

General Equilibrium and Economic Welfare

Lecture 7

Reading: Perloff Chapter 10

August 2017

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?

- 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.

- **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.

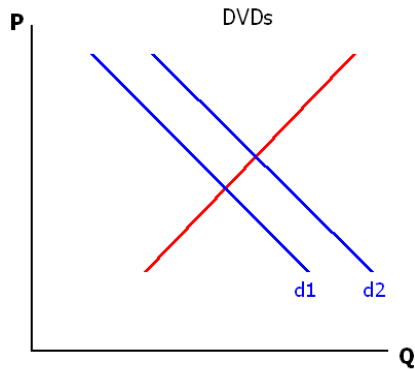
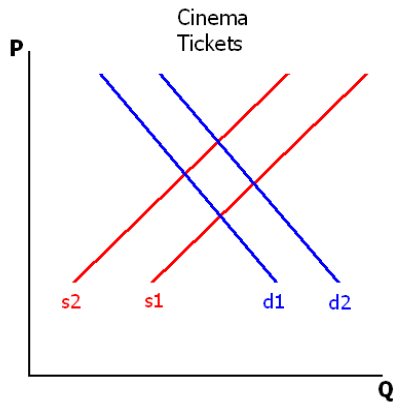
General Equilibrium

- 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

$$Q_1 = D_1(p_1, p_2)$$

$$Q_2 = D_2(p_1, p_2)$$

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

$$Q_1 = S_1(p_1)$$

$$Q_2 = S_2(p_2)$$

General Equilibrium

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

$$Q_1^d = a_1 - b_1 p_1 + c_1 p_2$$

$$Q_2^d = a_2 - b_2 p_2 + c_2 p_1$$

$$Q_1^s = d_1 + e_1 p_1$$

$$Q_2^s = d_2 + e_2 p_2$$

Equilibrium in Two Interrelated Markets

- The equilibrium prices would be

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

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.

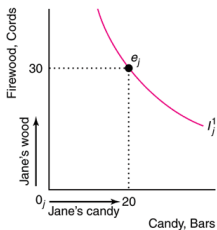
Trading Between Two People

- 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.

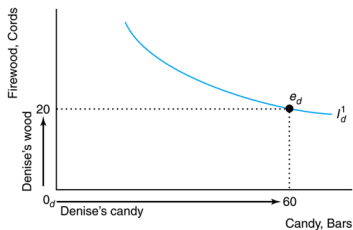
Trading Between Two People

- We can illustrate these endowments on an indifference map

(a) Jane's Endowment



(b) Denise's Endowment

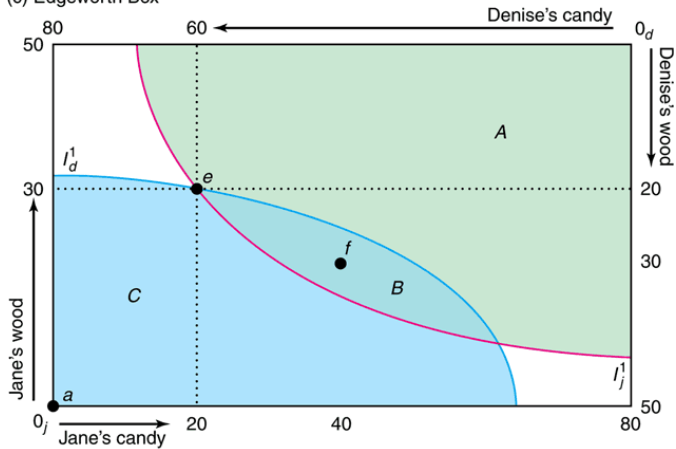


Trading Between Two People

- 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

(c) Edgeworth Box



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.

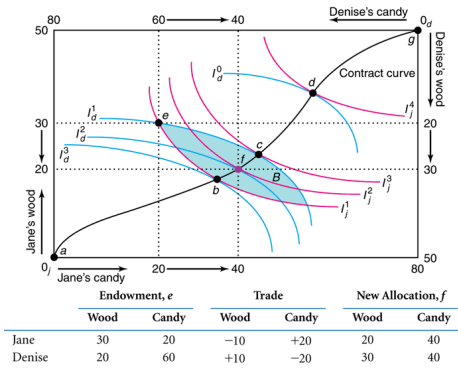
Trading Between Two People

- 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 their 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



EXAMPLE

- Draw an 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

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

- 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

$$\frac{\partial \mathcal{L}}{\partial q_{j1}} = \frac{\partial U_j}{\partial q_{j1}} - \lambda \frac{\partial U_d}{\partial q_{j1}} = 0 \quad (1)$$

$$\frac{\partial \mathcal{L}}{\partial q_{j2}} = \frac{\partial U_j}{\partial q_{j2}} - \lambda \frac{\partial U_d}{\partial q_{j2}} = 0 \quad (2)$$

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

Trading Between Two People

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

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

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)

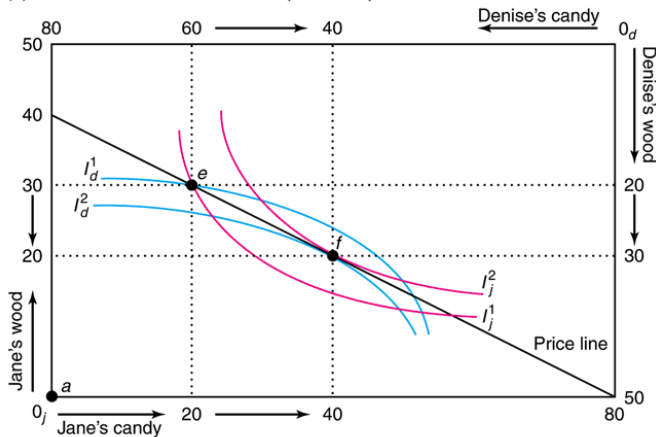
Competitive Exchange

- 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.

(a) Price Line That Leads to a Competitive Equilibrium



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

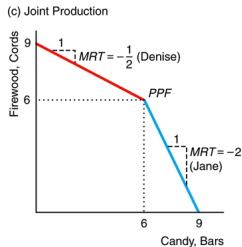
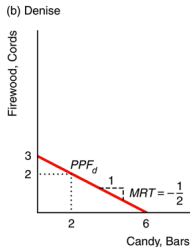
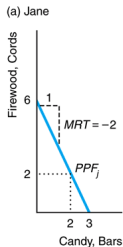
- Lets throw production in the mix.
- Jane can produce 3 candy bars or 6 cords of firewood (or she can split her time between)
- Denise can produce 3 cords of wood or 6 candy bars a day.

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

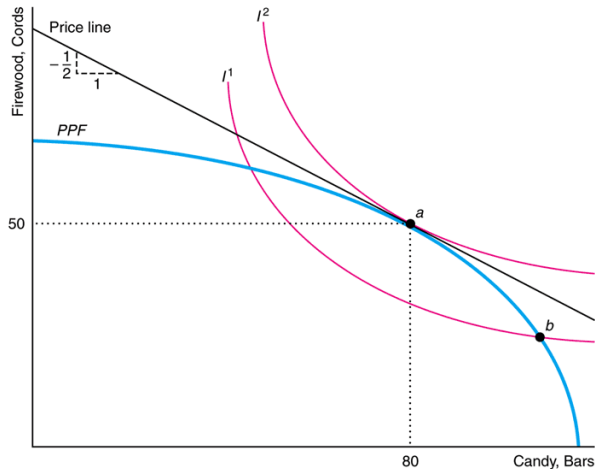
- The slope of the production possibilities frontier is the **marginal rate of transformation**.
- Jane and Denise have different marginal rates of transformation, so they can gain from trade.

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, they will set price equal to marginal cost.

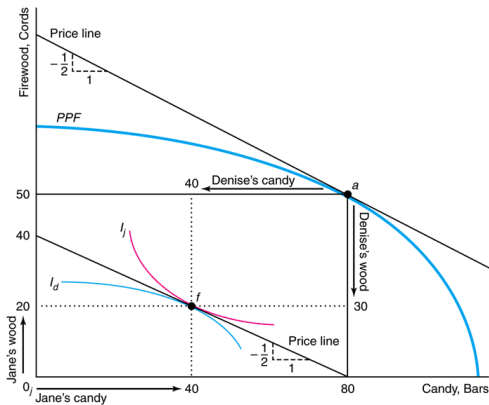
$$\begin{aligned}p_c &= MC_c \\p_w &= MC_w \\ \frac{p_c}{p_w} &= \frac{MC_c}{MC_w} = MRT\end{aligned}$$

- 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?

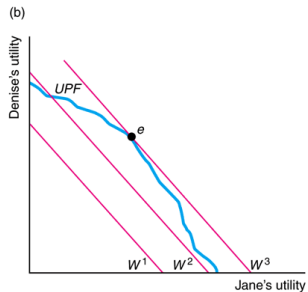
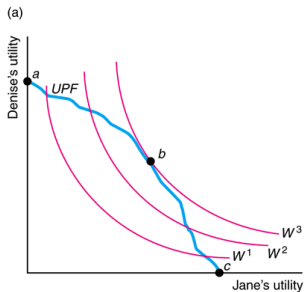
Efficiency and Equity

- 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**.

- 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

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

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

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

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

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

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 \nRightarrow 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?