General Equilibrium

Introduction (1/1)

15

Our analysis of markets, thus far, has been focused on individual markets; this is called **partial equilibrium analysis**.

In this chapter, we introduce **general equilibrium analysis**:

- A study of market behavior that incorporates cross-market influences to determine the equilibrium

Chapter Outline

General Equilibrium Effects in Action (1/17)

15.1

An Overview of General Equilibrium Effects

Since the oil crisis of the 1970's, the U.S. government has subsidized the production of ethanol, and most ethanol is made from corn in the U.S.

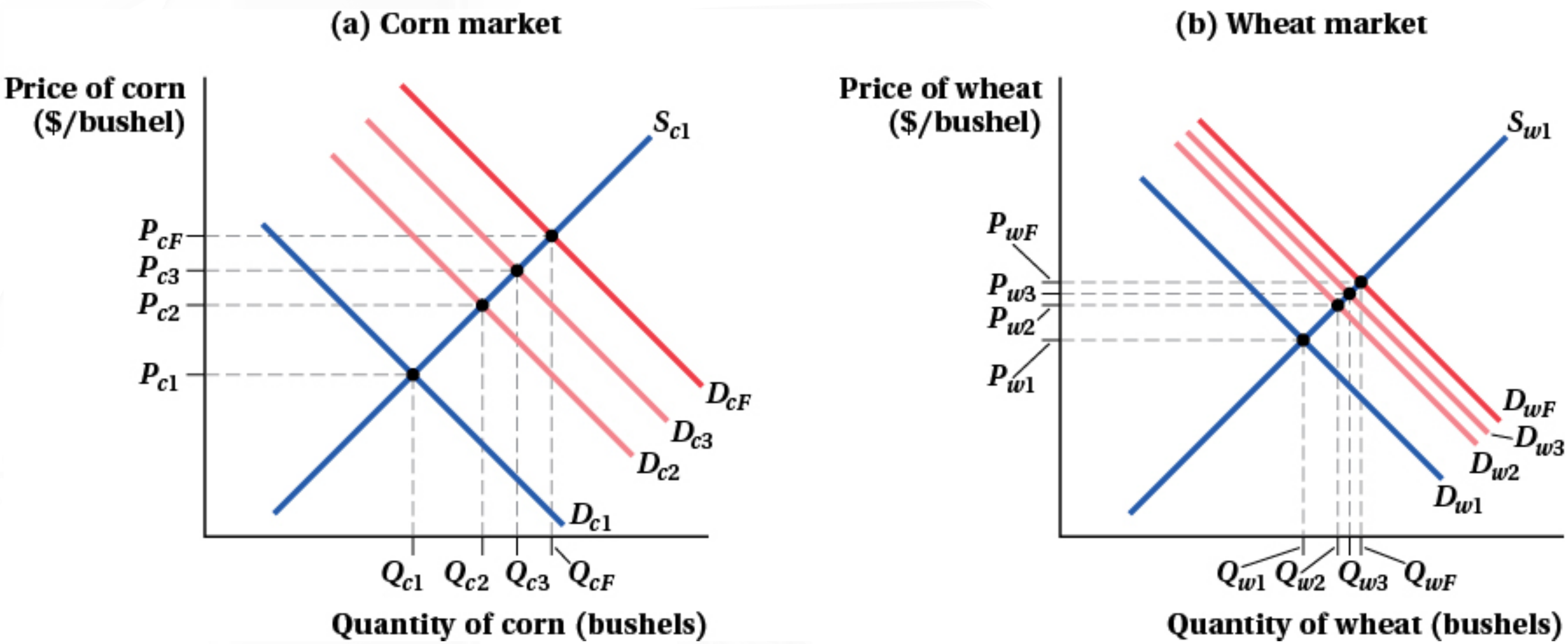
- This mandate increased demand for corn, hence the price.
- However, the prices of wheat, rice, and soybeans also increased during this period.
- As demand for corn increases, the price increases.
- As the price increases, consumers demand more of substitute goods.
  - For instance, wheat-based cereals versus corn-based
- As demand for other commodities increases, the demand for corn increases further.

These effects can be depicted graphically.

General Equilibrium Effects in Action (2/17)

15.1

Figure 15.1 General Equilibrium Effects in Corn and Wheat Markets



The ethanol mandate shifts corn demand outward, and the rise in corn prices increases the demand for wheat.

Higher wheat prices further increase demand for corn. This process continues until a final equilibrium is reached.

General Equilibrium Effects in Action (3/17)

15.1

Why else might the price of other commodity crops increase?

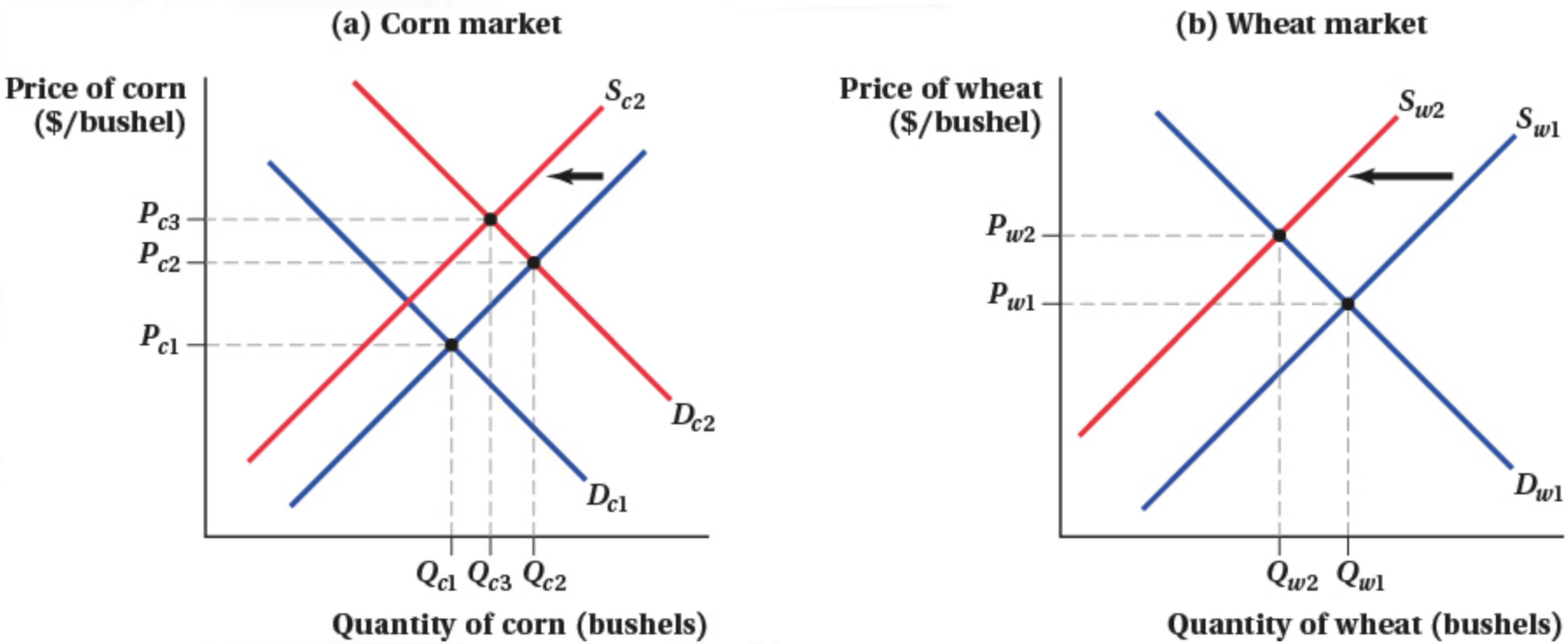
- As demand for corn increases, the price increases.
- As the price of corn increases, farmers will shift land to corn production from other crops, reducing the supply of other commodities and increasing prices.
- As in the case of demand-side spillovers, this increase in price in other commodities will lead farmers to shift land and other resources back to those commodities.

These effects can also be depicted graphically.

General Equilibrium Effects in Action (4/17)

15.1

Figure 15.2 Supply-Side Input Links across Industries



The increase in corn prices leads farmers to shift production away from wheat and into corn, shifting the supply of wheat inward.

This leads to an increase in the price of wheat, which in turn results in farmers switching back (at a lower magnitude) to wheat production, leading to an inward shift in the supply of corn.

General Equilibrium Effects in Action (5/17)

15.1

Quantitative General Equilibrium: The Corn Example with Demand-Side Market Links

- To get a better feel for general equilibrium, we use equations and numbers.
- For simplicity, assume there are only two goods in the economy, corn and wheat.

Demand for corn is given by: $$Q_c^d = 20 - P_c + P_w$$

where P_c is the price of corn and P_w the price of wheat (each in dollars per bushel). Quantities are measured in millions of bushels. Demand for wheat is given by:

$$Q_w^d = 20 - P_w + P_c$$

The supply of each is equal to price, $Q_c^s = P_c \ ; \ Q_w^s = P_w$

General Equilibrium Effects in Action (6/17)

15.1

Finding Equilibrium Prices

In a two-good general equilibrium market, we must solve for the pair of prices that clear the two markets.

- This means demand must equal supply in each market.

First, consider the market for wheat:

$$Q_W^d = Q_W^s \rightarrow 20 - P_W + P_C = P_W$$

$$P_W = 10 + \frac{P_C}{2}$$

General Equilibrium Effects in Action (7/17)

15.1

Finding Equilibrium Prices

Doing the same for corn yields:

$$Q_c^d = Q_c^s \rightarrow 20 - P_c + P_w = P_c$$

$$P_c = 10 + \frac{P_w}{2}$$

To solve for the equilibrium prices, substitute the equation for the wheat price:

$$P_c = 10 + \left(10 + \frac{P_c}{2}\right) \div 2 = 15 + \frac{P_c}{4}$$

$$\frac{3P_c}{4} = 15 \Rightarrow \quad P_c = \$20$$

General Equilibrium Effects in Action (8/17)

15.1

Finding Equilibrium Prices

Substituting the price of corn into the price equation for wheat:

$$P_w = 10 + \frac{P_c}{2} = 10 + \frac{20}{2} \Rightarrow \quad P_w = \$20$$

Finding Equilibrium Quantities

Using the supply or demand equation, plug in the prices:

$$Q_c^S = 20 - P_c + P_w = 20 - 20 + 20 \Rightarrow \ Q_c^S = 20 \text{ million}$$

$$Q_w^S = 20 - P_c + P_w = 20 - 20 + 20 \Rightarrow Q_w^S = 20 \text{ million}$$

General Equilibrium Effects in Action (9/17): Question 1

15.1

Suppose the demand for apple juice is $Q^d_{aj} = 40 - P_{aj} + 2P_{oj}$. If the supply of apple juice is equal to its price, the equilibrium price of apple juice is:

A. $P_{aj} = 20 + 2P_{oj}$
B. $P_{aj} = 20 + P_{oj}$
C. $P_{aj} = 40 + 2P_{oj}$
D. $P_{aj} = 40 + P_{oj}$

General Equilibrium Effects in Action (9/17): Question 1 – Correct Answer

15.1

Suppose the demand for apple juice is $Q^d_{aj} = 40 - P_{aj} + 2P_{oj}$. If the supply of apple juice is equal to its price, the equilibrium price of apple juice is:

A. $P_{aj} = 20 + 2P_{oj}$
B. $P_{aj} = 20 + P_{oj}$ (correct answer)
C. $P_{aj} = 40 + 2P_{oj}$
D. $P_{aj} = 40 + P_{oj}$

General Equilibrium Effects in Action (10/17)

15.1

General Equilibrium Effects

Consider how the renewable fuel mandate affects this market. Assume the mandate increases demand for corn by 12 million bushels at every price, so that the new demand for corn is given by:

$$Q_c^d = 32 - P_c + P_w$$

To determine the new equilibrium price and quantity in each market, we go through the same process as previously. Equating demand and supply in the corn market yields:

$$Q_c^d = Q_c^s \rightarrow 32 - P_c + P_w = P_c$$

$$P_c = 16 + \frac{P_w}{2}$$

General Equilibrium Effects in Action (11/17)

15.1

General Equilibrium Effects

The equilibrium condition for the wheat market is the same as before:

$$P_w = 10 + \frac{P_c}{2}$$

Substituting in the equilibrium condition for the corn market:

$$P_w = 10 + \left(16 + \frac{P_w}{2}\right) \div 2 = 18 + \frac{P_w}{4}$$

$$\frac{3P_w}{4} = 18 \Rightarrow \quad P_w = \$24$$

General Equilibrium Effects in Action (12/17)

15.1

General Equilibrium Effects

And the price of corn is:

$$P_c = 16 + \frac{P_w}{2} = 16 + \frac{24}{2} \Rightarrow \quad P_c = \$28$$

Finally, the new equilibrium quantities are:

$$Q_c^S = 32 - P_c + P_w = 32 - 28 + 24 \Rightarrow Q_c^S = 28 \text{ million bushels of corn}$$

$$Q_w^S = 20 - P_c + P_w = 20 - 24 + 28 \Rightarrow Q_w^S = 24 \text{ million bushels of wheat}$$

The increase in demand for corn has led to an increase in the equilibrium price and quantity of both corn and wheat.

General Equilibrium Effects in Action (13/17)

Quantitative General Equilibrium: The Corn Example with Supply-Side Market Links

- In previous examples, we allowed the wheat and corn markets to be linked via demand substitution effects.
- Now, consider the possibility that there are supply-side links.

Demand for corn is given by:

$$Q_c^d = 20 - P_c$$

where P_c is the price of corn and P_w the price of wheat (each in dollars per bushel). Quantities are measured in millions of bushels. Demand for wheat is given by:

$$Q_w^d = 20 - P_w$$

General Equilibrium Effects in Action (14/17)

15.1

Quantitative General Equilibrium: The Corn Example with Supply-Side Market Links

The supply of each is related to the supply of the other. The supply of corn is given by:

$$Q_c^s = 2P_c - P_w$$

The supply of wheat is given by:

$$Q_w^s = 2P_w - P_c$$

These equations capture the notion, for example, that as agricultural production shifts to corn, scarce resources are reallocated from wheat to corn, raising the marginal cost of production for wheat.

General Equilibrium Effects in Action (15/17)

15.1

Finding Equilibrium Prices

Setting supply equal to demand in the wheat market yields:

$$Q_w^d = Q_w^s \rightarrow 20 - P_w = 2P_w - P_c$$

$$P_w = \frac{20}{3} + \frac{P_c}{3}$$

And for corn,

$$Q_c^d = Q_c^s \rightarrow 20 - P_c = 2P_c - P_w$$

$$P_c = \frac{20}{3} + \frac{P_w}{3}$$

General Equilibrium Effects in Action (16/17)

15.1

Finding Equilibrium Prices

Solving for equilibrium prices yields a price of $10 in each market, with 10 million bushels of corn and wheat supplied.

Suppose again, there is a 12-million-bushel increase in the quantity of corn demanded at every price, so that:

$$Q_c^d = 32 - P_c$$

Going through the same process as before, we find that the equilibrium condition for the wheat market stays the same but the equilibrium condition for the corn market changes to:

$$P_c = \frac{32}{3} + \frac{P_w}{3}$$

General Equilibrium Effects in Action (17/17)

15.1

Finding Equilibrium Prices

The process of finding the equilibrium once more yields:

$$P_w = \$11.50 \qquad P_c = \$14.50$$

and

$$Q_w^s = 8,500,000$$

$$Q_c^s = 17,500,000$$

In summary, general equilibrium effects:

- matter for market outcomes.
- can be seen on both the supply and demand sides.

General Equilibrium: Equity and Efficiency (1/8)

15.2

Standards for Measuring Market Performance: Social Welfare Functions

General equilibrium analysis is an important tool for evaluating performance of policies, particularly to identify effects on specific sectors of the economy.

Often, policies and projects are evaluated with the use of a **social welfare function**.

- Mathematical function that combines individuals' utility levels into a single overall measure of an economy's performance
  - Allows economists to compare outcomes that have varying impacts on disparate groups

How do we rank, or weight, different groups in a social welfare function?

- Depends on the objective

General Equilibrium: Equity and Efficiency (2/8)

15.2

Standards for Measuring Market Performance: Social Welfare Functions

A common technique is to give equal weight to all individuals in an economy and simply add up utility functions.

This is a **utilitarian social welfare function**.

- Mathematical function that computes society's welfare as the sum of every individual's welfare:

$$W = u_1 + u_2 + \ldots + u_n$$

General Equilibrium: Equity and Efficiency (3/8)

15.2

Standards for Measuring Market Performance: Social Welfare Functions

While the utilitarian social welfare function is easy to use, the result is a relative indifference to inequality.

An alternative is to use the **Rawlsian social welfare function**.

- Mathematical function that computes society's welfare as the welfare of the worst-off individual:

$$W = \min[u_1, u_2, \ldots, u_n]$$

This specification is an extreme example of an **egalitarian** social welfare function.

- Belief that the ideal society is one in which each individual is equally well off

General Equilibrium: Equity and Efficiency (4/8): Question 1

15.2

A small town has four residents: Amy, Bob, Cara, and Devon. Amy has a utility level of U_A = 20 utils, Bob has a utility of U_B = 30 utils, Cara has a utility of U_C = 10 utils, and Devon has a utility of U_D = 25 utils. What is the measure of the small town's welfare using the *utilitarian social welfare function*?

A. 10 utils
B. 30 utils
C. 75 utils
D. 85 utils

General Equilibrium: Equity and Efficiency (4/8): Question 1 – Correct Answer

15.2

A small town has four residents: Amy, Bob, Cara, and Devon. Amy has a utility level of U_A = 20 utils, Bob has a utility of U_B = 30 utils, Cara has a utility of U_C = 10 utils, and Devon has a utility of U_D = 25 utils. What is the measure of the small town's welfare using the *utilitarian social welfare function*?

A. 10 utils
B. 30 utils
C. 75 utils
D. 85 utils (correct answer)

General Equilibrium: Equity and Efficiency (5/8): Question 2

15.2

A small town has four residents: Amy, Bob, Cara, and Devon. Amy has a utility level of U_A = 20 utils, Bob has a utility of U_B = 30 utils, Cara has a utility of U_C = 10 utils, and Devon has a utility of U_D = 25 utils. What is the measure of the small town's welfare using the *Rawlsian social welfare function*?

A. 10 utils
B. 30 utils
C. 75 utils
D. 85 utils

General Equilibrium: Equity and Efficiency (5/8): Question 2 – Correct Answer

15.2

A small town has four residents: Amy, Bob, Cara, and Devon. Amy has a utility level of U_A = 20 utils, Bob has a utility of U_B = 30 utils, Cara has a utility of U_C = 10 utils, and Devon has a utility of U_D = 25 utils. What is the measure of the small town's welfare using the *Rawlsian social welfare function*?

A. 10 utils (correct answer)

B. 30 utils

C. 75 utils

D. 85 utils

General Equilibrium: Equity and Efficiency (6/8)

15.2

Standards for Measuring Market Performance: Social Welfare Functions

While social welfare functions are useful for analyzing the distributional consequences of policies and projects, there are many complicating factors:

1. Choosing a social welfare function is ultimately subjective and different functions might give varied answers about what makes for desirable outcomes.

2. Furthermore, it is difficult to mathematically combine individuals' utility levels.

General Equilibrium: Equity and Efficiency (7/8)

15.2

Standards for Measuring Market Performance: Pareto Efficiency

Because of these difficulties, economists often rely on a related criterion: **Pareto efficiency**.

- An allocation of goods in which the goods cannot be reallocated without making at least one individual worse off
- When certain conditions are met, competitive market allocations are Pareto-efficient *and* consumer and producer surplus are maximized; and no alternative allocation can lead to gains to one person without being more than offset by losses to another.
- If a particular allocation is not Pareto-efficient, there may be opportunities for improvements through market intervention or the removal of market impediments.

General Equilibrium: Equity and Efficiency (8/8)

15.2

Three conditions for markets that result in Pareto-efficient allocations:

1. **Exchange efficiency**

- No one can be made better off with respect to consumption without harming another.
  - A Pareto-efficient allocation of a *set of goods across consumers*

2. **Input efficiency**

- No firm or individual can be made better off with an alternative input allocation without harming another.
  - A Pareto-efficient allocation of *inputs across producers*

3. **Output efficiency**

- The mix and amount of goods that the economy produces cannot be changed without making some consumer or producer worse off.
  - A Pareto-efficient allocation of *inputs and productive outputs in an economy*

Efficiency in Markets: Exchange Efficiency (1/10)

15.3

First, we introduce an analytical tool known as an **Edgeworth box**.

- A diagram of an economy with two economic actors and two goods that is used to analyze market efficiency

Suppose there are two consumers, Jerry and Elaine, and two types of goods, bowls of cereal and pancakes.

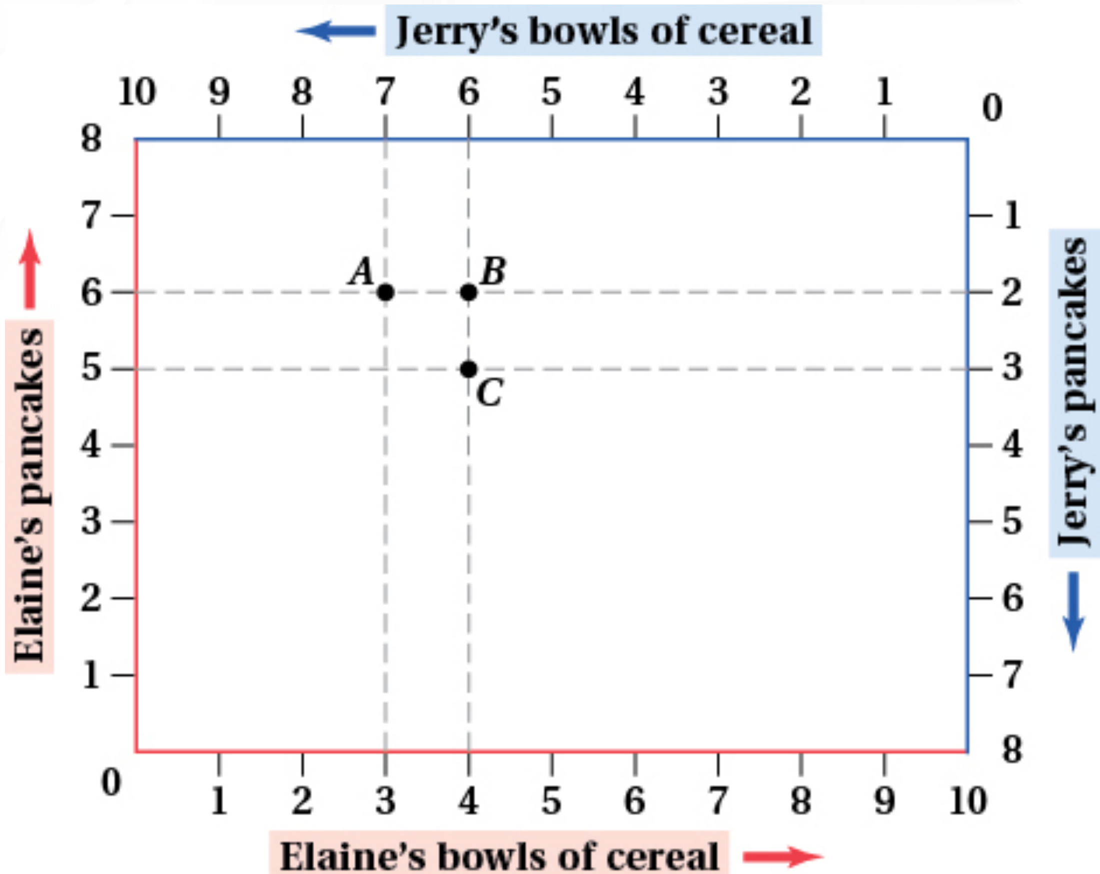
- A total of 10 bowls of cereal and 8 pancakes are available.
- We want to determine the Pareto-efficient ways these two goods can be split between Jerry and Elaine.

We can use an Edgeworth box to depict various allocations of cereal and pancakes.

Efficiency in Markets: Exchange Efficiency (2/10)

15.3

Figure 15.4 A Consumption Edgeworth Box



If Jerry consumes 7 bowls of cereal and 2 pancakes, Elaine consumes 3 bowls of cereal and 6 pancakes (point *A*).

If Jerry consumes one fewer bowl of cereal at point *B*, then Elaine's consumption of cereal increases by 1 bowl to 4 bowls of cereal (point *B*).

At point *C*, Jerry eats one more pancake, decreasing Elaine's consumption of pancakes by 1, to 5 pancakes (point *C*).

Efficiency in Markets: Exchange Efficiency (3/10)

15.3

Gains from Trade in the Edgeworth Box

To determine whether a particular allocation is efficient, we look to our analysis of consumer preferences introduced in Chapter 4.

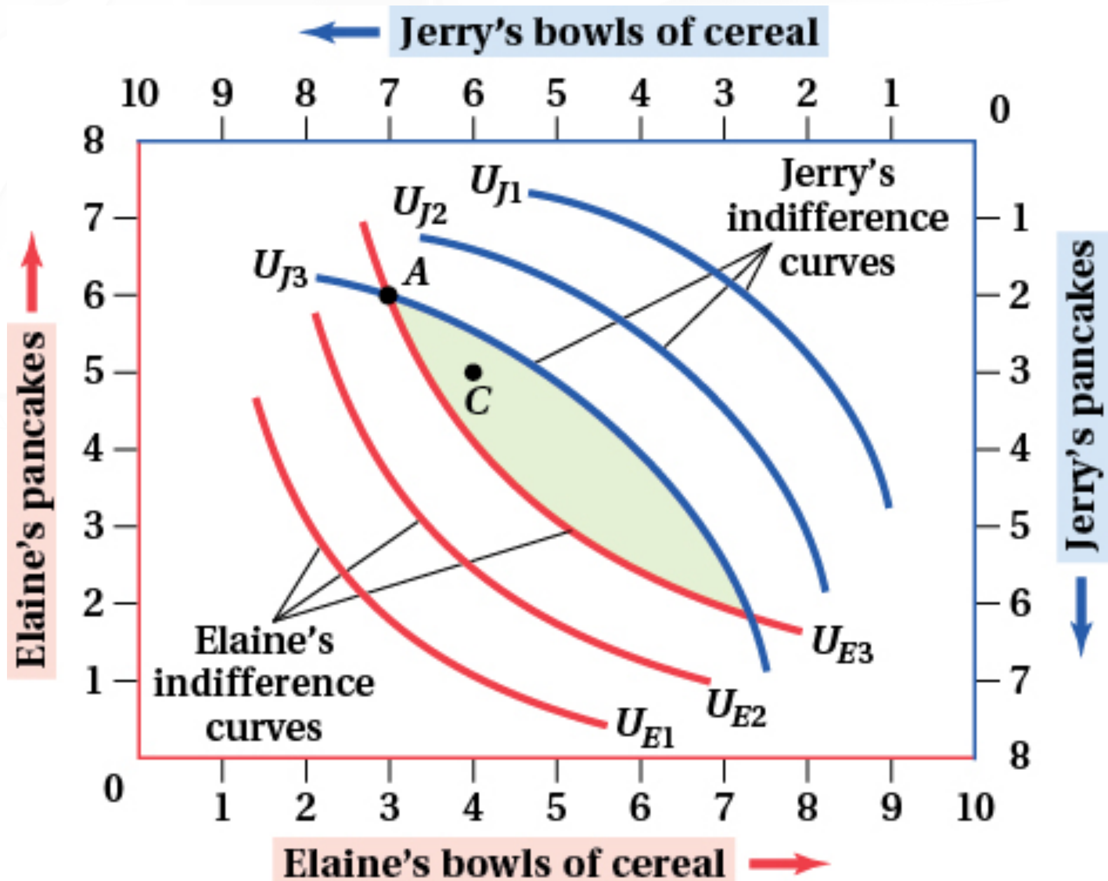
Analogous to the single-consumer case, Jerry and Elaine are assumed to gain utility from consuming pancakes and cereal.

- We represent utility with indifference curves.
- Indifference curves are bowed in toward the origin.
- *Complete preferences* means every possible allocation can be ranked for both Jerry and Elaine.

Efficiency in Markets: Exchange Efficiency (4/10)

15.3

Figure 15.5 Edgeworth Box with Two Sets of Indifference Curves



As indifference curves move away from the respective origins, they represent greater levels of utility.

Point *A* is an inefficient allocation because any point in the shaded area, including point *C*, will yield both Jerry and Elaine higher utilities.

Efficiency in Markets: Exchange Efficiency (5/10)

15.3

Gains from Trade in the Edgeworth Box

How might Jerry and Elaine move from the less desirable allocation A to the more desirable C?

They should trade.

- At allocation *A*, Jerry's marginal utility of consuming cereal is less than Elaine's, and Elaine's marginal utility of consuming pancakes is less than Jerry's.
  – Therefore, Jerry should be willing to trade some cereal for pancakes, and Elaine should be willing to trade some pancakes for cereal.

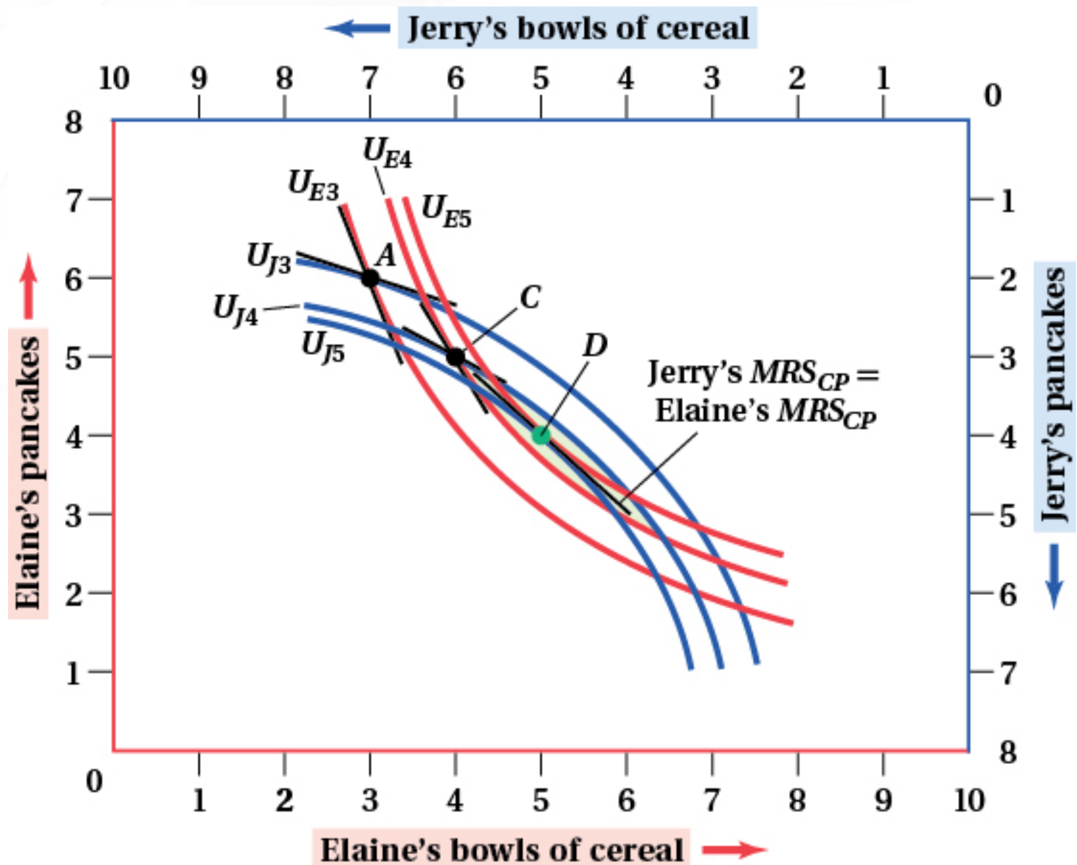
Is C an efficient allocation?

Possibly

Efficiency in Markets: Exchange Efficiency (6/10)

15.3

Figure 15.6 Closing In on Pareto Efficiency for Elaine and Jerry



A Pareto-efficient allocation of pancakes and bowls of cereal occurs at a tangency between Jerry's and Elaine's indifference curves.

In this case, the Pareto-efficient allocation is point *D*, where Elaine's indifference curve U_{E5} is tangent to Jerry's indifference curve U_{J5}. Here, Jerry and Elaine each consume 5 bowls of cereal and 4 pancakes.

Efficiency in Markets: Exchange Efficiency (7/10)

15.3

Gains from Trade in the Edgeworth Box

The fundamental outcome from this exercise is the following *necessary condition* for an efficient allocation in our Edgeworth box:

- For an allocation to be efficient, the **marginal rate of substitution** must be the same for each consumer:

$$MRS_{CP}^{Jerry} = MRS_{CP}^{Elaine} \rightarrow \frac{MU_C^{Jerry}}{MU_P^{Jerry}} = \frac{MU_C^{Elaine}}{MU_P^{Elaine}}$$

- Graphically, this condition means that an efficient allocation is associated with tangency between the two consumers' indifference curves.

Efficiency in Markets: Exchange Efficiency (8/10)

15.3

Prices and the Allocation of Goods

- While it is possible that Jerry and Elaine could barter their way to an efficient equilibrium, we know from Chapter 4 that our consumer equilibrium occurs when the *MRS* between two goods is equal to the ratio of prices, or

$$MRS_{CP}^{Jerry} = MRS_{CP}^{Elaine} = \frac{P_C}{P_P}$$

where P_C and P_P are the prices of cereal and pancakes, respectively.

Thus far, we have ignored the role of prices in our analysis of the Edgeworth box.

- A market with **exchange efficiency** will result in the goods' price ratios equaling consumers' marginal rates of substitution for those goods.

Efficiency in Markets: Exchange Efficiency (9/10)

15.3

The Consumption Contract Curve

Key condition of exchange efficiency

- At the efficient allocation, consumers' indifference curves are tangent to one another.

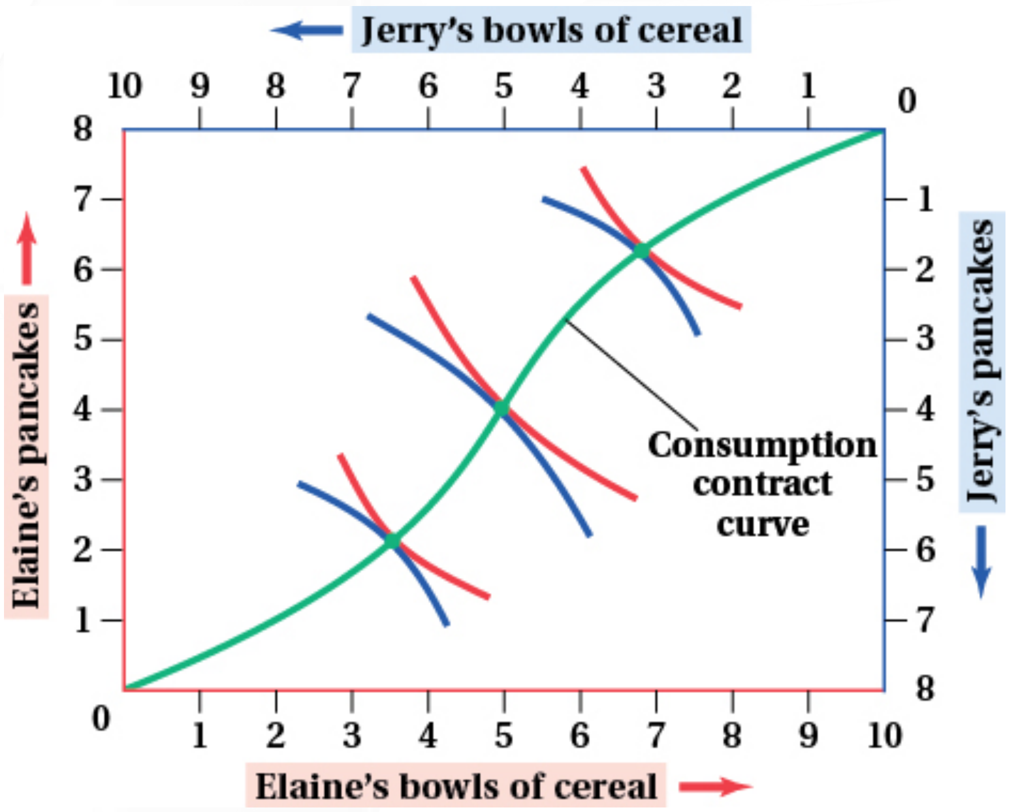
Does this mean there is only one efficient allocation?

- No, there is a set of efficient allocations, and it can be connected in a **consumption contract curve**.
  - Curve that shows all possible Pareto-efficient allocations of two goods across consumers

Efficiency in Markets: Exchange Efficiency (10/10)

15.3

Figure 15.7 A Consumption Contract Curve



The consumption contract curve connects every point of tangency between Jerry's and Elaine's indifference curves for bowls of cereal and pancakes.

Each point on the contract curve represents a Pareto-efficient allocation of bowls of cereal and pancakes between Jerry and Elaine.

Efficiency in Markets: Input Efficiency (1/8)

15.4

While exchange efficiency deals with the demand side of the market, we must also consider the supply side.

- Since production inputs (capital, labor) are scarce, **input efficiency** refers to the idea that we are allocating our inputs to the most valued production activities.
- We can use the same tools as we did in the previous section, namely, a **production Edgeworth box**.

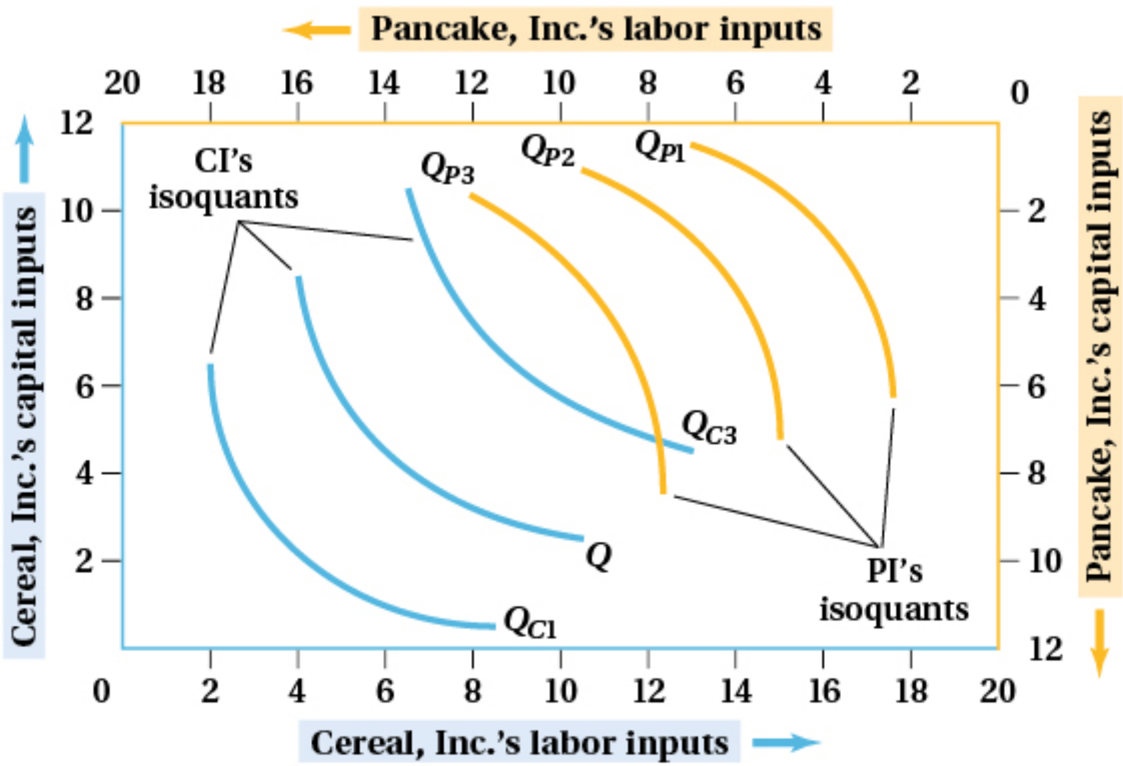
The production Edgeworth box plots all possible input allocations across two economic production activities.

- Consider again the example of pancakes (produced by Pancake, Inc.), and cereal (produced by Cereal, Inc.).
- Assume each production process uses labor and capital and that a total of 20 labor inputs and 12 capital inputs are available for use.

Efficiency in Markets: Input Efficiency (2/8)

15.4

Figure 15.8 A Production Edgeworth Box



An Edgeworth box can be used to determine the efficient input allocation between two firms. In this case, Cereal, Inc.'s and Pancake, Inc.'s labor inputs are on the horizontal axes and their capital inputs are shown on the vertical axes.

Q_{C1}, Q_{C2}, and Q_{C3} are examples of Cereal, Inc.'s isoquants, and Q_{P1}, Q_{P2}, and Q_{P3} are examples of Pancake, Inc.'s isoquants.

Efficiency in Markets: Input Efficiency (3/8)

15.4

The isoquants for the two firms are bowed outward from the origin because of our assumption of a diminishing marginal rate of technical substitution (*MRTS*).

- *MRTS*, the slope of the isoquant, indicates the rate at which two inputs can be traded off while maintaining a constant level of production (the ratio of the inputs' marginal products).

$$MRTS_{LK} = \frac{MP_L}{MP_K}$$

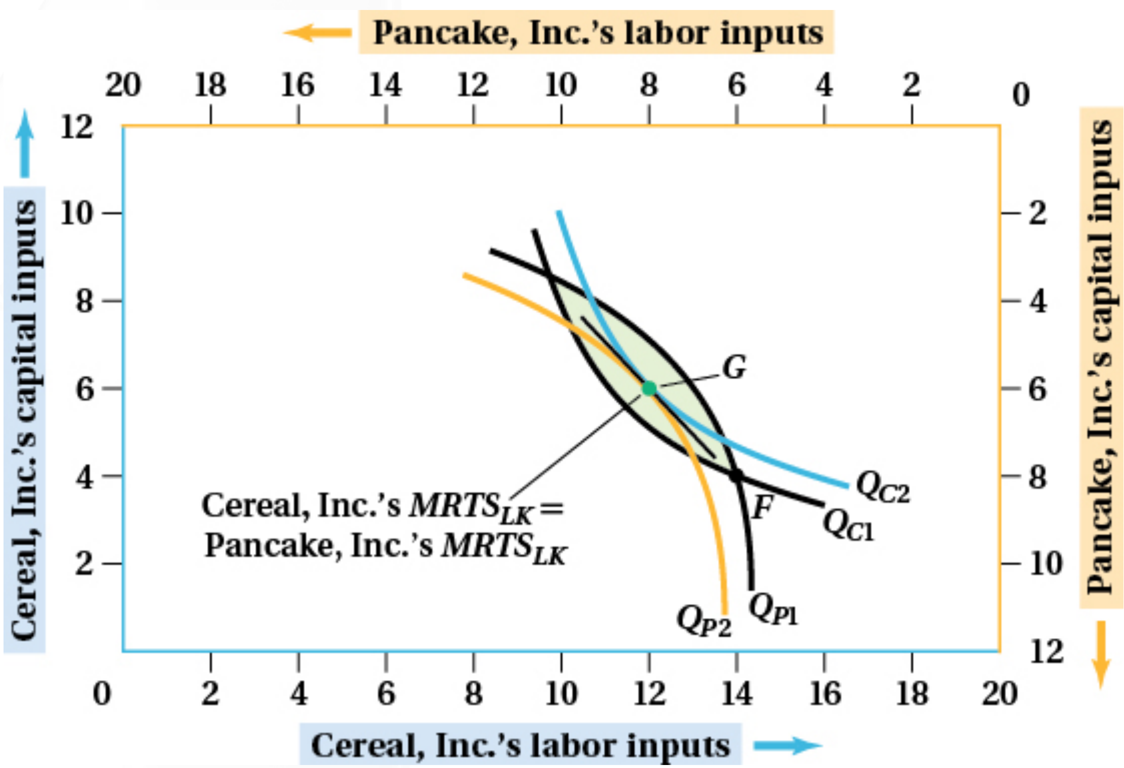
- Just as with the exchange efficiency example, input efficiency is achieved when the isoquants for the two firms are tangent, or

$$\text{CI's } MRTS_{LK} = \text{PI's } MRTS_{LK} \rightarrow \frac{MP_L^{CI}}{MP_K^{CI}} = \frac{MP_L^{PI}}{MP_K^{PI}}$$

Efficiency in Markets: Input Efficiency (4/8)

15.4

Figure 15.9 Edgeworth Box with Two Sets of Isoquants



A Pareto-efficient allocation of capital and labor inputs occurs at a tangency between Cereal, Inc.'s and Pancake, Inc.'s isoquants.

Point *F* shows a possible allocation of labor and capital between Cereal, Inc. and Pancake, Inc. Because it lies on the intersection of isoquants Q_{C1} and Q_{P1}—and not at the tangency—*F* is an inefficient allocation.

G, which lies at the tangency between Q_{C2} and Q_{P2}, is a Pareto-efficient input allocation.

Efficiency in Markets: Input Efficiency (5/8)

15.4

From Chapter 6, we know that cost-minimizing firms set their *MRTS* equal to the ratio of input prices (wage, *W,* and rental rate of capital, *R*).

- With this in mind, input efficiency implies:

$$\text{CI's } MRTS_{LK} = \text{PI's } MRTS_{LK} \rightarrow \frac{MP_L^{CI}}{MP_K^{CI}} = \frac{MP_L^{PI}}{MP_K^{PI}} = \frac{W}{R}$$

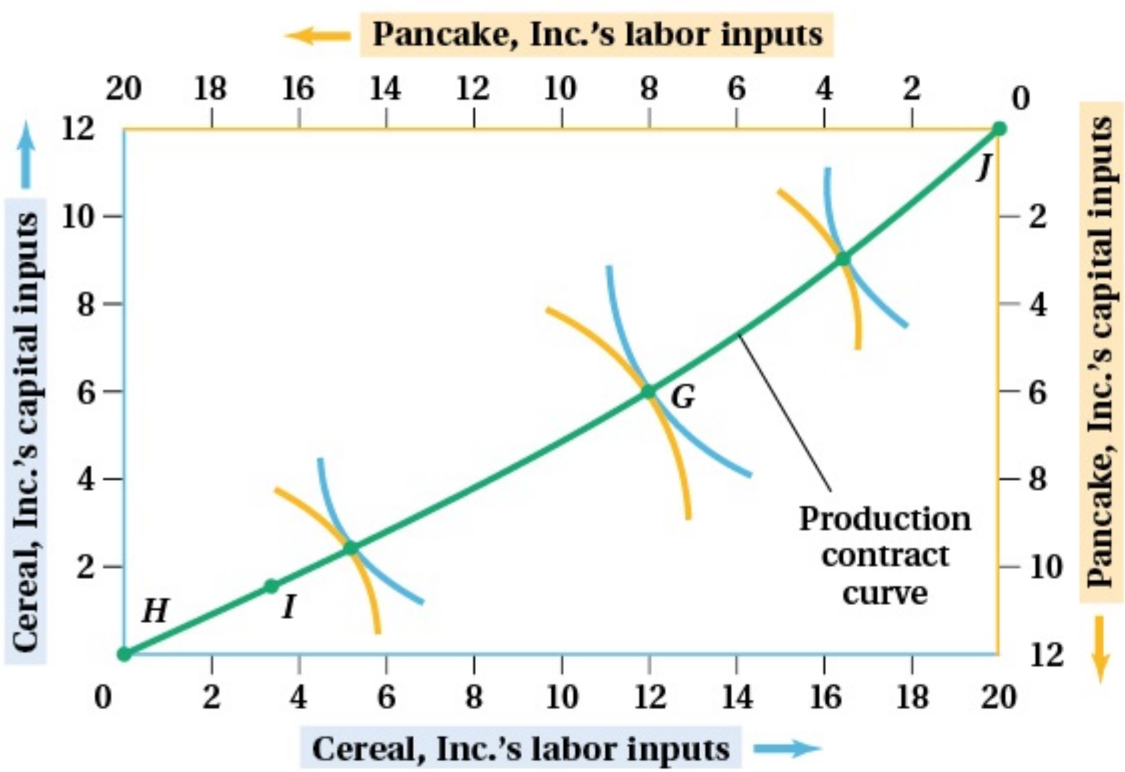
Again, following the example of exchange efficiency, we can use a **production contract curve** to map out all of the efficient input allocations.

- Curve shows all Pareto-efficient allocations of two inputs across producers.

Efficiency in Markets: Input Efficiency (6/8)

15.4

Figure 15.10 A Production Contract Curve



The production contract curve connects every point of tangency between Pancake Inc.'s and Cereal, Inc.'s isoquants for capital and labor.

At points *H* and *I*, relatively little cereal is produced, while many pancakes are produced. At point *J*, no pancakes are made, while Cereal, Inc. produces a lot of cereal.

Efficiency in Markets: Input Efficiency (7/8)

15.4

Examining the production contract curve yields further insights.

- The contract curve represents all efficient allocations of inputs across the production of two goods.
- As we move from point *H* to point *J*, we are producing fewer pancakes and more cereal.

This relationship can be used to construct a **production possibilities frontier (PPF)**.

- Curve connects all possible efficient output combinations of two goods.
- Instead of inputs on the axes, we have outputs.
- In general, this curve will be bowed outward from the origin because of the assumption of *diminishing returns to scale.*

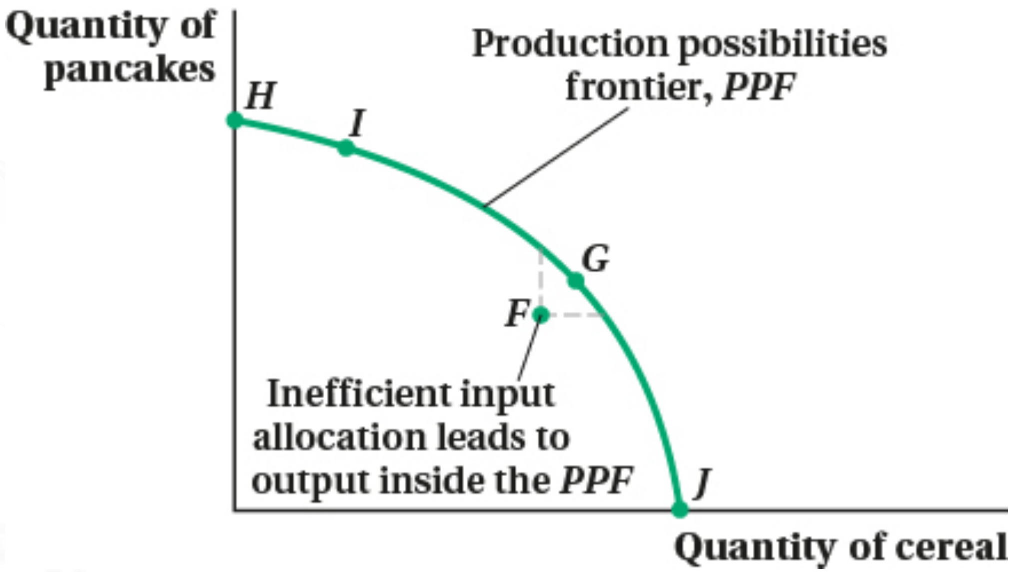
Efficiency in Markets: Input Efficiency (8/8)

15.4

Figure 15.11 A Production Possibilities Frontier

The production possibilities frontier (PPF) plots all possible output combinations of cereal and pancakes that are made if inputs are allocated efficiently.

- Points *H*, *I*, *G*, and *J* all lead to efficient outputs.
- Point *F*, which lies within the PPF, results from an inefficient allocation of inputs across producers.



Efficiency in Markets: Output Efficiency (1/7)

15.5

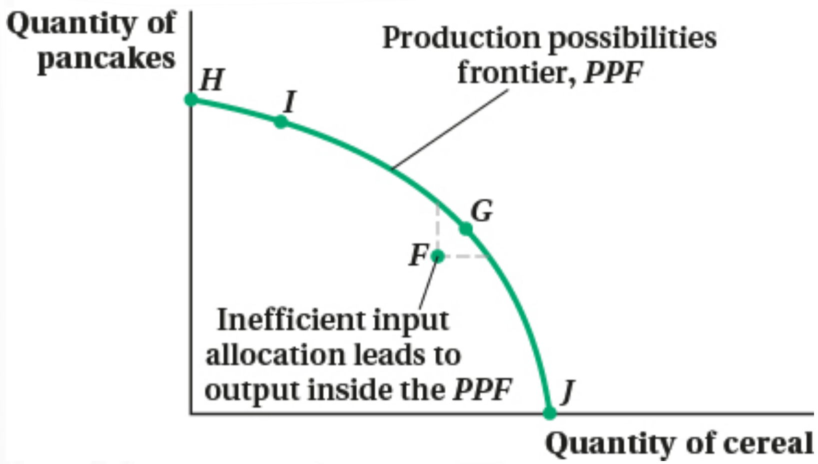
We now bring the two sides of the market together.

- *Exchange efficiency* and *input efficiency* helped develop consumption and production contract curves.
- Now look at the conditions determining the quantities of two products that will be produced and consumed in general equilibrium.
- Return to the PPF.
- The slope of the PPF is called the **marginal rate of transformation (*MRT*)**.
    - The tradeoff between the production of any two goods along the PPF
    - How much of one good must be given up to obtain one more unit of another?

Efficiency in Markets: Output Efficiency (2/7)

The slope of the PPF represents the *MRT* from pancakes to cereal.

Figure 15.11 A Production Possibilities Frontier



Goolsbee et al., *Microeconomics*, 3e, © 2020 Worth Publishers

- Low when many pancakes are being produced (high return associated with shifting inputs to cereal production), point *H*
- High when few pancakes are being produced (low return associated with shifting inputs to cereal production), point *J*
  - This relationship is due to an assumption of diminishing MP_L and MP_K.

Efficiency in Markets: Output Efficiency (3/7)

On the margin, the *MRT* is equivalent to the ratio of the marginal products of labor for the two products.

$$MRT_{PC} = \frac{MP_L^{PI}}{MP_L^{CI}}$$

What is the relationship between the *MRT* and the marginal products of capital?

Remember, the PPF represents all of the production combinations whose marginal rate of technical substitution is equal for the two products.

$$\text{CI's } MRTS_{LK} = \text{PI's } MRTS_{LK} \rightarrow \frac{MP_L^{CI}}{MP_K^{CI}} = \frac{MP_L^{PI}}{MP_K^{PI}}$$

This means that the *MRT* is also equal to the ratio of the marginal products of capital.

$$MRTS_{LK} = \frac{MP_L^{CI}}{MP_K^{CI}} = \frac{MP_L^{PI}}{MP_K^{PI}} \rightarrow \frac{MP_L^{PI}}{MP_L^{CI}} = \frac{MP_K^{PI}}{MP_K^{CI}}$$

Efficiency in Markets: Output Efficiency (4/7)

15.5

To see how this fits with the consumption side of the market, assume that the input and consumption sides of our two-person (Elaine and Jerry), two-good (pancakes, cereal) market have independently come to efficient allocations.

- Elaine and Jerry are at an *exchange-efficient* allocation on the contract curve; that is, the marginal rate of substitution between the two goods is 1.5 to 1.
  - Each is willing to give up 1.5 pancakes for another bowl of cereal.

- The production side has arrived at an efficient input allocation on the production possibilities frontier, where the marginal rate of transformation from pancakes to cereal is 1 to 1.
  - One pancake of output must be given up to make another bowl of cereal.

What can we say about this market allocation?

It is inefficient.

Efficiency in Markets: Output Efficiency (5/7)

15.5

There is a mismatch between consumers' willingness to substitute one good for the other and firms' ability to switch from producing one to the other.

- To consume one more bowl of cereal, Elaine and Jerry are both willing to give up 1.5 pancakes.
- To produce one more bowl of cereal, society need give up only 1 pancake.
  - Because Elaine and Jerry's relative preferences for cereal are stronger than the relative costs of making cereal, society should allocate additional inputs to cereal making.

This example shows that exchange and input efficiency are *not* enough for economic efficiency.

Efficiency in Markets: Output Efficiency (6/7)

This missing link between efficiency on the consumption and production sides of the economy is **output efficiency**.

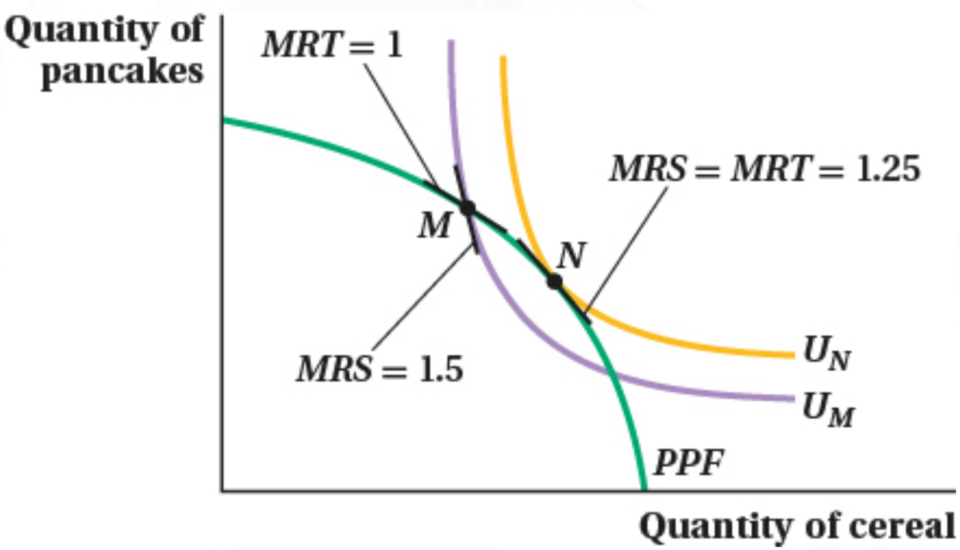
- Output efficiency exists when the tradeoffs on the consumption and production sides of an economy are equal.
  - The tradeoff on the consumption side is the marginal rate of substitution (*MRS*).
  - The tradeoff on the production side is the marginal rate of transformation (*MRT*).

Output efficiency requires that *MRS* = *MRT*.

Efficiency in Markets: Output Efficiency (7/7)

15.5

Figure 15.12 Achieving Output Efficiency



Exchange efficiency occurs at the tangency between the consumers' indifference curves and the production possibilities frontier, where the *MRS* equals the *MRT*.

Point *M* shows a possible output combination of pancakes and cereal. Because it lies on the intersection of the PPF and the indifference curve U_M — and not at the tangency—*M* is an inefficient output.

N, which lies at the tangency between the PPF and U_N where *MRS* = *MRT* = 1.25, is an efficient output allocation.

Markets, Efficiency, and the Welfare Theorems (1/4)

15.6

Our discussion has suggested that the simple solution to inefficiency on the exchange, input, and output margins is to shift the allocation of inputs or outputs.

However, this extremely simple model assumes the following:

- Only two inputs, two outputs, two firms, and two consumers
- Perfect information

The real economy is vastly more complicated.

- It is likely impossible for a central planner to efficiently allocate inputs and outputs across firms and consumers.

What does this imply for economies? Can an economy ever reach an efficient outcome?

Markets, Efficiency, and the Welfare Theorems (2/4)

15.6

With *exchange efficiency*, if consumers maximize their utility (taking prices as given), they will have the same *MRS.*

- Thus, consumers will reach exchange efficiency without market intervention.

For any given set of input prices, profit-maximizing firms will choose their input mix so that their *MRTS* equals the input-price ratio.

- Firms *will* achieve input efficiency without market intervention.

The final link, output efficiency, ties these two conditions together.

- Output efficiency's *MRS* = *MRT* condition sets the ratio of goods' prices equal to their marginal costs of production.
- If the goods are produced by a perfectly competitive industry, price will equal marginal cost; therefore, the price and cost ratios are equal, satisfying output efficiency while preserving input and exchange efficiency.
- *Decentralized competitive markets can achieve all three efficiency conditions.*

Markets, Efficiency, and the Welfare Theorems (3/4)

This leads to the **First Welfare Theorem.**

- Perfectly competitive markets in general equilibrium distribute resources in a Pareto-efficient way.

Requires a number of assumptions to be satisfied:

1. Firms and consumers take the prices of goods and inputs as given (have no market power).
2. Firms and consumers act rationally and without any cognitive limitations.
3. There is no *asymmetric information, externalities,* or *public goods.* (These *market failures* are discussed further in Chapters 16 and 17.)

Even accounting for the necessity of these assumptions, the First Welfare Theorem is an amazing result.

- Competitive markets are efficient without any governmental intervention.
  - However, the First Welfare Theorem does not speak to the issue of equity, or fairness.

Markets, Efficiency, and the Welfare Theorems (4/4)

15.6

While the initial allocation of inputs and goods across consumers and firms does not affect the efficiency of competitive markets, it does affect the distribution of final goods and income across consumers and firms.

This leads to the **Second Welfare Theorem**.

- Any given Pareto-efficient equilibrium can be achieved by choosing the right initial allocation of goods.
- If equity is a concern, society can reallocate some inputs across society and still not sacrifice the efficiency of markets.

Nevertheless, redistribution *CAN* lead to efficiency losses.

- If the amounts of redistribution are affected by the choices of firms and individuals, efficiency losses will occur.
- To maintain efficiency, redistribution should take the form of a **lump-sum transfer,** a transfer whose size is unaffected by the individual's choices.

Conclusion (1/1)

15.7

In this chapter, we examined how all markets are interconnected and introduced the concept of general equilibrium.

When markets are not competitive or when there are information problems, externalities, or public goods, markets will fail to achieve efficiency.

In the next two chapters, we examine problems with information, externalities, and public goods, starting in Chapter 16 with the topic of asymmetric information.