General Equilibrium and Economic Welfare

Lecture 7

Reading: Perloff Chapter 10

August 2015

Introduction

- Shocks affect many markets at the same time.
- Different markets feed back into each other.
- Today, we look at how equilibrium is determined in the market as a whole.

Introduction

- We then compare different possible equilibria.
- Is one equilibrium better than another?
- Is this equilibrium efficient?
- Is this equilibrium equitable?

Introduction

- When comparing different outcomes, we often look at **Pareto efficiency**.
- An outcome is Pareto efficient if you cannot make anybody better off without harming somebody else.

EXAMPLE

- Which of these situations is Pareto efficient? Sean has 10 fish and Anna has no fish.

1. Anna hates fish and Sean loves fish.
2. Sean hates fish and Anna loves fish.
3. Both Sean and Anna like fish, but Sean likes fish more so than Anna.
4. Both Sean and Anna like fish, but Anna likes fish more so than Sean.

Outline

- **General Equilibrium** - Looking at all the markets at once.
- **General Equilibrium Exchange Economy: Trading Between Two People** - Equilibrium in an economy when there are just two people who trade.
- **Competitive Exchange** - Equilibrium in an economy when there are prices.
- **Production and Trading** - Equilibrium when there is production.
- **Efficiency and Equity** - There are many Pareto-efficient allocations, but which is best?

General Equilibrium

- We have only looked at **partial-equilibrium analysis** in this course.
- In partial-equilibrium analysis, we look at one market in isolation, other markets are fixed.
- But the economy is a complex system and markets feedback into each other.
- **General-equilibrium analysis** studies equilibrium in all markets simultaneously.

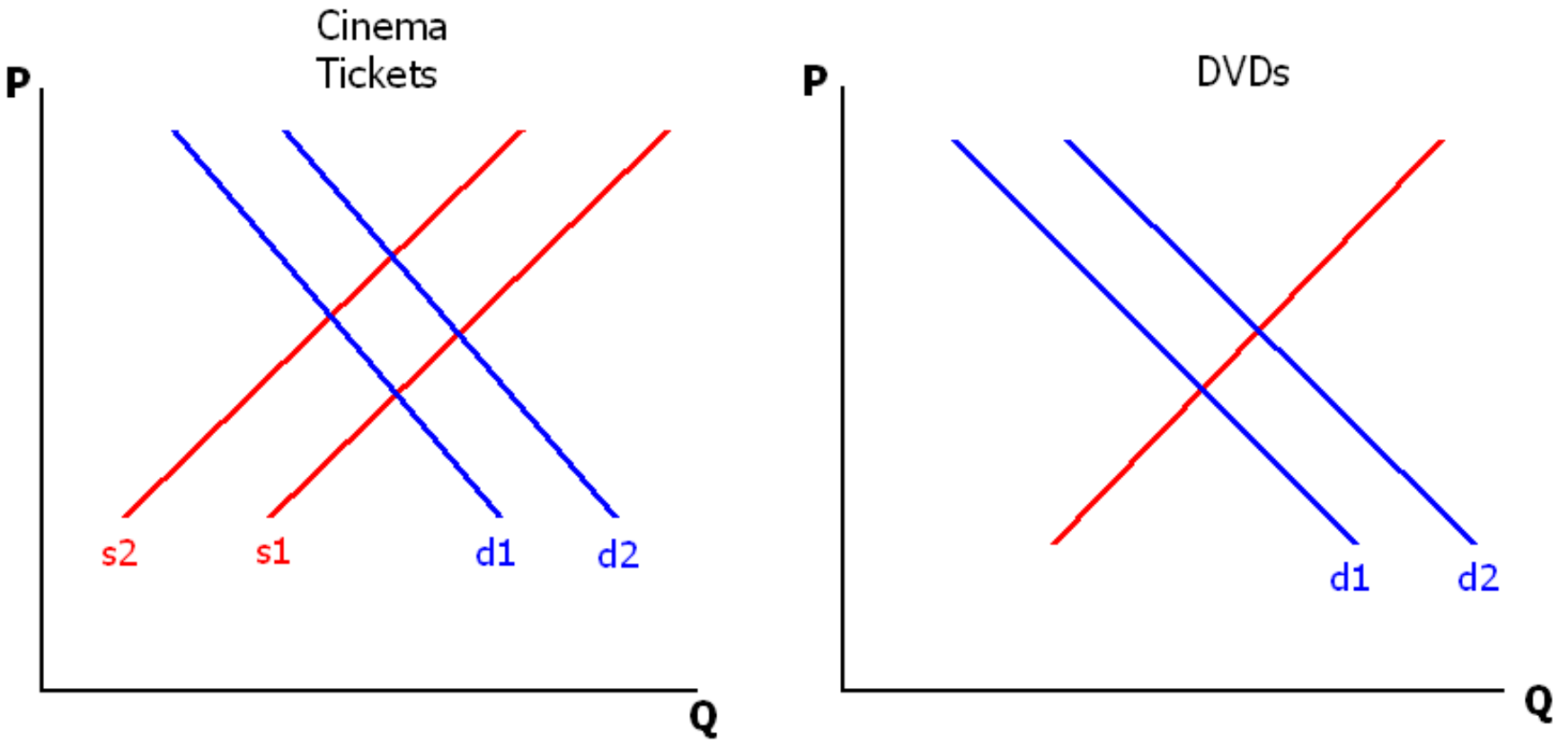
General Equilibrium

- Partial equilibrium analysis can lead to bias.
- Consider the market for DVDs and cinema tickets.
- The government taxes movie tickets.
- If we look at partial equilibrium, the supply curve for movie tickets shifts and we are done.
- If we look at general equilibrium, we consider how this might affect the DVD market (which feed back into the movie ticket market).

General Equilibrium

- A leftward shift in the supply for cinema tickets will increase the price of cinema tickets.
- This will increase demand for DVDs because DVDs and cinema tickets are substitutes.
- The price of DVDs will go up.
- The demand curve for cinema tickets will shift to the right because the price of DVDs went up.

General Equilibrium



EXAMPLE

- Tea and sugar are complements.
- Sugar workers go on strike.
- Use general equilibrium analysis to determine what will happen in the sugar and tea markets.

General Equilibrium

- We can analytically find the price and quantity as well.
- Suppose the demand for goods 1 and 2 depend on the prices of both goods

$$\begin{aligned} Q_1 &= D_1(p_1, p_2) \\ Q_2 &= D_2(p_1, p_2) \end{aligned}$$

- Suppose supply for each good depends on only the good's price

$$\begin{aligned} Q_1 &= S_1(p_1) \\ Q_2 &= S_2(p_2) \end{aligned}$$

General Equilibrium

- To solve for equilibria, we must find a simultaneous equilibrium in all markets.
- It is easy if everything is linear

$$\begin{aligned} Q_1^d &= a_1 - b_1 p_1 + c_1 p_2 \\ Q_2^d &= a_2 - b_2 p_2 + c_2 p_1 \\ Q_1^s &= d_1 + e_1 p_1 \\ Q_2^s &= d_2 + e_2 p_2 \end{aligned}$$

Equilibrium in Two Interrelated Markets

- The equilibrium prices would be

$$
\begin{aligned}
p_1 &= \frac{(b_2 + e_2)(a_1 - d_1) + c_1(a_2 - d_2)}{(b_1 + e_1)(b_2 + e_2) - c_1 c_2} \\
p_2 &= \frac{(b_1 + e_1)(a_2 - d_2) + c_2(a_1 - d_1)}{(b_1 + e_1)(b_2 + e_2) - c_1 c_2}
\end{aligned}
$$

Equilibrium in Two Interrelated Markets

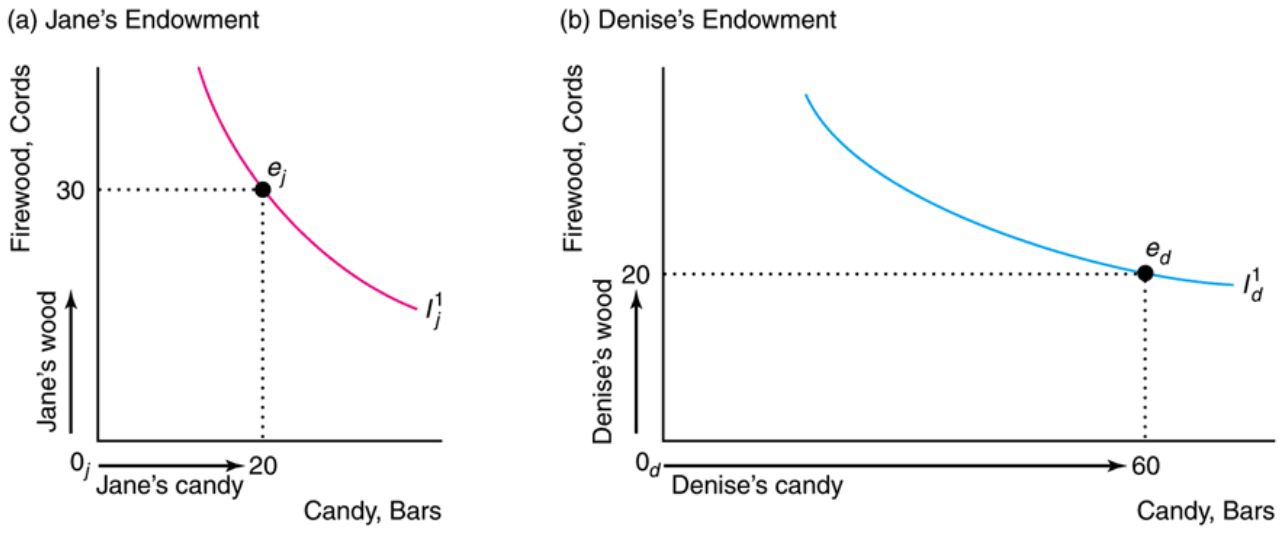
- In partial equilibrium analysis, you have 2 equations in your system.
- In general equilibrium, you have $2N$ equations in your system where N is the number of markets.

Trading Between Two People

- There are thousands of markets out there and they all will feed back into each other.
- Lets make our economy as simple as we can can.
- Two people have **endowments** of two goods and they voluntarily trade with each other.
- In this simple world, the price of goods are jointly determined.
- This allows us to easily compare equilibria.

Trading Between Two People

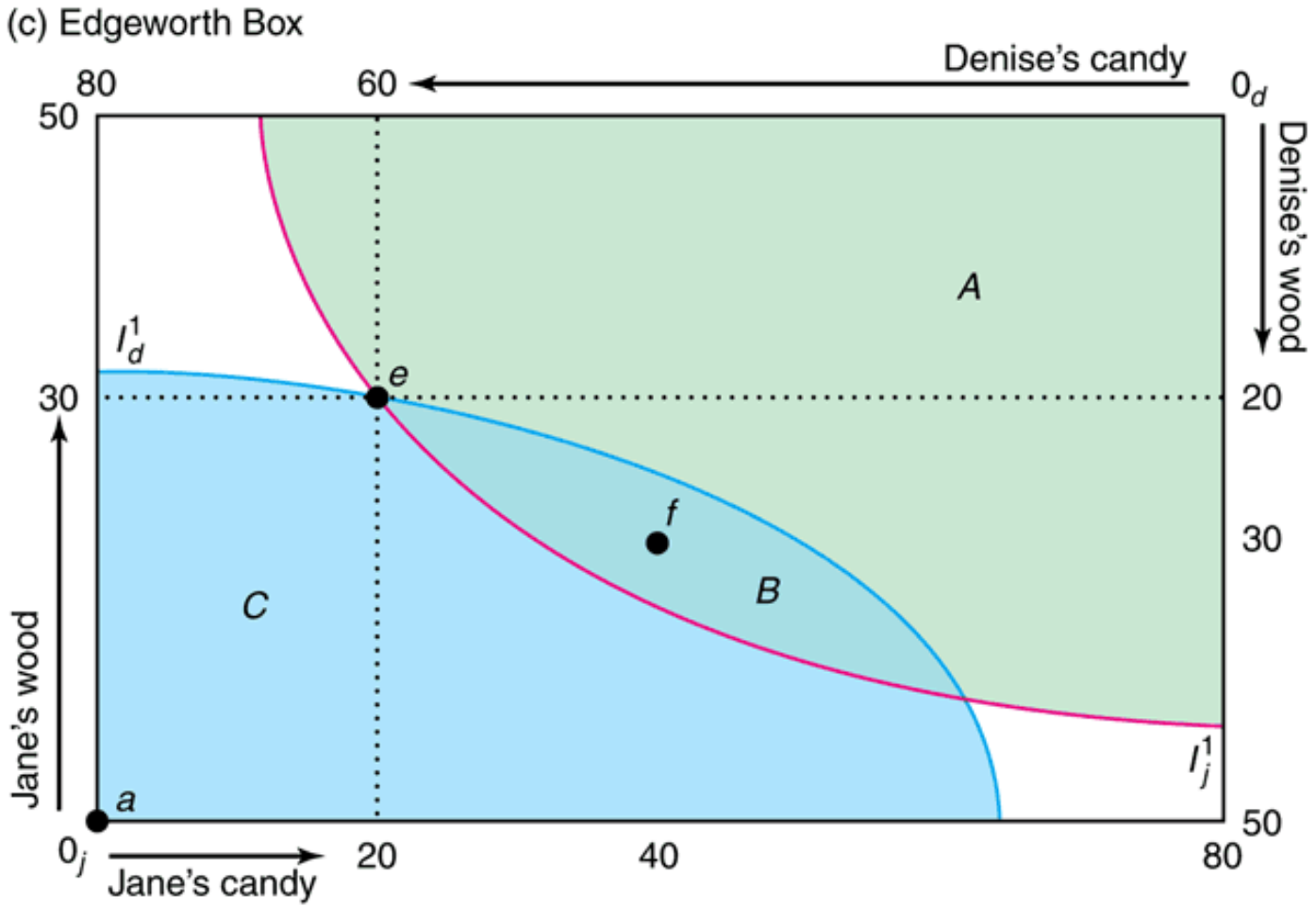
- We can illustrate these endowments on an indifference map



Trading Between Two People

- Flip one of their maps upside down and we get an **Edgeworth Box.**
- The size of the box represents how much of each good there is in the economy.
- Point e is the endowment point.
- The two people can voluntarily trade with each other and get to any point on the box.
- Both people want to be further from their origin.

Trading Between Two People



EXAMPLE

- Draw an Edgeworth box for Kimon and Rebecca for bananas and apples. Show their indifference curves and the endowment point.
  - Kimon has 10 bananas and 1 apple.
  - Rebecca has 4 apples and 10 bananas.

Trading Between Two People

- Now back to the previous case with Denise and Jane.
- Denise and Jane will trade if they can both be made better off.
- When will trading stop?

Trading Between Two People

- Lets make some assumptions about their tastes
  - **Utility maximization** - Everybody is maximizing their utility
  - **Convex indifference curves** - Indifference curves are the usual convex shape (very easy to relax)
  - **Non-satiation** - More is better, everybody wants to go as far from their origin as they can.
  - **No interdependence** - Don't care how much the other person gets.

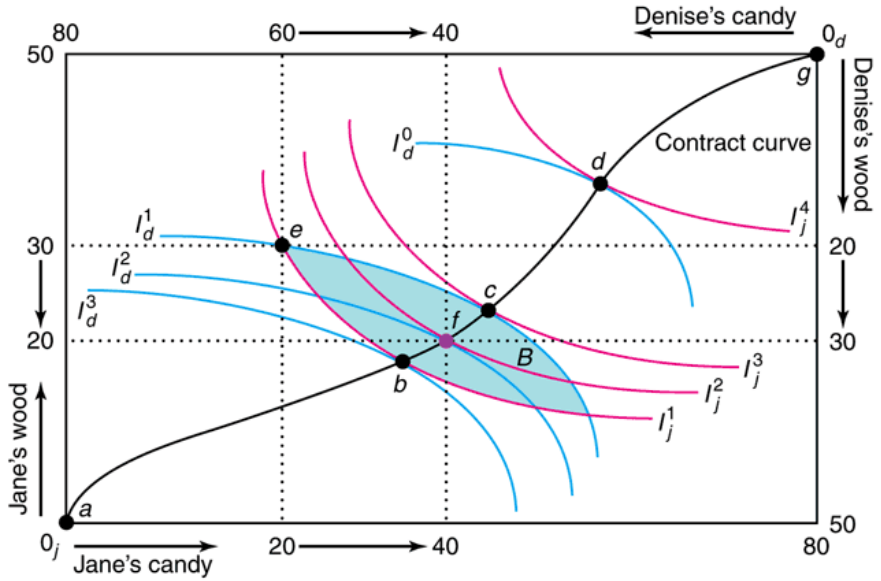
Trading Between Two People

- Consider point e, can do mutually beneficial trades exist?
- Yes, you could move to point f and both people are better off.
- Point e is therefore not an equilibrium.

Trading Between Two People

- People will keep trading until no mutually beneficial trades remain. This occurs at point f.
- At point f, their indifference curves are tangent $(MRS_J = MRS_D)$
- We can connect all the Pareto efficient points (all the points where there indifference curves are tangent) to get the **contract curve**.
- No matter where the endowment point is, people will trade until they reach the contract curve.
- If you are not on the contract curve, mutually beneficial trades exist.

Trading Between Two People



	Endowment, *e*		Trade		New Allocation, *f*	
	Wood	Candy	Wood	Candy	Wood	Candy
Jane	30	20	−10	+20	20	40
Denise	20	60	+10	−20	30	40

EXAMPLE

- Draw and edgeworth box showing a point that is not Pareto efficient, a point that is Pareto efficient and draw the contract curve.

EXAMPLE

- Suppose Sonia's utility function is $U_S = yx^2$
- Anne's utility function is $U_A = xy$
- Sonia has 4 x and 2 y
- Anne has 2 x and 8 y
- Is this efficient? Can they gain from trade?

Trading Between Two People

- We can derive the contract curve analytically using constrained optimization.
- Remember we are trying to find the condition under which we can make one individual as well off as possible without harming the other.
- We fix one person's utility and maximize the other person's with respect to it.

Trading Between Two People

$$\max \mathcal{L} = U_j\left(q_{j1}, q_{j2}\right) + \lambda\left[U_d\left(q_1 - q_{j1}, q_2 - q_{j2}\right) - \overline{U}_d\right]$$

- We are maximizing the utility of Jane such that the utility of Denise does not change.
- $q_1 = q_{j1} + q_{d1}$ is the total amount of q_1 and $q_1 - q_{j1}$ is how much of q_1 Denise has

Trading Between Two People

$$\frac{\partial \mathcal{L}}{d_{q_{j1}}} = \frac{\partial U_j}{d_{q_{j1}}} - \lambda \frac{\partial U_d}{d_{q_{j1}}} = 0 \tag{1}$$

$$\frac{\partial \mathcal{L}}{d_{q_{j2}}} = \frac{\partial U_j}{d_{q_{j2}}} - \lambda \frac{\partial U_d}{d_{q_{j2}}} = 0 \tag{2}$$

$$\frac{\partial \mathcal{L}}{d\lambda} = U_d\left(q_1 - q_{j1}, q_2 - q_{j2}\right) - \overline{U}_d = 0$$

Trading Between Two People

- If we equate equation 1 and 2 we find the same result

$$MRS_j = \frac{\frac{\partial U_j}{d_{q_{j1}}}}{\frac{\partial U_j}{d_{q_{j2}}}} = \frac{\frac{\partial U_d}{d_{q_{j1}}}}{\frac{\partial U_d}{d_{q_{j2}}}} = MRS_d$$

Competitive Exchange

- We have made no references to prices so far
- Denise and Jane can somehow bargain with each other to get to the contract curve
- But now lets say that Denise and Jane can purchase wood and candy bars at a market price

Competitive Exchange

- In a competitive market, prices will adjust until quantity supplied equals quantity demanded
- Think of an auctioneer who calls out relative prices and asks how much each person wants to sell and buy
- If quantity demanded does not equal quantity supplied, the auctioneer will call out another price
- Once they are equal, the auctioneer stops

Competitive Exchange

- The equilibrium we get to has two nice properties

1. The competitive market equilibrium is efficient (Pareto)
2. Any efficient allocation you desire can be achieved by competition

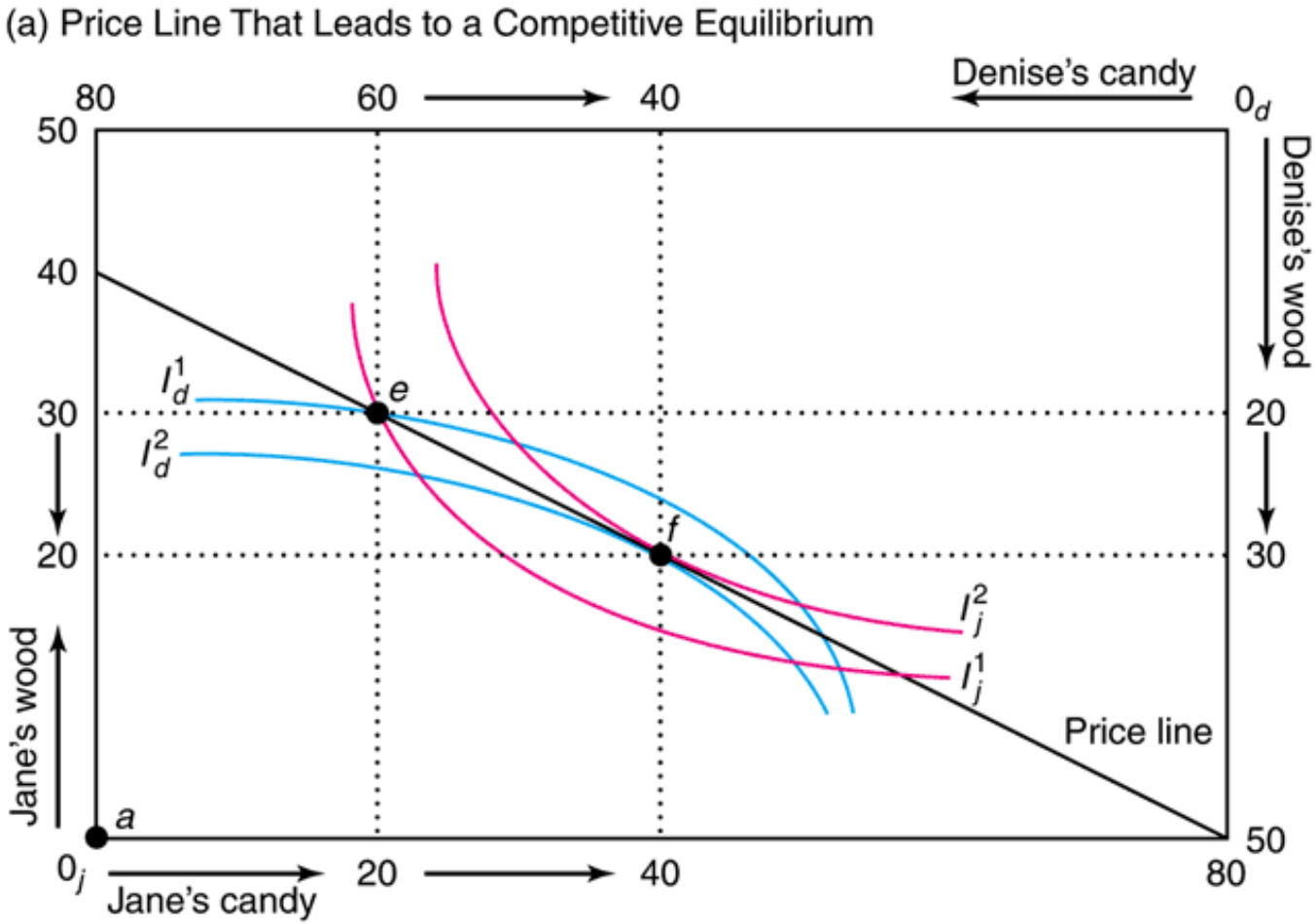
- These are the first and second theorems of welfare economics respectively (Adam Smith)

Competitive Exchange

- Remember people will maximize their utility subject to the budget line
- The slope of the budget line is just the price ratio.

Competitive Exchange

- Prices will adjust until both people's indifference curves are tangent to their budget line.
- We reach point f once again.



Competitive Exchange

- At this point, $MRS_j = -\frac{p_c}{p_w} = MRS_d$
- The number of units Jane wants to sell is exactly equal to the number Denise wants to buy at the price ratio and *vice versa*.
- At any other price ratio, one individual will demand more units than the other is willing to supply.
- This is efficient, and this leads us to the first theorem of welfare economics that any competitive equilibrium is Pareto efficient.
- This is Adam Smith's invisible hand (**first welfare theorem**)

Competitive Exchange

- We know that the competitive equilibrium will occur on the contract curve.
- If the social planner has some equilibrium in mind on the contract curve, she can achieve it.
- Just redistribute the endowment to anywhere on the equilibrium price line.
- This is Smith's **second welfare theorem.**

Production and Trading

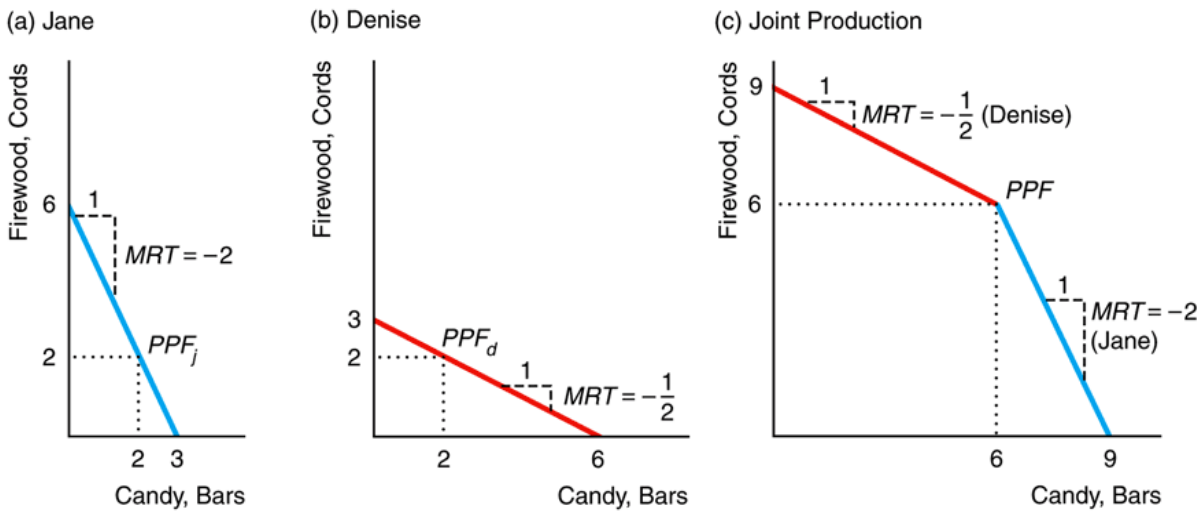
- Lets throw production in the mix.
- Jane can produce 3 candy bars or 6 cords of firewood (or she can split her time between)
- Denise can produce 3 cords of wood or 6 candy bars a day.

Production and Trading

- The *opportunity cost* of producing one candy bar for jane is 2 pieces of wood, it is half a piece of wood for Denise
- Because Denise has a lower opportunity cost of producing candy, she has a **comparative advantage** in the production of that good.
- Comparative advantage is what drives classical international trade theory.

Production and Trading

- We can plot the **production possibilities frontier**
- This shows how much of each good Jane and Denise can produce by themselves or jointly.



- Why does the joint production not kink the other way?

Production and Trading

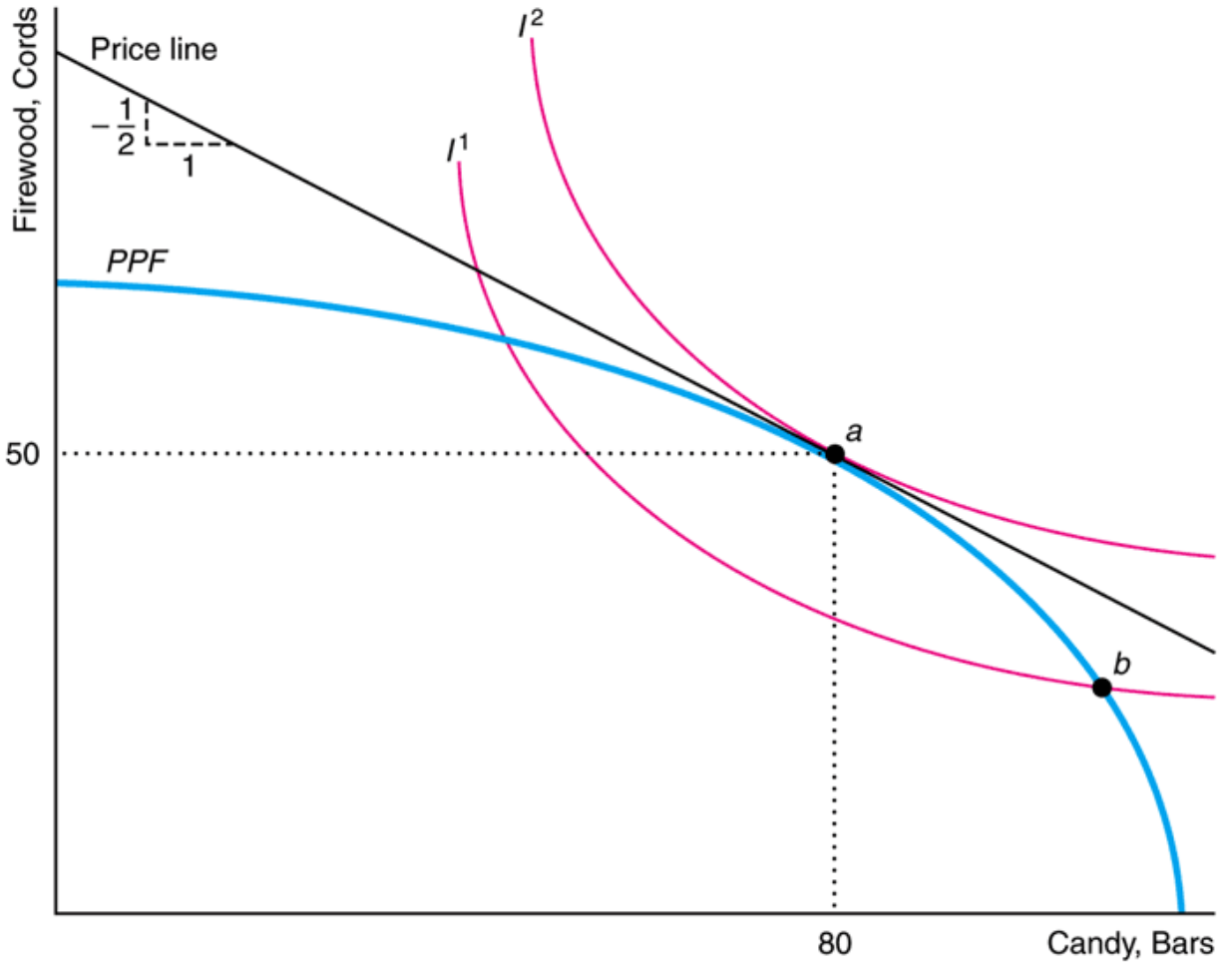
- The slope of the production possibilities frontier is the **marginal rate of transformation.**
- Jane and Denise have different marginal rates of transformation, so they can gain from trade.

Production and Trading

- If we add a third person with a different MRT, we get a second kink.
- Keep adding at we get a smooth PPF.
- The slope of the PPF is the ratio of marginal costs
- If $MC_A = \$2$ and $MC_B = \$1$, the producer must give up half a unit of A to get one unit of B.

Production and Trading

- If there is just one person, she will produce where her $MRT = MRS$ (highest indifference curve)



Production and Trading

- Each price-taking consumer picks a bundle such that $MRS = -\frac{p_c}{p_w}$.
- If all consumers face the same prices and have the same MRS, they will pick the same bundle.
- Cannot redistribute to make anybody better off so we achieve *consumption efficiency.*

Production and Trading

- If firms are competitive, the will set price equal to marginal cost.

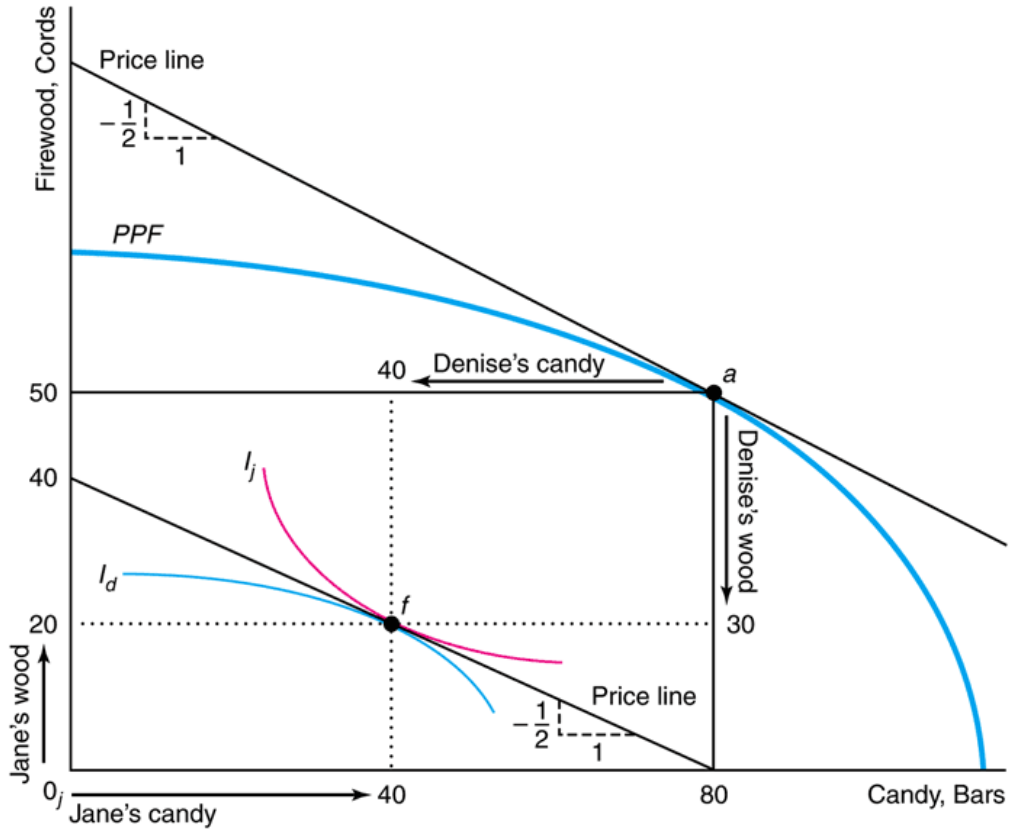
$$\begin{aligned} p_c &= MC_c \\ p_w &= MC_w \\ \frac{p_c}{p_w} &= \frac{MC_c}{MC_w} = MRT \end{aligned}$$

- Thus, in the competitive equilibrium.

$$MRS = \frac{p_c}{p_w} = MRT$$

- We achieve an *efficient product mix* even though there is no social planner.

Production and Trading



Efficiency and Equity

- There are many different possible equilibria. Some are more equitable than others.
- By redistributing endowments, the government determines who gets how much of the pie.
- What should the government's objective be with this tool?

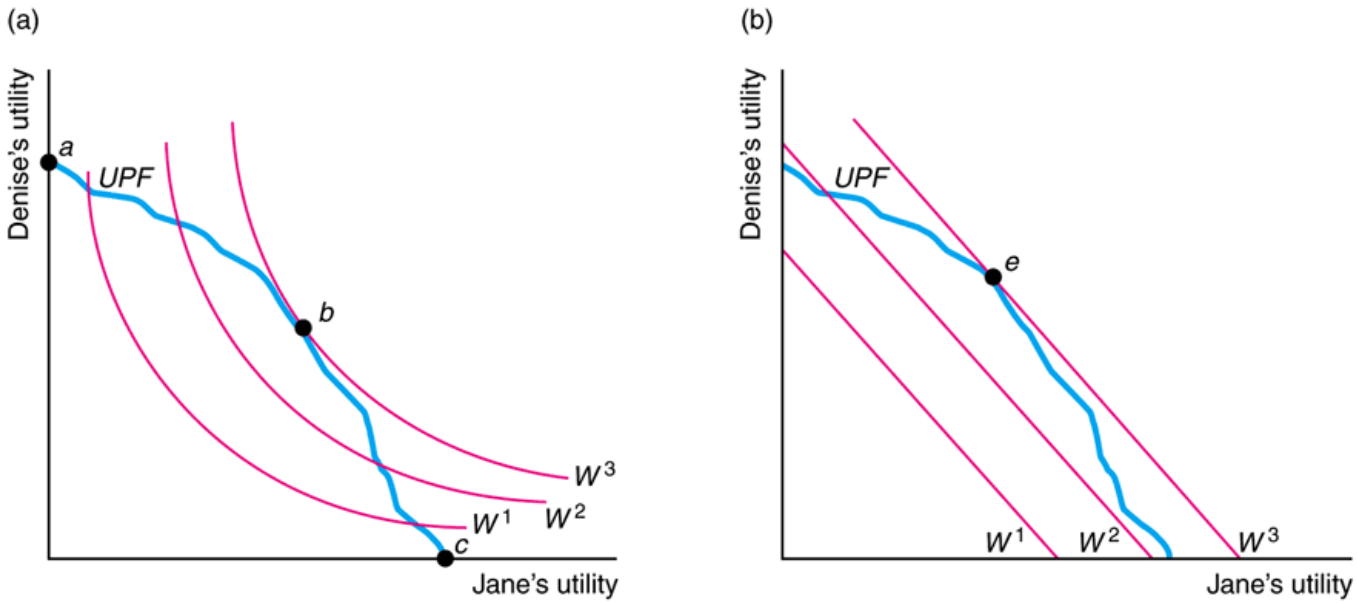
Efficiency and Equity

- Many say we should use the Pareto principle to rank allocations.
- If x is Pareto ranked above y, people are better off at x and nobody else is harmed.
- x is **Pareto superior** to y.
- But there are many Pareto efficient allocation.

Efficiency and Equity

- If we can't use the Pareto principle, we must make additional value judgments to rank allocations
- We need to have some **social welfare function**, which ranks different allocations based on a combination of people's utilities.
- We can plot all the combinations of utilities which is called a utility possibilities frontier
- Then we can pick which point on the frontier gives us the highest welfare through **isowelfare curves**.

Efficiency and Equity



Efficiency and Equity

- But which social welfare function should we use?
- We could settle it by voting, where we allow the majority to select which allocation they prefer most
- But if people have different orderings, society much have intransitive preferences over bundle comparisons

Efficiency and Equity

- For democratic decision making to occur, a number of conditions must be met.
- This is due to Nobel Prize winner Kenneth Arrow

Efficiency and Equity

1. Social preferences must be complete and transitive
2. If everybody prefers a to b, a should be preferred socially to b.
3. Society's rankings of a and b should depend only on individuals orderings of the two allocations
4. Dictatorship is not allowed, social preferences must not reflect the preferences of a single individual.

- Arrow proved that it is impossible to find a rule that satisfies all this... this is **Arrows Impossibility Theorem**.

Efficiency and Equity

- If you were to vote, which social welfare function would you want?
- The most simple is the **egalitarian rule**, which gives everybody the exact same endowment.
- Jeremy Bentham, John Stewart Mills and other utilitarian philosophers suggest our goal should be to maximize the sum of people's utilities

$$W = U_1 + U_2 + ... + U_n.$$

Efficiency and Equity

- Or we could generalize this and give different people different weights in a generalized **utilitarian welfare function**

$$W = \alpha_1 U_1 + \alpha_2 U_2 + ... + \alpha_n U_n.$$

- Rawls suggested that we should seek to maximize the utility of the least well off in society, the **Rawlsian welfare function** is

$$W = \min(U_1, U_2, ..., U_n)$$

Efficiency and Equity

- Depending on what social welfare function we seek to maximize, society might prefer an inefficient allocation to an efficient one.
- If allocation *a* gives Bill Gates $\$1,000,000,000$ and 9 get nothing, it is Pareto efficient.
- But surely society would prefer allocation *b* where all 10 people get $\$100,000$
- *Pareto efficiency* $\not\Rightarrow$ *equity*

Efficiency and Equity

- A **distortion** is anything that prevents people from maximizing their welfare.
- Market power, incomplete information, externalities, public goods are distortions
- These will lead to inefficiency

Efficiency and Equity

- If we are in a competitive economy with no distortions, it is **first-best** and any distortion will decrease efficiency.
- We shouldn't tax a distortion free economy
- But if an economy has at least two distortions, correcting one might increase welfare.
- This is the **theory of second best.**

Summary

- What is the difference between general and partial equilibrium?
- What is Pareto efficiency?
- What is the contract curve?
- In an exchange economy, equilibrium will occur where?
- In a competitive economy, equilibrium will occur where?
- In an economy with production, equilibrium will occur where?

Summary

- What are Adam Smith's first and second welfare theorems?
- What is Arrow's Impossibility Theorem?
- What is the theory of second best?