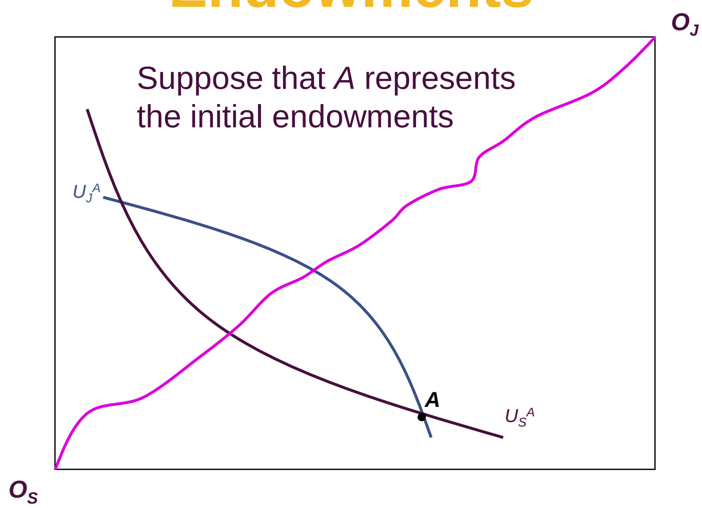
67

Exchange with Initial Endowments

- Neither person would engage in a trade that would leave him worse off
- Only a portion of the contract curve shows allocations that may result from voluntary exchange

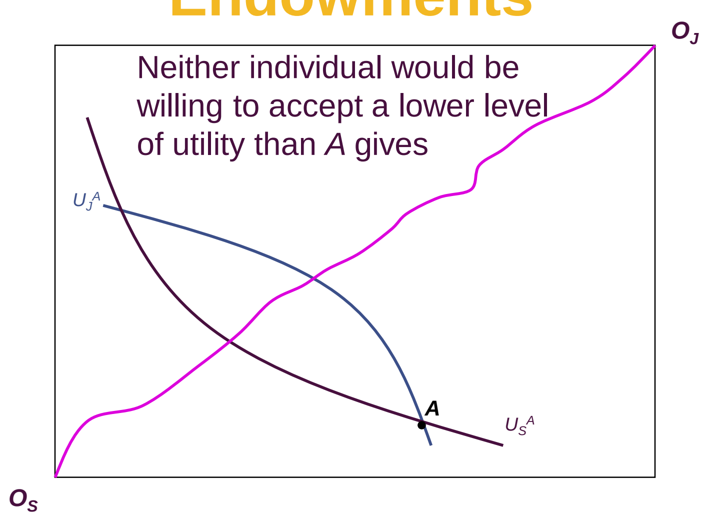
68

Exchange with Initial Endowments



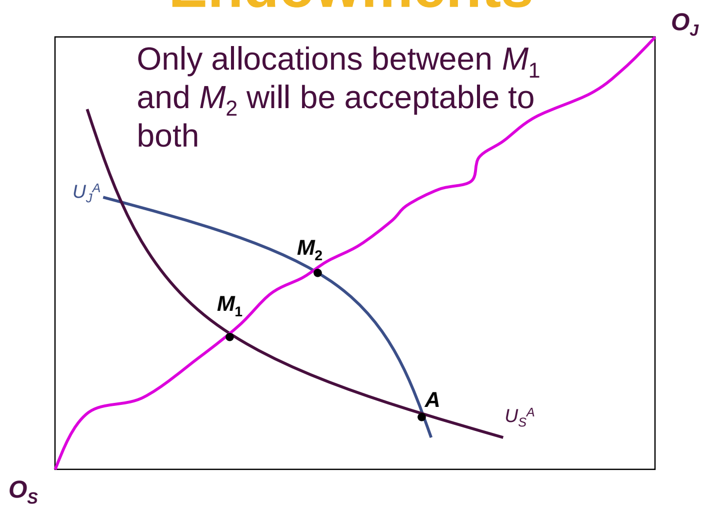
69

Exchange with Initial Endowments



70

Exchange with Initial Endowments



71

The Distributional Dilemma

- If the initial endowments are skewed in favor of some economic actors, the Pareto efficient allocations promised by the competitive price system will also tend to favor those actors
  - voluntary transactions cannot overcome large differences in initial endowments
  - some sort of transfers will be needed to attain more equal results

72

The Distributional Dilemma

- These thoughts lead to the “Second Theorem of Welfare Economics”
  – any desired distribution of welfare among individuals in an economy can be achieved in an efficient manner through competitive pricing if initial endowments are adjusted appropriately

73

Important Points to Note:

- Preferences and production technologies provide the building blocks upon which all general equilibrium models are based
  – one particularly simple version of such a model uses individual preferences for two goods together with a concave production possibility frontier for those two goods

74

Important Points to Note:

- Competitive markets can establish equilibrium prices by making marginal adjustments in prices in response to information about the demand and supply for individual goods
  – Walras’ law ties markets together so that such a solution is assured (in most cases)

75

Important Points to Note:

- Competitive prices will result in a Pareto-efficient allocation of resources
  – this is the First Theorem of Welfare Economics

76

Important Points to Note:

- Factors that will interfere with competitive markets' abilities to achieve efficiency include
  - market power
  - externalities
  - existence of public goods
  - imperfect information

77

Important Points to Note:

- Competitive markets need not yield equitable distributions of resources, especially when initial endowments are very skewed
  - in theory any desired distribution can be attained through competitive markets accompanied by lump-sum transfers
    - there are many practical problems in implementing such transfers

78