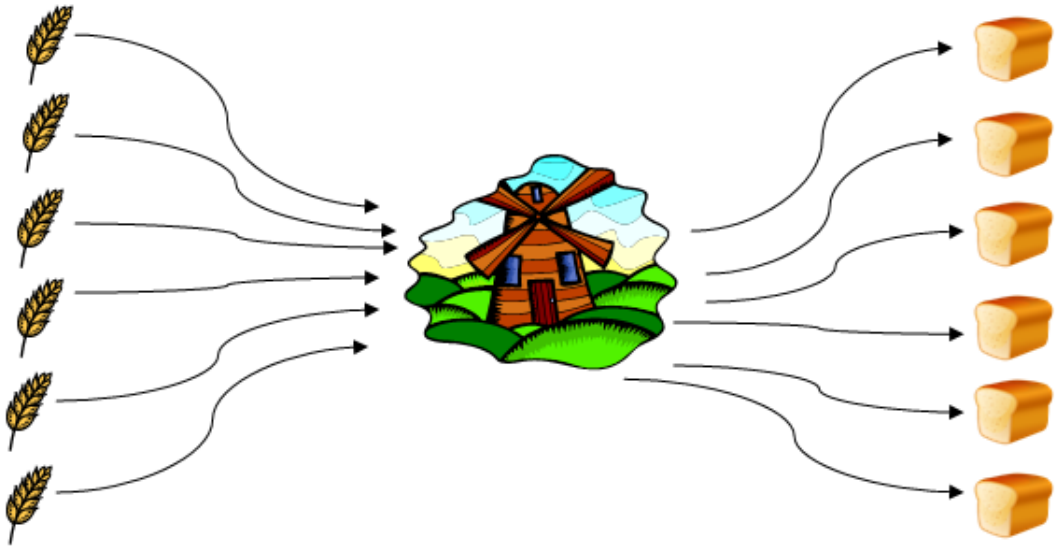
AGBE 321: Economics of Agricultural Marketing

Course Notes



Anton Bekkerman

Any errors in this document are the responsibility of the author. Corrections and comments regarding any material in this text are welcomed and appreciated. The material in this document is intended to be supplementary (not as a substitute) to attending lectures regularly.

Direct correspondence to: anton.bekkerman@montana.edu

This page intentionally left blank.

Contents

Chapter 1: Introduction to Agricultural Marketing

1.1 Typical Issues and Where to Find Answers

In recent years, there have been significant discussion about the following issues that relate to agricultural marketing:

- Grain & cattle prices – volatility due to a cross-relationship
- Market volatility and convergence – inability to hedge risk using futures markets
- Biofuels – are they viable? Who wants them? Who doesn't?
- Issues in foreign nations – trade agreements, food safety issues
- Economic downturn and its effects on agricultural markets – lower food prices; drop in demand

To find the most current news about these and other issues in agricultural markets, you can visit the following websites:

- www.cattlenetwork.com
- www.agweb.com
- www.feedstuffs.com
- www.wsj.com
- www.farmpolicy.com
- www.cbot.com

1.2 What is "marketing?"

Marketing is the change of ownership of agricultural and food products. The process of marketing is the link between agricultural production and food consumption.

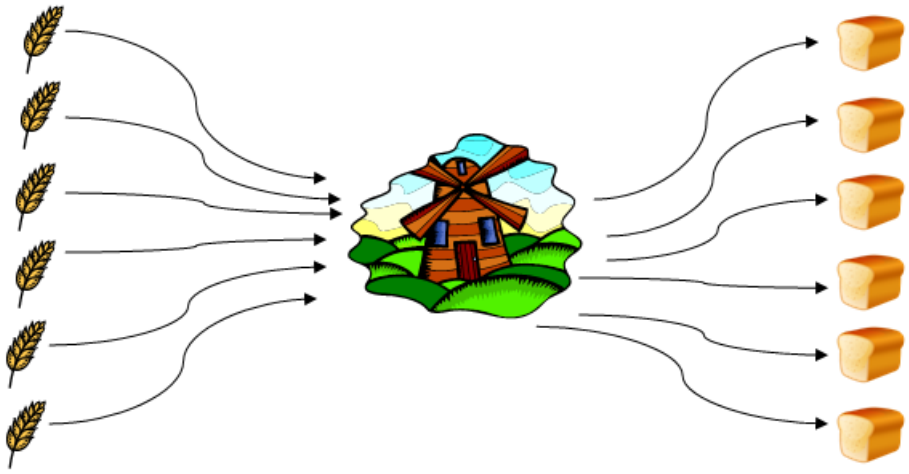
1.2.1 The dimensions of market transactions

- *Spatial* – Transactions occurs across space. It coordinates locations where buyers and sellers meet (e.g. The Billings wheat market). In a broader context, a market location may be the U.S. wheat market or the the world wheat market.
- *Temporal* – Transactions occur across time. Producers and consumers may contract agricultural transactions months, or even years in advance.
- *Transformational* – Transactions occur for various forms of agricultural products. Some products are sold raw while others are sold processed (e.g. bushels of wheat versus bread).

1.2.2 The Benefits of Markets

There are three important functions of markets:

- *Coordination of exchange* – Markets coordinates consumers and producers of agricultural products using the price system. This makes these products available to consumers who are willing to pay for them and shows suppliers where their products are most needed.
- *Value-adding activities* – Marketing *adds value* to agricultural products. Such value-adding activities include product transformation through processing, transportation to a market with higher demand or storage for future use.
- *Facilitating exchange* – Marketing facilitates the exchange of goods. It sets standards to be followed by consumers and producers that reduce the *transaction costs* of exchange.
  - Business climate – A conducive business environment is encouraged in a market. This may include a clear understanding of ownership privileges and the legal code.
  - Standard measures – Marketing encourages standardized units and often a system of merchandise quality inspection for sale of agricultural products.
  - Economic information – Current and prospective market conditions (e.g., local and futures prices).
  - Financial services – Provide liquidity for day-to-day exchanges and minimize transactions costs.



1.3 What's Special About Agricultural Markets?

- *Biological characteristics* – Marketing goods that were once alive has special challenges. For instance, agricultural products have fixed periods of production and seasonality. Growing seasons affect the demand and supply of the product. Further, there is a risk of perishability of agricultural products. A risk that the good will become unusable is an additional cost to producers. Finally, there are unpredictable events that may affect the supply of agricultural products, such as weather (e.g. frost, hail, drought) and invasive species (e.g. karnal bunt, grasshoppers, wheat stem rust, mad cow disease (BSE)). All of these biological characteristics lead to greater price volatility.

- *Product homogeneity* – Competitive markets (price taking environment) encourage product homogeneity. Supply and demand determine the prices for a homogeneous product; producers accept these prices when they sell, and consumers accept these prices when they buy. For example, 13% protein wheat is the same in Montana and Kansas.

- *Large government involvement* – The U.S. government and others place price supports that augment agricultural product prices. Further, governments subsidize crop insurance and implement trade policies such as tariffs and quotas. All of these policies affect agricultural product prices.

- *Bulkiness (low initial value-per-unit weight)* – Transportation and processing are crucial to agricultural product value-added. Further, economies of scale often encourage only a few processing facilities for large geographic areas.

1.4 Trends in U.S. Agricultural Markets

Agricultural and food markets are changing. Here are several reasons for these changes:

- *Demographics* – The U.S. is evolving demographically over time in three important ways. First, population growth in the U.S. is slowing (*see* Figure **??**). Similarly, the average U.S. household size has decreased from 3.3 in 1960 to 2.6 in 2008. Baby boomers caused greater production growth in the 1950s through the 1970s, but today that economic growth has fallen off due to a similar trend in population growth. However, population and economic growth in other nations has out-paced the slower U.S. growth. Second, the preferences of older and younger generations are diverse. Agricultural market preferences are affected over time by changes in the distribution of these generations in society. Finally, there is an influx of immigrants into the United States. Although immigration has been common throughout U.S. history, the source of immigrants (and ethnic preferences) changes over time. Immigration leads to variations in demand for different agricultural products. Further, immigrant agricultural labor often reduces producer costs, which in turn affect market prices.

- *Higher incomes* – Overall income in the U.S. has an effect on the demand for agricultural products. Over time, less food is cooked at home, and more is purchased outside of home. The ratio of household expenditure for food at home to outside dining has evolved from 2:1 in 1970 to 1:1 in 2007. This trend is probably caused by the opportunity cost of time. As household income increases, the opportunity cost of cooking food in the home increases. Furthermore, food processors and restaurants enjoy greater economies of scale than a household (how often do you make your own bread?).

- *Other influential trends* – Other trends affecting agricultural markets include international trade and domestic policies; increasing female labor force participation; evolving consumer concerns regarding health, food safety, quality, and nutrition; and increasing production technology such as high-speed Internet in rural areas, computerized farming genetically modified crops (GMOs), and longer product shelf lives due to preservatives and refrigeration.

Chapter 2: Basics of Supply and Demand

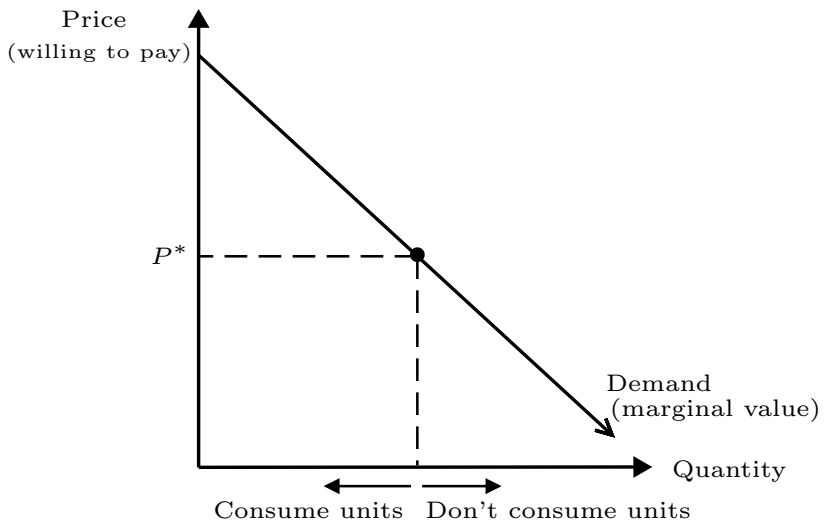
2.1 Demand

Demand is the amount of a product that will be consumed for any conceivable price. It consists of consumers that have some "willingness to pay" for an agricultural good. Consumers continue to buy while the benefit from the next unit exceeds the costs of the next unit of the good.

2.1.1 Demand terminology:

- *Demand schedule* – Tabular representation of the demand for a product. It lists the product quantities desired at alternative prices. Can be used to find the *marginal value* of the last unit consumed.
- *Demand curve* – Continuous graphical illustration of the demand for a product. It is downward sloping to represent the Law of Demand: as price increases, the quantity demanded decreases and vice versa.
- *Marginal value* (marginal benefit) (MB) – amount of "value" received from the next unit of agricultural product.
- *Marginal cost* (MC) – the cost of the next unit of agricultural product.

Figure 2.1: Demand curve plot: Consumers continue to buy while MB > MC.



2.1.2 Properties of a demand curve

- Constrained by income (or wealth)
- Has a negative slope (i.e. elasticity or steepness) based on the following factors:
  - Availability of complements and substitutes (e.g. rice as a substitute for corn, ketchup as a complement for ground beef)
  - The rate of change in consumer marginal value (i.e. would you buy 5 times as much food if the price fell by one fifth?)
  - Whether demand is in the short or the long run
  - How "necessary" the good is to consumers.
- Movements along versus shifts of the demand curve:
  - Change in price → movement along the demand curve
  - Change in external variable (e.g., income, price of complements or subsitutes) → shift of the demand curve.

2.1.3 Numerically solving for quantity demanded and price

Suppose Sarah consumes beef according to the following consumption function:

$$Q_{Sarah} = 60 - 0.5P_{beef}$$

Perform the following:

1. Calculate the *inverse demand* function (i.e., solve for P).
2. Calculate Sarah's beef demand if the price of beef is \$10. What if it's \$18?
3. Calculate the price of beef if Sarah consumes 25 pounds of beef. What if she consumes 60 pounds?

Steps to solve:

1. Add P_{beef} to both sides; subtract Q_{sarah} from both sides; divide through by 0.5

$$P_{beef} = 120 - 2Q_{sarah}$$

2. Beef demand:

$$\text{If } P_{beef} = \$10 \ \rightarrow \ Q_{sarah} = 55$$
$$\text{If } P_{beef} = \$18 \ \rightarrow \ Q_{sarah} = 51$$

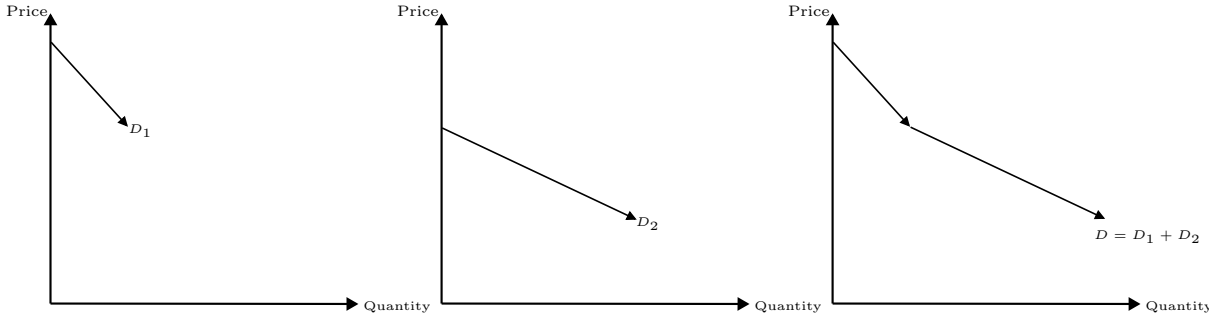
3. Price of beef:

$$\text{If } Q_{sarah} = 25 \ \rightarrow \ P_{beef} = \$70$$
$$\text{If } Q_{sarah} = 60 \ \rightarrow \ P_{beef} = \$0$$

2.2 Aggregate Demand

There are millions of consumers who consume agricultural commodities. How do we determine the demand functions for the entire population? We *horizontally aggregate* all individual demand functions (i.e. add up the quantities demanded at each price). The result of horizontal aggregation is *aggregate demand*.

Figure 2.2: Market Demand Curve – Horizontal Aggregation of Individual Demand Curves



2.2.1 Numerically aggregating demand

Suppose there are four consumers with the following demand functions:

$$\begin{aligned} Q_{sarah} &= 60 - 0.5P_{beef} \\ Q_{rob} &= 30 - 0.2P_{beef} \\ Q_{jen} &= 45 - 0.35P_{beef} \\ Q_{greg} &= 50 - 0.45P_{beef} \end{aligned}$$

To find aggregate demand, you simply add the four equations: $Q^D_{beef} = Q^D_{sarah} + Q^D_{rob} + Q^D_{jen} + Q^D_{greg}$

$$\begin{array}{c} Q^D_{sarah} = 60 - 0.5P_{beef} \\ + \\ Q^D_{rob} = 30 - 0.2P_{beef} \\ + \\ Q^D_{jen} = 45 - 0.35P_{beef} \\ + \\ \underline{Q^D_{greg} = 50 - 0.45P_{beef}} \\ Q^D_{beef} = 185 - 1.5P_{beef} \end{array}$$

2.2.2 Properties of aggregate demand

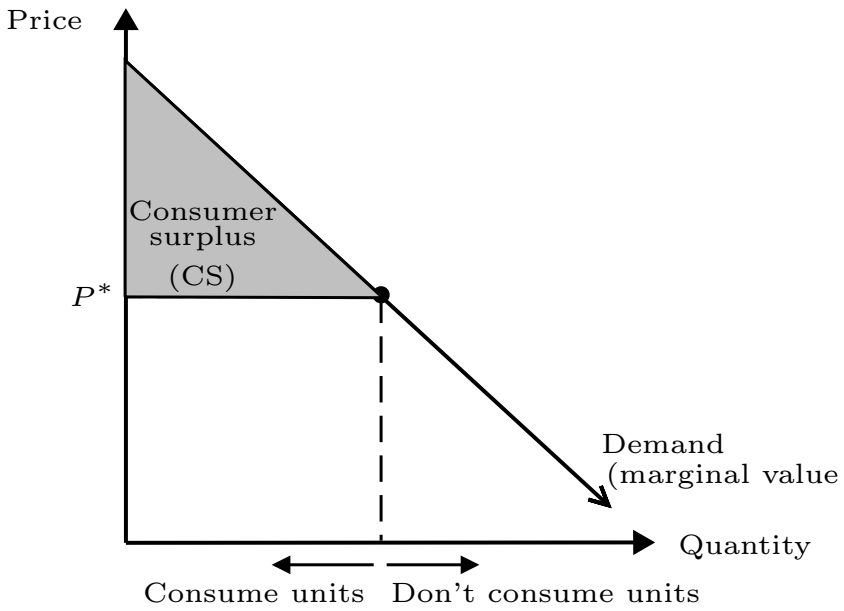
- As more consumers are added to the aggregate demand curve, the more *elastic* the curve becomes (i.e., flatter).

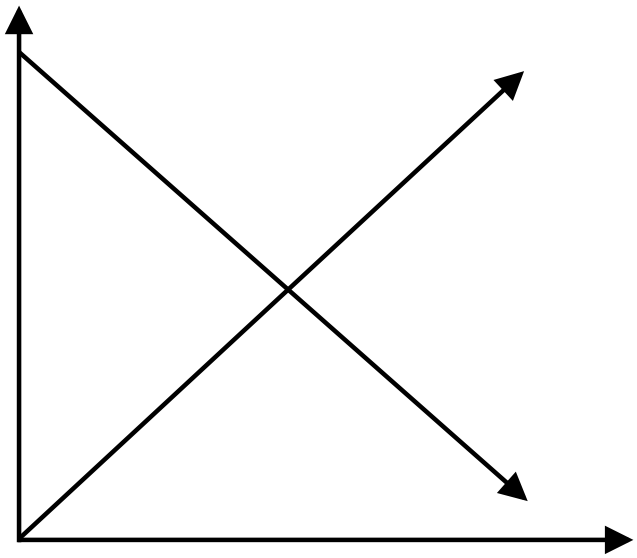
- What can shift/rotate the aggregate demand curve?
  - Structure change and competition in agricultural processing and retail suppliers, themselves the aggregate demand for raw agricultural product.
  - Population growth in the U.S.
  - Shifting demographics of the U.S. population.

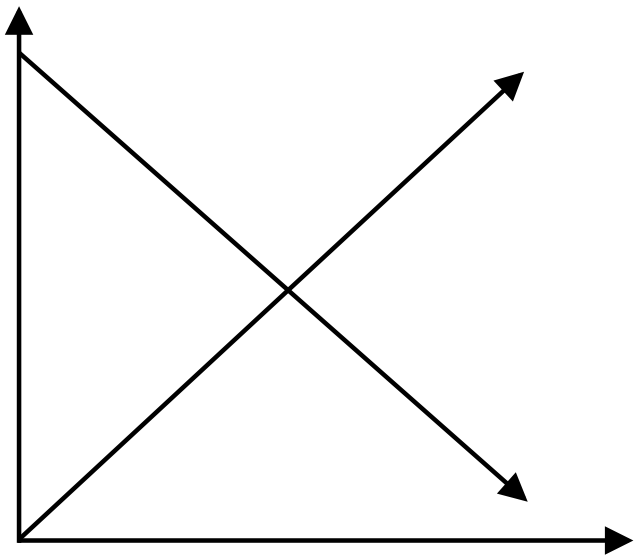
2.2.3 Consumer surplus

Consumer surplus (CS) is the total amount of value that is derived by the consumer *net* the aggregate price that was paid for all the units sold. Typically, CS is the area *below* the demand curve and above the price. It is frequently modeled as a triangle (*see* Figure 2.3).

Figure 2.3: Consumer Surplus is the Area Below the Demand Curve and Above Price







2.3 Supply

Supply is the quantity of product supplied for any conceivable price. Supply consists of a collection of firms or individuals able to provide the agricultural product as some *economic profit* (i.e. the revenues gained from exchange are greater than costs, including the *opportunity cost* of engaging in the activity). Suppliers will continue to produce while the *marginal revenue* (MR) gained is greater than the marginal cost (MC). In a competitive market, Price = MR = MC.

2.3.1 Supply terminology

- *Supply schedule* – Tabular representation of the supply of a product. It lists product quantities supplied at alternative prices. Can be used to find the marginal cost of the last produced unit.
- *Supply curve* – Continuous graphical illustration of the supply of a product. Upward sloping to represent the Law of Supply: As price increases, the quantity supplied increases.
- *Marginal revenue* (MR) – amount of income received from the sale of the next unit of agricultural product.

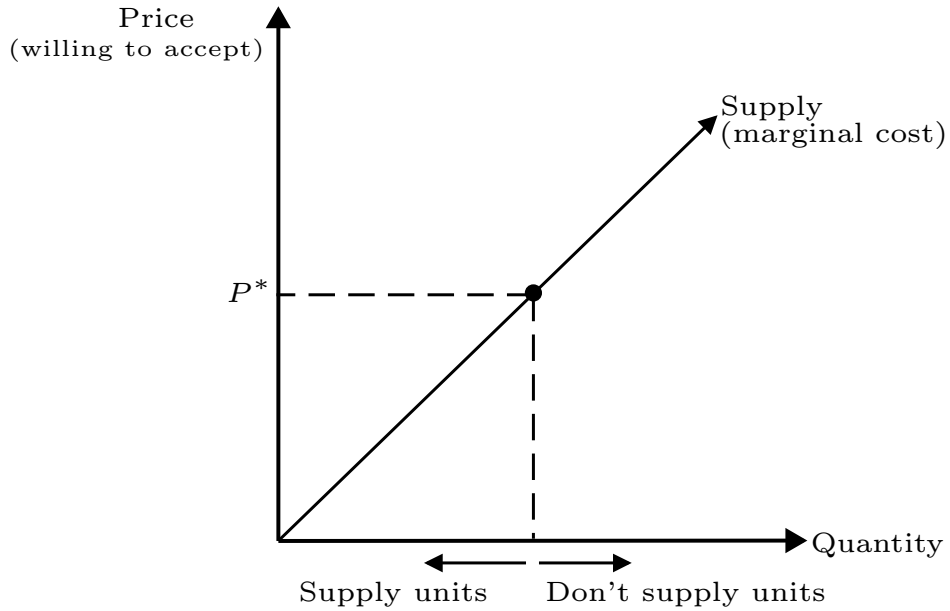
2.3.2 Properties of supply

These properties assume the firm does not determine the market price.

- *In the long run* – Firms must be able to gain revenue on the marginal unit to cover their long-run average total costs (ATC). If P $<$ ATC, then the firm halts production in the long run. Note that, in the long run, any fixed cost can be eliminated, and is thus a "variable" cost.
- *In the short run* – Firms must be able to cover their short-run average variable costs (AVC). If P $<$ AVC, then the firm halts production in the short run. Recall that AVC $\leq$ ATC (why?).

Remember: *Opportunity cost* is the benefit (revenue minus cost) gained from of the next best opportunity. All costs are opportunity costs because even monetary costs may be spent on the next best opportunity. This is important when thinking about costs in the agricultural sector.

Figure 2.4: Producer's Marginal Cost (supply) Curve



2.3.3 What changes supply?

- Change in price will result in a *movement along* the supply curve. A price shift may occur because of a change in demand. For instance, ethanol regulations cause an increase in the demand for corn. Corn production increases in response.
- Change to an external factor will *shift* the supply curve. Here are some examples of *supply shifters*.
  - Relative price changes of production inputs
  - Creation and adoption of technology (e.g., GM crops, farming equipment)
  - Price change in a production substitute (e.g., ethanol regulations pushes up the demand for corn, consequently decreasing the supply of soy beans as acreage is turned over to corn).
  - Changing risk levels and crop insurance policies
  - Government acreage controls (CRP).
  - Weather.

2.4 Aggregate Supply

Just as with aggregate demand, *horizontal aggregation* is used to derive the market supply curve.

Consider: Three farms supplying wheat have these supply functions

$$\begin{aligned} Q_1^S &= -45 + 2P_{wheat}^S \\ Q_2^S &= -80 + 2.5P_{wheat}^S \\ Q_3^S &= -35 + 3.5P_{wheat}^S \end{aligned}$$

Market Supply

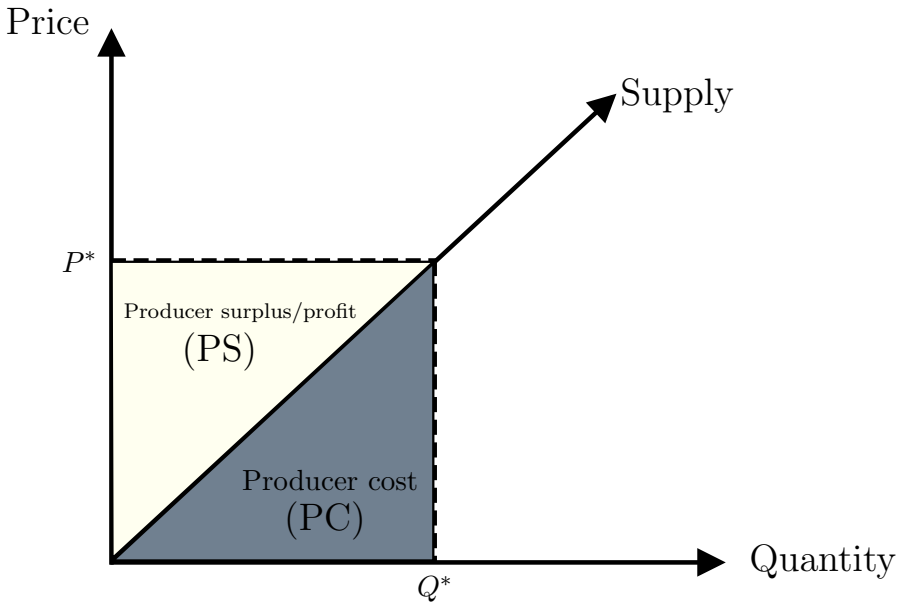
$$\begin{aligned} Q_{wheat}^S &= -160 + 8P_{wheat}^S \\ P_{wheat}^S &= 20 + 0.125Q_{wheat}^S \end{aligned}$$

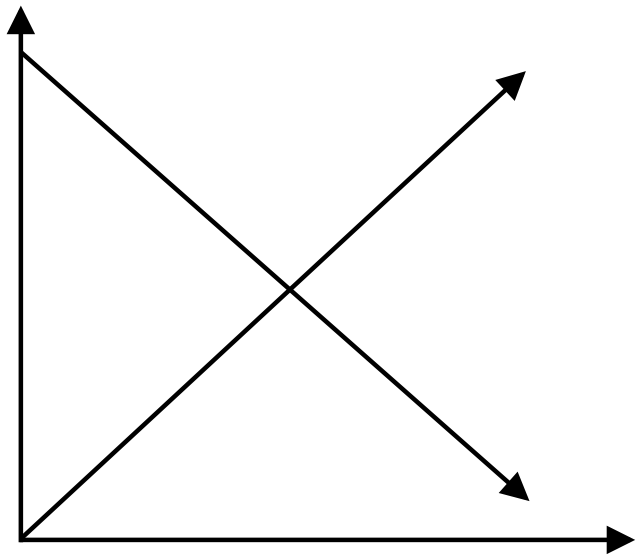
2.4.1 Producer surplus and producer cost

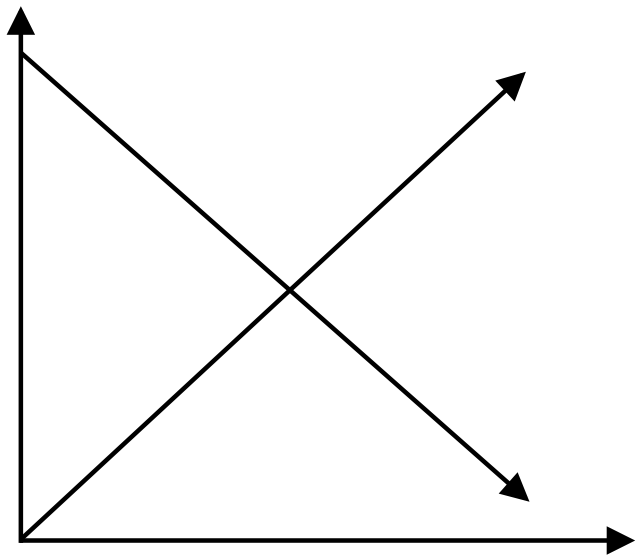
Producer cost (PC) is the total cost that is incurred by the supplier for making and selling a certain number of goods. It is measured as the area *below* the supply curve, bounded by the quantity supplied.

Producer surplus (PS) is the amount of value the firm receives *above* the marginal cost incurred to produce and sell the good. It is measured as the area *above* the supply curve, bounded by the sales price.

Figure 2.5: Producer Surplus and Costs



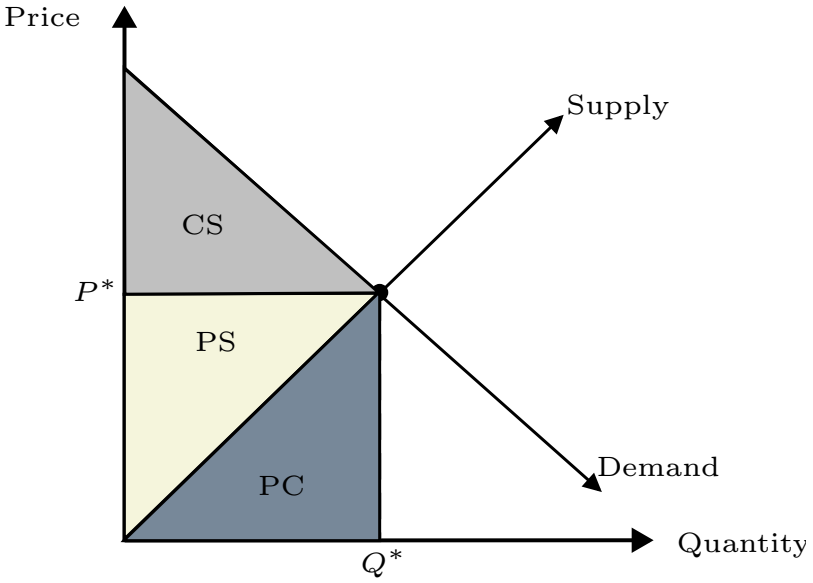




2.5 Equilibrium

Under perfect competition, rationing and resource allocation will cause prices to adjust until supply equals demand.

Figure 2.6: Market Equilibrium is Characterized by the Crossing of the Supply and Demand Curves



2.5.1 What do S & D models tell us?

Here are some examples of what supply and demand curves can be used to determine and analyze:

- Whether Price and quantity sold increases or decreases. (e.g. the price increases but quantity sold decreases or price decreases but quantity sold increases.)
- The welare effect of a new tax
- The welfare effect of a new quota

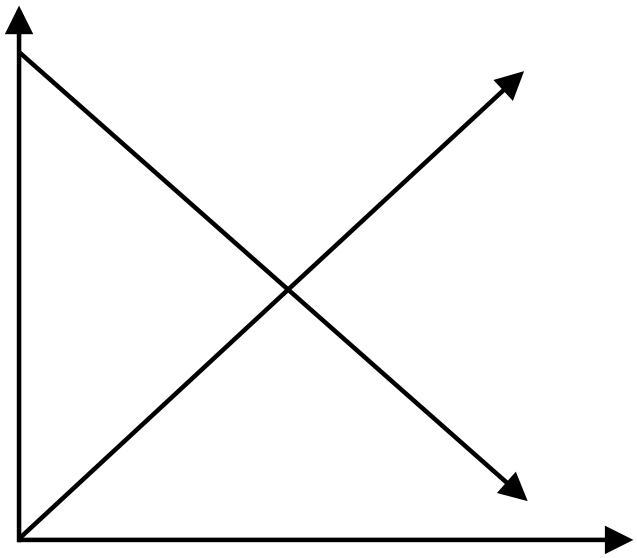
2.5.2 The role of prices

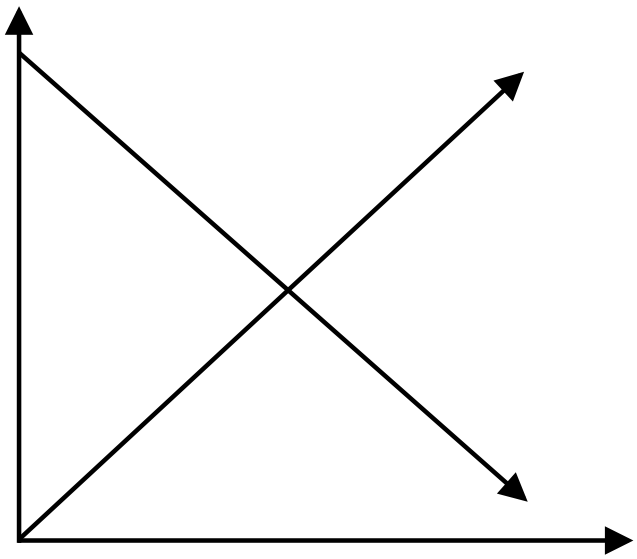
Prices convey an immense amount of information to consumers and producers and play an integral role in agricultural markets. Price is an aggregated signal of the supply and demand for a product. Prices coordinate the production and consumption of a good by providing an incentive to act. Governments can play a large role in affecting prices in agricultural markets. Knowing and predicting future prices is important in agricultural markets due to seasonal delays between production and consumption. Price predictions are extremely hard to do and are a focus of this course.

2.5.3 Practice problems

Indicate on a graph and with words how each of the following events would be expected to affect the U.S. market for strawberries:

1. A 15% increase in the price of strawberries because of increased costs of production.
2. A 10% decrease in the price of raspberries.
3. A drought during the strawberry growing season.





2.6 Solving for Equilibrium

Analyzing market scenarios involves understanding how to interpret market situations and mathematically derive important results. Let's start with a simple example and work through the steps of solving for equilibrium. Consider an isolated town in which wheat is grown and processed into flour. Suppose you are the flour producer in town and you have information about your production, the supply of wheat and the supply of labor. How can you determine how much of your commodity to produce and what price to charge? The following details are available:

- The demand for flour is: $Q_f = 10 - \frac{1}{5}P_f$
- To process the wheat, one laborer is able to process one bushel of wheat into one vat of flour during one day. The production of flour requires only the work of laborers.
- Labor is provided according to the following labor supply function: $Q_L = -\frac{1}{4} + \frac{1}{8}P_L$
- The market price of the input, wheat, is \$7/bushel.

As the flour producer, you are interested in determining the following:

1. Supply curve for flour, equilibrium price of flour, and equilibrium quantity of flour.
2. Equilibrium price and supply of labor.

Follow these steps to solve:

1. Organize and label (very important):
   You know that you have a demand function for flour: $D:\ Q_f^D = 10 - \frac{1}{5}P_f^D$
   You know that you have a supply function for labor: $S:\ Q_L^S = -\frac{1}{4} + \frac{1}{8}P_L^S$
   You know the input cost of wheat: $P_{wheat} = \$7Q$

2. Convert all functions to inverse demand and inverse supply (in other words, solve for price):

$$\begin{aligned} ID:\ P_f^D &= 50 - 5Q_f^D \\ IS:\ P_L^S &= 2 + 8Q_L^S \end{aligned}$$

3. Define the production function, and the price of production. Defining the production function is the most intuitive step that you will have to make. In order to do so, you have to read the problem carefully and think about what components are necessary to produce the final product. In this case, you are told that the production of flour takes one laborer (L) and one bushel of wheat (W) to make one 60lbs bag of flour (F). Mathematically, we can represent this production as the following:

$$F = 1L + 1W$$

Now that you've got a production function, you need to determine how much it will cost to produce flour. If you know this cost, then you will be able to determine how much you can sell on the market. Assume we are in a competitive agricultural market. Thus, the flour producer will set the price of the output (P_f) equal to the price of the two inputs (P_L^S and P_w^S). In other words:

$$IS: \ P_f^S = P_L^S + P_w$$

Now, in step 1 you wrote out the price of wheat, and in step 2 you solved for the price of supplied labor. Plug these equations into the formula for $IS: \ P_f^S$. Assume the restriction that Labor and Wheat must be used in equal proportions (i.e. $Q_L = Q_w$). Note that the production function then forces $Q_f = Q_L = Q_w$.

$$\begin{aligned} IS: \ P_f^S &= (2 + 8Q_L^S) + (7Q_w^S) \\ &= (2 + 8Q_f^S) + (7Q_f^S) \\ P_f^S &= 2 + 15Q_f^S \end{aligned}$$

Now, at equilibrium, you know that the supply and demand curves cross. At the intersection of this cross, there is only one price. In other words, the price at which flour will sell will be the **same** as the price at which flour will be purchased: $P_f^S = P_f^D$. Similarly, the quantity of flour sold will be the same as the quantity of flour purchased: $Q_f^S = Q_f^D$. To determine the equilibrium quantity, you set the equation for $IS: \ P_f^S$ equal to the equation $ID: \ P_f^D$, and then solve for Q_f. Remember, when you set these two equations equal to each other, you *should only have Q as the variable* to solve:

$$\begin{aligned} 2 + 15Q_f &= 50 - 5Q_f \\ 20Q_f &= 48 \\ Q_f^* &= 2.4 \text{ bags} \end{aligned}$$

Now that you have the equilibrium quantity of flour, you need to determine the equilibrium price. To do so, you plug in Q_f^* into the inverse demand formula of

flour, $ID: \ P_f^D$ (*or* inverse supply, $IS: P_f^S$). Then, solve for the equilibrium price of flour:

$$\begin{aligned} P_f^* &= 50 - 5(2.4) \\ P_f^* &= \$38/\text{bag} \end{aligned}$$

Next, you need to determine the amount of labor and the price that workers will be paid in order to produce the equilibrium quantity of flour. We will start by determining the price of labor (wage). But, we were only given the supply function of labor, $S: \ Q_L^S$.

Remember that in step 3, we solved for the price of flour: $P_f^S = P_L^S + P_w$. From this equation, we can also solve for the price of labor (P_L):

$$P_f^S = P_L^S + P_w$$

Solving for P_L^S:

$$P_L^* = P_f^S - P_w$$

It looks like we still don't have enough information to solve. But wait! Recall that we already have the price of wheat, $P_w = \$7 Q_w$, that $Q_w = Q_f = 2.4$ and we solved for the price of flour in step 6, $P_f^* = \$38$. All we need to do now is plug these values into the equation for P_L^* and solve:

$$\begin{aligned} P_L^* &= \$38 - \$7(2.4) \\ P_L^* &= \$21.20/\text{labor-day} \end{aligned}$$

We now have the equilibrium price of labor. Next, we need to find how many workers you will need to produce the equilibrium quantity of flour. For this, we need a supply of function for labor. It so happens that we have it written out in step 1: $S: \ Q_L^S = -\frac{1}{4} + \frac{1}{8} P_L^S$. Since we already have the equilibrium price of labor, we simply plug it into the labor supply function, and solve for $S: \ Q_L^S$:

$$\begin{aligned} Q_L &= -\tfrac{1}{4} + \tfrac{1}{8} \cdot (\$21.20) \\ Q_L^* &= 2.4 \end{aligned}$$

2.6.1 Practice problems: solving for equilibrium

1. Consider the example above. Suppose that everything is exactly the same, but that now the Environmental Protection Agency (EPA) imposes a carbon price. This implies that for each unit of flour that you produce, you now have to pay an additional cost. Let the carbon price cost (CPC) be dependent on the quantity of flour you produce. That is, $CPC = 2 + 6Q$. Follow the steps above and solve for the new equilibriums in the flour and labor markets. How does CPC impact the price and quantity that you sell, and the price and number of laborers that you hire?

2. Consider a simple cattle operation in which feeder cattle are sent to feedlots to be brought up to weight (live cattle). The demand function for live cattle is

$$Q_{LC} = 5000 - 10P_{LC}$$

Bringing a feeder cattle to weight requires labor and feed. This is as follows:

- To raise one live cattle, the required feed is 100 lbs at \$1 per pound.
- Feedlot operators are the required labor. Operators work for a fixed wage per each cattle. One operator is required to raise one cattle. The minimum wage is \$50. When the wage is above that, the supply of feedlot operators follows the labor supply function:

$$Q_L = -500 + 10P_L$$

- A feeder cattle is priced at \$100 per head.

Complete the following:

(a) Determine the supply function for live cattle.

(b) Calculate the equilibrium price and quantity of live cattle.

(c) Calculate the equilibrium number of feedlot operators and the wage paid to each feedlot operator.

3. Consider a market for quaker oat cereal. The demand quaker oats is characterized as: $Q_Q = 800 - 5P_{LC}$
Producing one unite of quaker oats requires one unit of labor and one unit of electricity. Workers have the following labor supply function:

$$Q_L = -50 + 10P_L$$

- The price of raw oats is \$2.00/bu, and one bushel is required to produce one unit of quaker oats.
- One unit of electricity is required to produce one unit of quaker oats. Electricity costs \$1.00/unit.

(a) Determine the supply function for quaker oats.

(b) Calculate the equilibrium price and quantity of quaker oats.

(c) Calculate the equilibrium number of workers and the wage paid to each worker.

Chapter 3: Elasticities and flexibilities

When measuring the demand, it is very useful to know the relationship between the change in quantity demanded after a change in price and vice versa. **But**, doing so using only the slope ($\frac{\Delta Q}{\Delta P}$) does not allow for comparisons across goods. Elasticities and flexibilities provide a unit-less measures that describe the relationship between changes in the quantity demanded or quantity supplied and price. In other words, you can *directly* analyze how a change in price will affect quantity exchanged, even across different commodity markets.

3.1 Definitions

Elasticity: indicates the percentage change in quantity demanded if price changes by 1%

$$\varepsilon = \frac{\Delta Q}{\Delta P} \cdot \frac{P}{Q}$$

This can also be thought of as the product of the slope of a demand curve and the ratio of price to quantity.

Flexibility: indicates the percentage change in price if quantity demanded changes by 1%

$$\phi = \frac{\Delta P}{\Delta Q} \cdot \frac{Q}{P}$$

This can also be thought of as the product of the slope of an inverse demand curve and the ratio of quantity to price.

3.1.1 Basic example

Sarah's demand and inverse demand functions are as follows.

$$\begin{aligned} Q_{sarah} &= 60 - 0.5P_{beef} \\ P_{beef} &= 120 - 2Q_{sarah} \end{aligned}$$

Calculate the following:

1. Sarah's price elasticity of beef when:
   - $P = 60$ and $Q = 30$
   - $P = 80$ and $Q = 20$
   - $P = 20$ and $Q = 50$
2. Sarah's quantity flexibility of beef when:
   - $P = 60$ and $Q = 30$
   - $P = 80$ and $Q = 20$
   - $P = 20$ and $Q = 50$

As you solve the elasticities above, note that as the price increases, demand becomes more *elastic*. That is, the percent change in quantity demanded per 1% change in price becomes more greatly negative. Conversely, as price decreases, demand becomes less elastic, or more *inelastic*.

Let's solve the price elasticity when $P = 20$ and $Q = 50$:

1. For the elasticity, we need the slope, $\frac{\Delta Q}{\Delta P}$. Recall that for a simple linear function, $y = a + mx$, a is the intercept and m is the slope. In the Sarah's demand function, Q_{sarah}, we see that $a = 60$ and $m = -0.5$. So, $m = \frac{\Delta Q}{\Delta P} = -0.5$.
2. Now that we have the slope, we can solve for the elasticity: $\varepsilon = \frac{\Delta Q}{\Delta P} \cdot \frac{P}{Q}$

$$\begin{aligned} \varepsilon &= -0.5 \cdot \tfrac{20}{50} \\ \varepsilon &= -0.2 \end{aligned}$$

What does this mean? Well, when price increases by 1%, Sarah will consume 0.2% *less* beef. This makes intuitive sense because the demand function is downward sloping. So, if price goes up, the demand for beef will go down.

Now, let's solve the beef flexibility when $P = 20$ and $Q = 50$:

1. For flexibilities, we again need a slope. But in this case, the slope we're looking for is $\frac{\Delta P}{\Delta Q}$. That is, how does price change when quantity of beef changes? To get this slope, we use the inverse demand function, $P_{beef} = 120 - 2Q_{sarah}$. As with the elasticity, the slope is $m = \frac{\Delta P}{\Delta Q} = -2$.

2. Now that we have the slope, we can solve for the elasticity: $\phi = \frac{\Delta P}{\Delta Q} \cdot \frac{Q}{P}$

$$\begin{aligned} \phi &= -2 \cdot \tfrac{50}{20} \\ \phi &= -5 \end{aligned}$$

What does this result mean? Well, when quantity demanded of beef increases by 1%, then the price of beef will decrease by 5%. Note that the elasticity and flexibility are the reciprocal of one another. That is, 1 over the elasticity is the flexibility, and vice versa.

3.2 Properties of Demand Elasticities

- For normal goods, demand elasticity is *negative*.
- If $\varepsilon < -1$, then:
  - The good is *price elastic*.
  - A 1% change in price will cause a greater than 1% change in quantity demanded.
  - Total revenue changes in the direction of quantity (i.e., if price goes down, then quantity and total revenue go up).
- If $-1 < \varepsilon < 0$, then:
  - The good is *price inelastic*.
  - A 1% change in price will cause a less than 1% change in quantity demanded.
  - Total revenue changes in the direction of price (i.e., if price goes up, then total revenue go up).

3.3 Properties of Demand Flexibilities

- For normal goods, demand flexibility is *negative*.
- If $\phi < -1$, then:
  - The good is *price flexible*.
  - A 1% change in quantity demanded will cause a greater than 1% change in price.
  - Total revenue changes in the direction of price (i.e., if quantity goes down, then price and total revenue go up).
- If $-1 < \phi < 0$, then:
  - The good is *price inflexible*.
  - A 1% change in quantity demanded will cause a less than 1% change in price.
  - Total revenue changes in the direction of quantity demanded (i.e., if quantity goes up, then total revenue go up).

3.4 Analyzing More Complex Relationships

Realistically, demand for a good must be able to take into account factors such as income and prices of other goods.

Let's reconsider Sarah's demand function for beef:

$$Q_{sarah,\ beef} = 60 - 0.5P_{beef} + 0.1P_{pork} - 0.2P_{bbq\ sauce} + 0.25I$$

P_{beef}	P_{pork}	$P_{bbq\ sauce}$	Income	$Q_{sarah,\ beef}$
30	20	5	60	61

From Sarah's demand function, we can see that three things can affect Sarah's consumption of beef:

1. Change in the price of beef.
2. Change in the price of another good.

3. Change in Sarah's income.

This implies that we can calculate three types of elasticity measures:

1. Own-price elasticity: the percentage change in quantity demanded if the price of the good changes by 1%.
2. Cross-price elasticity: the percentage change in quantity if the price of another good changes by 1%.
3. Income elasticity: the percentage change in quantity if income changes by 1%.

3.4.1 How do we find demand elasticities?

Remember that to calculate an elasticity, we need a slope $\frac{\Delta Q}{\Delta P}$, and the quantity and price at which we want to determine the elasticity. We already know the quantity and price, so we need to determine the slope.

In a more complex equation (such as above) there are numerous "slopes." For example, there is a slope for beef ($\frac{\Delta Q_{beef}}{\Delta P_{beef}}$), there is a slope for pork ($\frac{\Delta Q_{beef}}{\Delta P_{pork}}$), for BBQ sauce ($\frac{\Delta Q_{beef}}{\Delta P_{bbq\_sauce}}$), and income ($\frac{\Delta Q_{beef}}{\Delta I}$). This implies that we can calculate **four** elasticities. How do we find each of the "slopes?" Well, if we use our intuitive thinking, we can see that a slope tells us the following: When everything else is the same, the quantity of beef demanded changes by a certain amount when a particular price changes. Another way to interpret "when everything else is the same" is to do the following:

1. Determine the elasticity that you want to calculate.
2. Based on this, determine the price that you're interested in.
3. Set all of the other prices to zero. Re-write the demand function.

For example, suppose that you're interested in determining the own-price elasticity of beef. That is, you'd like to know how much the quantity of beef demanded will increase when the price of beef decreases. So, you're interested in looking at P_{beef}. Thus, set all the other prices (and income) equal to zero:

$$\begin{aligned} Q_{sarah,\ beef} &= 60 - 0.5P_{beef} + 0.1 \cdot (0) - 0.2 \cdot (0) + 0.25 \cdot (0) \\ Q_{sarah,\ beef} &= 60 - 0.5P_{beef} \end{aligned}$$

Now you have a very familiar demand function, which has the form $y = a + mx$. From here, you can directly get the slope, $m = \frac{\Delta Q}{\Delta P} = -0.5$. Then, simply use the formula for an elasticity to solve:

$$\varepsilon = -0.5 \cdot \tfrac{30}{61} = -0.25$$

In a similar fashion, we calculate the cross-price and income elasticities.

3.5 Properties of Cross-Price Elasticities of Demand

There are threes aspects that can cause an adjustment to quantity demanded. For good i:

1. Income: a change in income can increase or decrease purchasing power. For normal goods, an increase in income implies greater consumption of the good.
2. Substitutes: an increase in the price of another good will lead to a greater consumption of good i. $\varepsilon_{i,j} > 0$
3. Complements: an increase in the price of another good will lead to a lesser consumption of good i. $\varepsilon_{i,j} < 0$

3.6 Price Elasticities of Demand in Agricultural Markets

In general, food is relatively inelastic: -0.4% (own-price); 0.36% (income)

	Other major commodities				
	Beef	**Pork**	**Chicken**	**Fish**	**Income**
Beef	-1.17	0.081	-0.064	-0.32	2.72
Pork	0.115	-0.827	0.051	0.0059	1.083
Chicken	0.244	0.25	-0.842	-0.0027	-0.106
Fish	-0.087	0.034	0.071	-0.26	0.121

3.7 Elasticities of Supply

Price Elasticity of Supply: the percentage change in quantity supplied if there is a 1% change in price.

Price Flexibility of Supply: the percentage change in price if there is a 1% change in quantity supplied.

3.7.1 Properties of supply elasticities

- As quantity increases, supply elasticity nears unity.
- As price increases, the supply curve flattens (becomes more elastic).
  Higher price → higher incentive to plant → more acres
  → more supply curves included in aggregate supply

Important: in agriculture, elasticities of supply typically differ depending on the time period being examined.

- Short-run (day / week / month): price of supply is relatively elastic.
  Farmers can alter the amount of a commodity that they sell based on the current price

  Week 1: P_{wheat} is high → Sell more wheat
  Week 2: P_{wheat} is lower → Sell less wheat

- Intermediate-run (marketing period): price is least elastic.
  - The supply is fixed (can't grow extra corn in December).
  - Supply is not perfectly inelastic – if the price gets too low or high, there is possibility of import/export.
- Long-run (beyond the marketing period): price elasticity is greater than that during the marketing period because there are no longer fixed costs.

3.7.2 Solving for elasticities of supply

Consider the following supply function for Montana wheat:

$$Q_{wheat} = 25 + 25P_{wheat} - 10P_{rye} - 15P_{barley} - 8W_{fuel} + 10Rain$$

$$P_{wheat} = \$5 \qquad P_{rye} = \$5.50 \qquad P_{barley} = \$5$$

$$W_{fuel} = \$2.50 \quad Rainfall = 10in.$$

Solve for the following:

1. Aggregate supply of wheat.
2. Own and cross-price elasticities at the given values.

1. Total quantity of wheat supplied: 100
2. When solving supply elasticities, follow the same process as if you were solving demand price elasticities. Elasticities at given values:

	$\frac{\Delta Q}{\Delta P}$	$\varepsilon_{i,j}$
P_{wheat}	$\frac{\partial Q}{\partial P_{wheat}} = 25$	1.25
P_{rye}	$\frac{\partial Q}{\partial P_{rye}} = -10$	-0.55
P_{barley}	$\frac{\partial Q}{\partial P_{barley}} = -15$	-0.75
W_{fuel}	$\frac{\partial Q}{\partial W_{fuel}} = -8$	-0.2
$Rainfall$	$\frac{\partial Q}{\partial Rain} = 10$	1

Note that the final elasticity is not a price elasticity, but rather a elasticity of supply with respect to weather.

Chapter 4: Equilibrium Displacement Models

We analyze economic scenarios using supply and demand diagrams. However, we often esoterically say that although we can show the market reaction on a graph, we need additional information to solve the math. Well, the excuses are over: let's actually determine by how much shocks affect markets.

Equilibrium Displacement Model (EDM) calculations are excellent for analyzing events such as:

- Market shocks to the supply or demand.
- Government policies.
- Effects of invasive species.
- Interaction of substitutes and complements.

4.1 Single Commodity EDM Analysis

Consider a basic scenario:

1. There is a negative shock to the supply of wheat, causing the supply curve to shift inward.
2. The resulting rise in price causes a decrease in the quantity demanded until a new equilibrium is reached.
3. Question: how much did the price and quantity actually change due to the shock? That is:
   (a) What is the percentage change in quantity demanded ($\%\Delta QD$)?

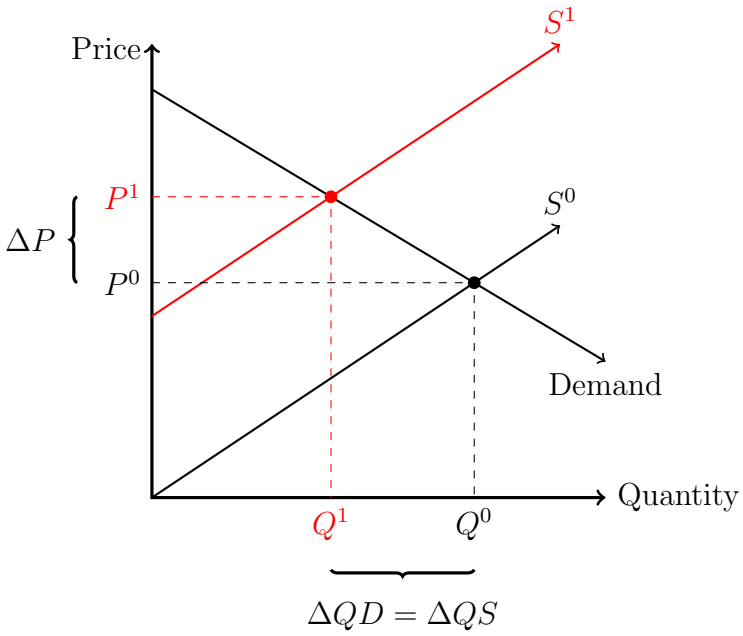
(b) What is the percentage change in quantity supplied ($\%\Delta QS$)?

(c) What is the percentage change in price ($\%\Delta P$)?

To answer these questions, we do need some information. Specifically we need the:

- Elasticities of supply and demand curves (ε_D and ε_S).
- Amount of the shock (shift) to the supply curve (S_S).

Figure 4.1: Changes the Equilibrium Displacement Models Help Quantify



Once we have these, we can solve for the changes in quantity demanded and supplied using the following formulas:

$$\frac{\Delta QD}{Q^0} = \%\Delta QD = \varepsilon_D \cdot \%\Delta P + S_D$$

$$\frac{\Delta QS}{Q^0} = \%\Delta QS = \varepsilon_S \cdot \%\Delta P + S_S$$

Here's the key to solving this problem: when the curves shift, what is the relationship of $\%\Delta QD$ to $\%\Delta QS$? In other words, how much does $\%\Delta QD$ change relative to $\%\Delta QS$?

The answer is easy: because after the shock the market returns to an equilibrium, the amount that quantity demanded changed by is the same as the amount that the quantity supplied changed. In other words, $\%\Delta QD = \%\Delta QS$!

This means that we can the two equations equal to each and then solve for $\%\Delta P$:

$$\begin{array}{lcl} \varepsilon_D \cdot \%\Delta P + S_D & = & \%\Delta QD = \%\Delta QS = \varepsilon_S \cdot \%\Delta P + S_S \\ \varepsilon_D \cdot \%\Delta P + S_D & = & \varepsilon_S \cdot \%\Delta P + S_S \\ 0 & = & \varepsilon_S \cdot \%\Delta P + S_S - \varepsilon_D \cdot \%\Delta P - S_D \\ 0 & = & (S_S - S_D) + \%\Delta P(\varepsilon_S - \varepsilon_D) \\ \%\Delta P & = & \frac{(S_D - S_S)}{(\varepsilon_S - \varepsilon_D)} \end{array}$$

Note: that the denominator $(\varepsilon_S - \varepsilon_D)$ is always positive (why?).

So, if we know the elasticities and amount of shocks, we can solve for $\%\Delta P$. Then, we plug in $\%\Delta P$ into either $\%\Delta QD$ or $\%\Delta QS$ to determine the change in the quantity demanded / quantity supplied that occurred due to some market shock.

4.1.1 Example

Suppose that due to a failure of eradication, the wheat stem sawfly has caused a substantial reduction in Montana wheat supply. The result is a 10% shock to the wheat supply. Analyze the changes in price and quantity demanded/supplied in the wheat market, knowing that the following is true:

Elasticity of wheat supply (ε_S)	1.5
Own-price elasticity of wheat demand (ε_D)	-2

1. First, you need to analyze what is happening. A drop in quantity supplied is 10% – this is the *exogenous* shock ($S_S = -10\%$). We model this as following:

$$\%\Delta QS = \varepsilon_S \cdot \%\Delta P - 10\%$$

2. Now, the reduction in quantity supplied will increase the prices that producers charge for wheat and consumers pay for wheat. The change in price is the *endogenous* readjustment of the equilibrium in the wheat market. How do we determine this adjustment? We need to solve for the unknown $\%\Delta P$, which will tell us the true price adjustment due to the supply shock. In other words, $\%\Delta P$ reveals the true adjustment in price, after taking into account the elasticities of both the supply and demand curves. We solve this as we did above:

$$\begin{aligned}
\varepsilon_D \cdot \%\Delta P + S_D &= \%\Delta QD = \%\Delta QS = \varepsilon_S \cdot \%\Delta P + S_S \\
\varepsilon_D \cdot \%\Delta P + S_D &= \varepsilon_S \cdot \%\Delta P + S_S \\
-2 \cdot \%\Delta P + 0 &= 1.5 \cdot \%\Delta P - 10\% \\
10\% &= 3.5 \cdot \%\Delta P \\
\%\Delta P &= 2.86\%
\end{aligned}$$

   This indicates that the effect of the wheat stem sawfly caused prices to rise by 2.86% as a result in the drop of quantity supplied. This result should make sense, because we know that a negative supply shock will cause prices to rise.

3. We know how much the price of wheat will increase, but we don't know how much quantity supplied/demanded changed. We can find out by simply plugging in $\%\Delta P$ into the equation for $\%\Delta QD$ or $\%\Delta QS$.

$$\begin{aligned}
\%\Delta QD &= \varepsilon_D \cdot \%\Delta P + S_D \\
\%\Delta QD &= -2 \cdot 2.86\% + 0 \\
\%\Delta QD &= -5.72\%
\end{aligned}$$

   Because we are back in an equilibrium, we know that $\%\Delta QS$ was exactly the same.

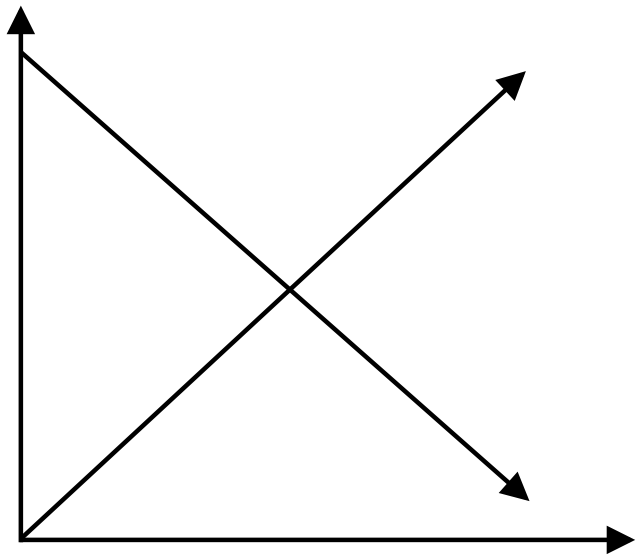
4.1.2 Additional practice

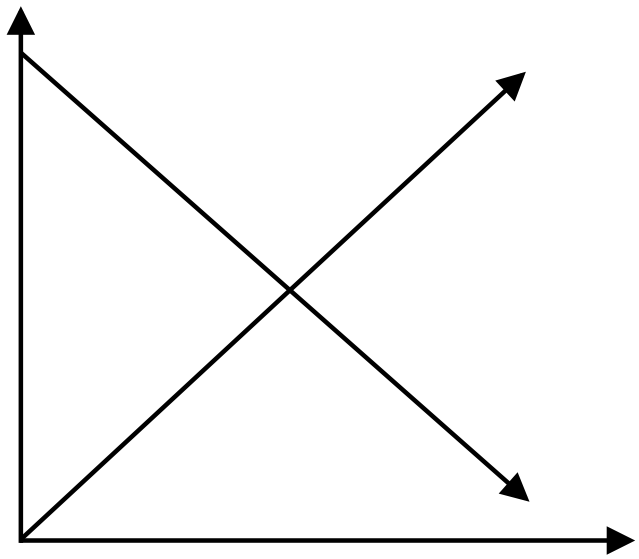
Consider the following information:

Elasticity of apple supply (ε_S)	3
Own-price elasticity of apple demand (ε_D)	-2.5
Elasticity of pear supply (ε_S)	5
Own-price elasticity of pear demand (ε_D)	-3

Analyze the percentage change in prices and quantities if the following scenarios occurred:

1. A rise in the price of oranges causes the demand for apples to increase by 15%.
2. A tax is imposed on pear producers, causing pear production costs to rise by \$5/bu, when the current price of pears received by producers is \$50/bu.
3. A drop in apple supplies and the resulting rise in apple prices causes the demand for pears to increase by 5%. Assume that apples and pears are substitute goods.





4.2 General Equilibrium Displacement Models – GEDM

In the simple EDM calculation, we consider only a "partial equilibrium." In other words, we only ask the question: How does a shock affect one market?

This is not very realistic! Shocks in one market can affect related markets (such as substitute or complementary goods), which can then cause feedback effects.

4.2.1 For example

Consider *Additional practice* problem 3. You are told that apple supplies decrease, causing apple prices to rise and the demand for pears to rise, because apples and pears are substitute goods. However, the rise in the demand for pears will then cause a feedback effect on the apple market. That is, higher pear demand will increase pear prices and cause some consumers to demand more apples, in turn causing apple prices to rise further.

How do we analyze this particular scenario? Well, it seems intuitive that we will be analyzing both the apple and pear markets, and we also need some way to determine the interaction between these two markets. The interaction is the cross-price elasticity. Assume that:

Elasticity of apple supply (ε_S)	3
Own-price elasticity of apple demand (ε_D)	-2.5
Elasticity of pear supply (ε_S)	5
Own-price elasticity of pear demand (ε_D)	-3
Cross-price elasticity of apple demand with respect to pear prices ($\varepsilon_{apple,pear}$)	0.5
Cross-price elasticity of pear demand with respect to apple prices ($\varepsilon_{pear,apple}$)	0.25

4.2.2 Problem setup

Let's set up the four markets:

$$\%\Delta QS_{apples} = \varepsilon_{S,apples} \cdot \%\Delta P_{apples} + S_{S,apples}$$

$$\%\Delta QD_{apples} = \varepsilon_{D,apples} \cdot \%\Delta P_{apples} + \varepsilon_{apple,pear} \cdot \%\Delta P_{pear} + S_{D,apples}$$

$$\%\Delta QS_{pears} = \varepsilon_{S,pears} \cdot \%\Delta P_{pears} + S_{S,pears}$$

$$\%\Delta QD_{pears} = \varepsilon_{D,pears} \cdot \%\Delta P_{pears} + \varepsilon_{pear,apple} \cdot \%\Delta P_{apple} + S_{D,pears}$$

Note that we directly account for the interaction of the two markets by including the terms $\varepsilon_{apple,pear}$ and $\varepsilon_{pear,apple}$.

Suppose that the supply of apples decreases by 10%. How do we solve for the changes in the price of apples ($\%\Delta P_{apples}$) and price of pears ($\%\Delta P_{pears}$)?

1. First, we know that in equilibrium, $\%\Delta QS_{apples} = \%\Delta QD_{apples}$ and $\%\Delta QS_{pears} = \%\Delta QD_{pears}$. For each relationship, solve for $\%\Delta P_{apples}$ and $\%\Delta P_{pears}$, respectively.

$$\varepsilon_{S,apples} \cdot \%\Delta P_{apples} + S_{S,apples} = \varepsilon_{D,apples} \cdot \%\Delta P_{apples} + \varepsilon_{apple,pear} \cdot \%\Delta P_{pear} + S_{D,apples}$$

$$3 \cdot \%\Delta P_{apples} - 10\% = -2.5 \cdot \%\Delta P_{apples} + 0.5 \cdot \%\Delta P_{pear} + 0$$

$$5.5 \cdot \%\Delta P_{apples} = 0.5 \cdot \%\Delta P_{pear} + 10\%$$

$$\boldsymbol{\%\Delta P_{apples} = 0.091 \cdot \%\Delta P_{pear} + 1.818\%} \quad (1)$$

$$\varepsilon_{S,pears} \cdot \%\Delta P_{pears} + S_{S,pears} = \varepsilon_{D,pears} \cdot \%\Delta P_{pears} + \varepsilon_{pear,apple} \cdot \%\Delta P_{apples} + S_{D,pears}$$

$$5 \cdot \%\Delta P_{pears} + 0 = -3 \cdot \%\Delta P_{pears} + 0.25 \cdot \%\Delta P_{apples} + 0$$

$$8 \cdot \%\Delta P_{pears} = 0.25 \cdot \%\Delta P_{apples}$$

$$\boldsymbol{\%\Delta P_{pears} = 0.031 \cdot \%\Delta P_{apples}} \quad (2)$$

2. Now, we have two equations (equations (1) and (2)) and two unknowns ($\%\Delta P_{apples}$ and $\%\Delta P_{pears}$). Two solve, plug in the equation for $\%\Delta P_{pears}$ into the equation for $\%\Delta P_{apples}$. Then solve for $\%\Delta P_{apples}$:

$$\%\Delta P_{apples} = 0.091 \cdot \%\Delta P_{pear} + 1.818\%$$

$$\%\Delta P_{apples} = 0.091 \cdot (0.031 \cdot \%\Delta P_{apples}) + 1.818\%$$

$$\%\Delta P_{apples} = 0.003 \cdot \%\Delta P_{apples} + 1.818\%$$

$$0.997 \cdot \%\Delta P_{apples} = 1.818\%$$

$$\boldsymbol{\%\Delta P_{apples} = 1.823\%}$$

Now that you have the percentage change in the price of apples, plug it into the equation for the price of pears to solve for $\%\Delta P_{pears}$:

$$\%\Delta P_{pears} = 0.031 \cdot \%\Delta P_{apples}$$

$$\%\Delta P_{pears} = 0.031 \cdot (1.823\%)$$

$$\boldsymbol{\%\Delta P_{pears} = 0.057\%}$$

3. Having both the $\%\Delta P_{apples}$ and $\%\Delta P_{pears}$, you can now solve for $\%\Delta QD_{apples}$ ($\%\Delta QS_{apples}$) and $\%\Delta QD_{pears}$ ($\%\Delta QS_{pears}$):

$$\%\Delta QD_{apples} = \varepsilon_{D,apples} \cdot \%\Delta P_{apples} + \varepsilon_{apple,pear} \cdot \%\Delta P_{pear} + S_{D,apples}$$

$$\%\Delta QD_{apples} = -2.5 \cdot \%\Delta P_{apples} + 0.5 \cdot \%\Delta P_{pear} + 0$$

$$\%\Delta QD_{apples} = -2.5 \cdot 1.823\% + 0.5 \cdot 0.057\%$$

$$\boldsymbol{\%\Delta QD_{apples} = -4.529\%}$$

$$\%\Delta QD_{pears} = \varepsilon_{D,pears} \cdot \%\Delta P_{pears} + \varepsilon_{pear,apple} \cdot \%\Delta P_{apple} + S_{D,pears}$$
$$\%\Delta QD_{pears} = -3 \cdot \%\Delta P_{pears} + 0.25 \cdot \%\Delta P_{apples} + 0$$

$$\%\Delta QD_{pears} = -3 \cdot 0.057\% + 0.25 \cdot 1.823\%$$

$$\boldsymbol{\%\Delta QD_{pears} = 0.285\%}$$

4.2.3 Additional problems

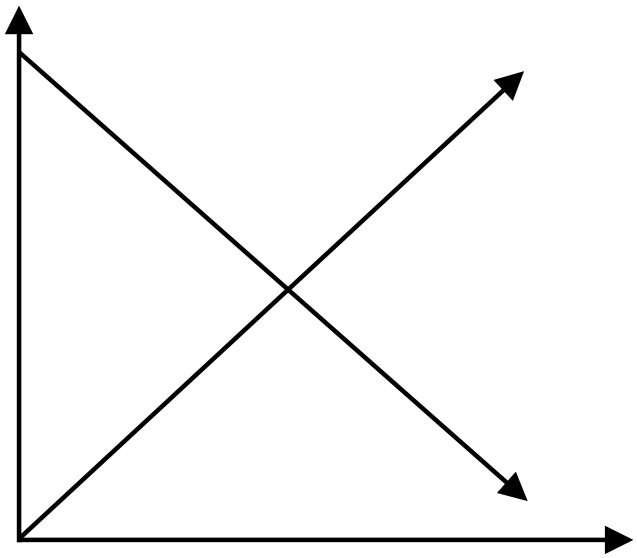
Sugar can be produced from sugar beets grown in Montana or sugar cane grown in Texas. These markets are linked, and so shocks to one market must be analyzed with respect to the other market.

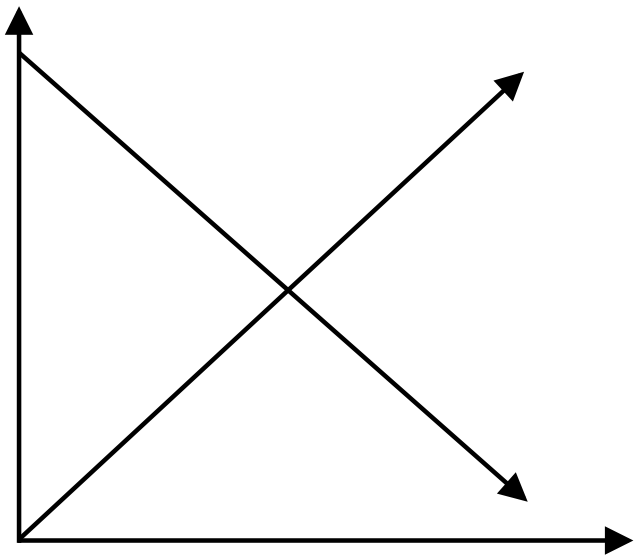
Consider the following information:

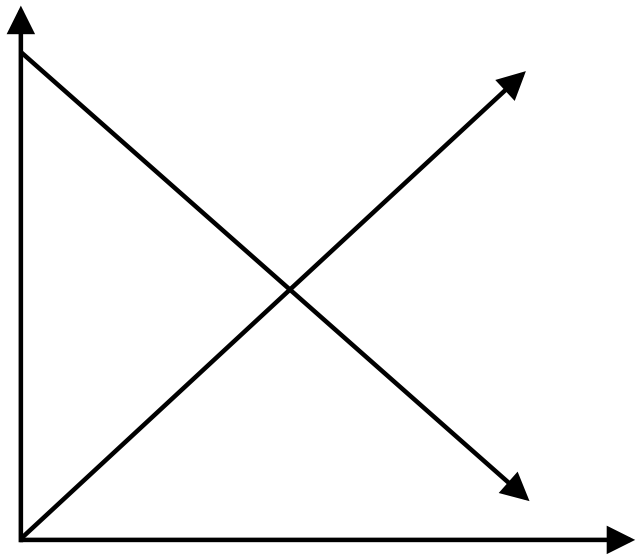
Elasticity of sugar beets supply (ε_S)	1.2
Own-price elasticity of sugar beets demand (ε_D)	-0.9
Elasticity of sugar cane supply (ε_S)	1.5
Own-price elasticity of sugar cane demand (ε_D)	-1
Cross-price elasticity of sugar beets demand with respect to sugar cane prices ($\varepsilon_{beet,cane}$)	1.2
Cross-price elasticity of sugar cane demand with respect to sugar beet prices ($\varepsilon_{cane,beet}$)	1.5

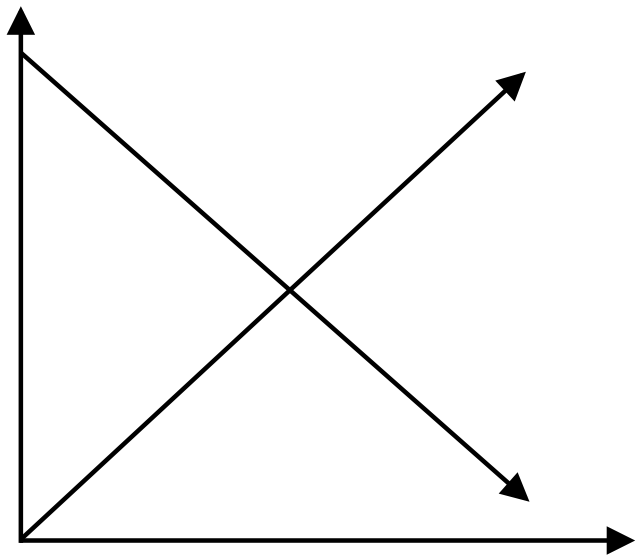
Analyze the following situations:

1. Sugar cane supply increases by 25%.
2. The FDA restricts only non Round-up Ready sugar beets to be planted, increasing the demand for beets by 5%.
3. Prices of sugar beets fall by \$5/ton from the original price of \$50/ton.









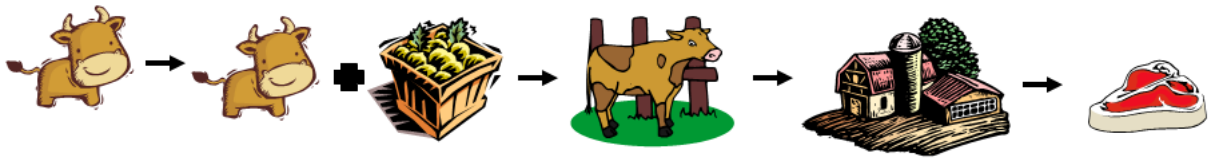
Chapter 5: Food Marketing Channel

Imagine you're at Stacey's steakhouse and you order a nice, local, 24-ounce steak (medium-rare, of course). 15 minutes later you're enjoying the steak's delicious taste and smell. You then pay $30 for your dinner, and you're on your way.

If you've ever been to Stacey's, you probably know that they don't have any steak-trees or meat-bushes on which steaks grow. This makes you wonder: Where did the steak come from? How did it get there? And why was it so expensive?!?

Answering these questions is the goal of analyzing the food marketing channel.

Consider the following diagram describing the process of a Stacey's Steakhouse steak:



1. Calves are born and they are grass-fed until they can be sent off to feedlots.
2. At feedlots, cattle are brought up to weight.
3. Fed cattle are processed into meat products.
4. Meat products are transported to various locations (including Stacey's).
5. A medium-rare steak is provided to the customer.

Each one of these steps involves a cost, which is incorporated into the final price of the steak.

It should be intuitive that a shock at any one of these steps will have an impact on the others. For example, suppose that customers changed their tastes and started consuming pork. The demand for steak would decrease causing:

1. Decrease in the demand for meat by Stacey's.
2. Decrease in transportation of meat because less meat consumers need the product.
3. Decrease in how much meat is processed.
4. Decrease in the production (quantity supplied) of fed cattle.
5. Decrease in the production of feeder cattle.

And, because the demand at all of these steps has decreased, the following will happen to prices:

1. Decrease in the price that Stacey's is willing to pay for beef products.
2. Decrease in how much transporters of beef receive because consumers are less willing to pay.
3. Decrease in how much feedlot operators receive.
4. Decrease in how much feeder cattle producers receive.

As a producer, you may be very interested in understanding and modeling the effects of changes in the food marketing channel. For example, you may want to know how much less you will receive for your feeder cattle if there is a bovine spongiform encephalopathy (BSE) outbreak that causes consumers to consume less beef.

5.1 Understanding the Food Marketing Channel – Derived Demand

Agricultural production is unique! One of the ways that it is unique is that many agricultural commodities are produced in *constant proportions* from some raw input.

Cattle	→ Hamburger meat → Steaks
Chicken	→ Two legs → Two wings → Two breasts
Soybeans	→ Soybean meal → Soybean oil

As consumers, we demand the end product, such as chicken breasts or soybean meal (for feed). As producers, we supply the product and process it into consumables.

Questions of importance:

- How do we determine the demand for the agricultural raw input (farm level demand) product? In other words, what's the demand for chickens or soybeans?
- How do we determine the supply of the agricultural raw input product?
- What are the equilibrium prices of input and final goods?

Recall that in chapter 2, we solved for the supply functions and used provided demand equations to solve for equilibrium. The three questions above will allow us to solve for the demand functions. After completing this, we will be able to solve for *both* the demand and supply sides of the market equilibrium relationship.

To start answering these questions, we work backward. That is, we ask the question: *how much of the final, processed products do consumers demand?*

An intuitive way to answer this question is plotting the demands of all food products derived from an agricultural commodity on a single plane. For example, assume that from one fed cattle, you can produce steaks and hamburgers. At any quantity, consumers are willing to pay more for a steak than a hamburger. The sum of steaks and hamburgers makes up the *total demand* for beef. This is illustrated in Figure 5.1.

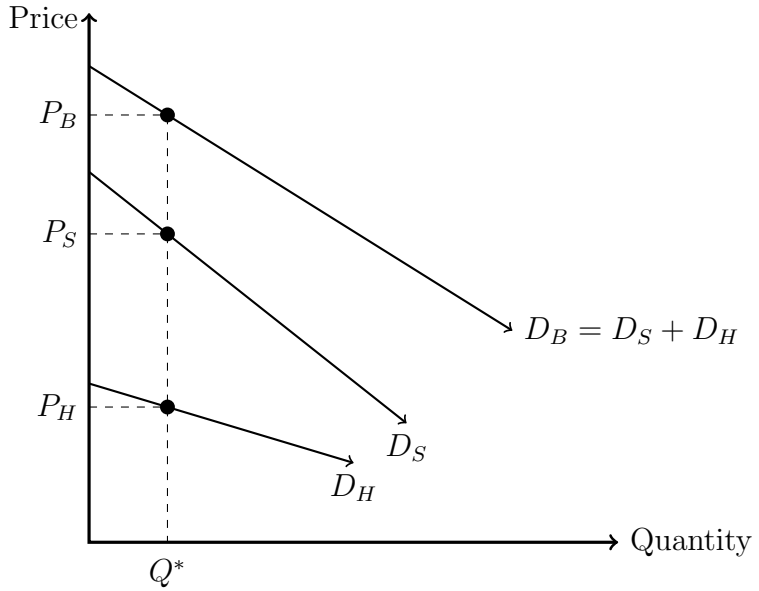
You can see that the total demand for beef is the vertical sum of the demands for steaks (D_S) and hamburger (D_H), and for some quantity of meat ($Q*$), the price of steak is always higher than the price of hamburger.

Now that we know what the total demand for beef looks like, we are interested in understanding how this demand can be used to derive the demand for the agricultural commodity, fed cattle.

To understand this, we must consider that fed cattle are slaughtered to become beef as well as transported to a final destination through *processing and marketing* (P&M). So, the amount of P&M will determine how many fed cattle will become beef. That is:

$$D_{beef} = D_{fed\ cattle} + S_{P\&M}$$

Figure 5.1: Vertical Summation of Demand Curves for Derived Products



In other words, the amount of beef available for consumption is equal to the amount of fed cattle plus the amount of processing. It is then easy to see that to find the *derived demand* for fed cattle, we simply subtract $S_{P\&M}$ from both sides:

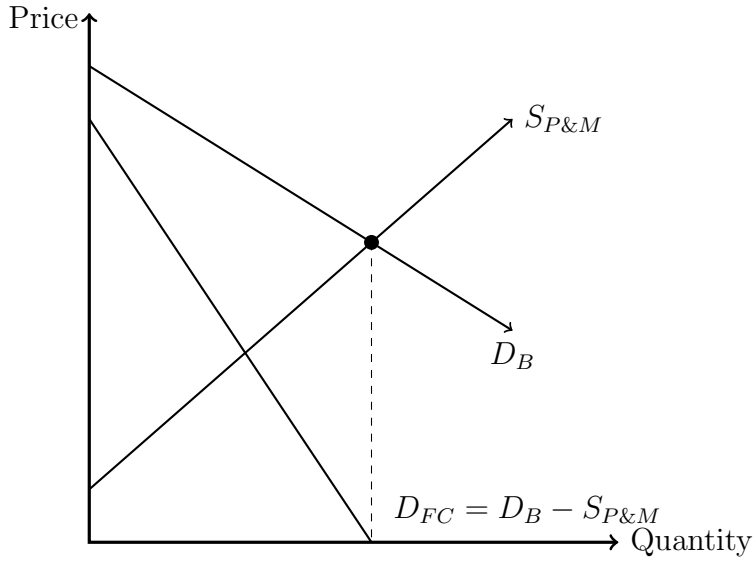
$$D_{fedcattle} = D_{beef} - S_{P\&M}$$

To interpret this relationship, consider that the demand for fed cattle will continue to be positive until the point at which the consumer market is satiated with enough processed beef. That is, until $D_{beef} - S_{P\&M} = 0$. If $D_{beef} > S_{P\&M}$, then there is excess demand for beef and processors will continue to supply their services. And because an input into processing is fed cattle, the demand for fed cattle will be positive. If $D_{beef} < S_{P\&M}$, then there is excess supply of beef, and processor will not need additional fed cattle to process into meat. This relationship is shown in Figure 5.2.

The curve D_B comes directly from the previous diagram in which the sum of steaks and hamburgers determined the demand for beef. The supply of P&M is given, and the demand curve for fed cattle D_{FC} is determined by the vertical difference between the $S_{P\&M}$ and D_B curves. This figure clearly illustrates how the demand for the agricultural commodity is determined by the consumers of the final goods.

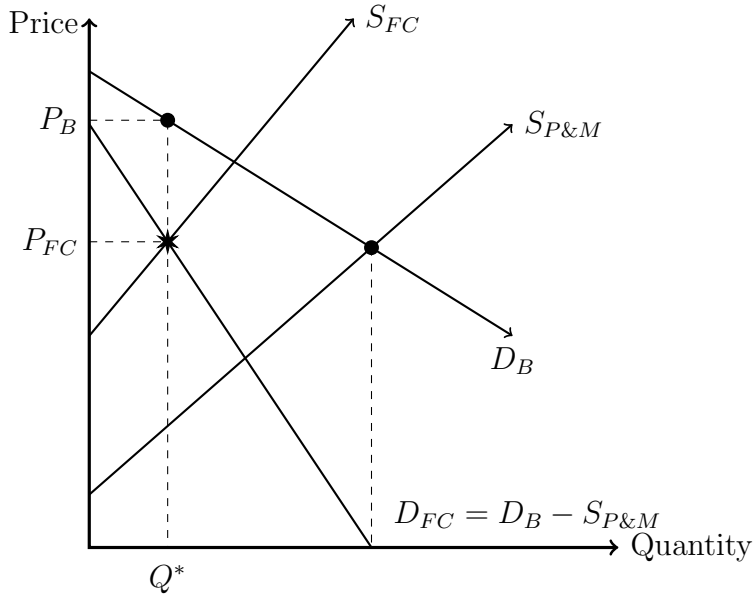
To find the equilibrium quantity and price of fed cattle (which as a feedlot operator, you're most interested in), we can simply look to the intersection of the supply and demand curves

Figure 5.2: Vertical Summation of Demand Curves for Derived Products



of fed cattle. Assuming that the supply curve of fed cattle is known, the equilibrium in the fed cattle market is shown in Figure 5.3.

Figure 5.3: Equilibrium in the Fed Cattle Market



The intersection of D_{FC} and S_{FC} determines the equilibrium price and quantity of fed cattle. Also, because the slaughter of fed cattle produces fixed proportions of beef products, the quantity of fed cattle (Q^*) is implicitly the quantity of beef that will be available. So, we simply project the quantity of beef onto the demand curve for beef (D_B) to retrieve the equilibrium price of beef. Lastly, we can also determine the price that processors receive by projecting the equilibrium quantity Q^* into the supply curve of processing and marketing $S_{P\&M}$.

To determine the prices of steak and hamburgers, we simply project the equilibrium quantity onto the first graph. The overall analysis is shown in Figure 5.4.

5.2 Scenario Analysis

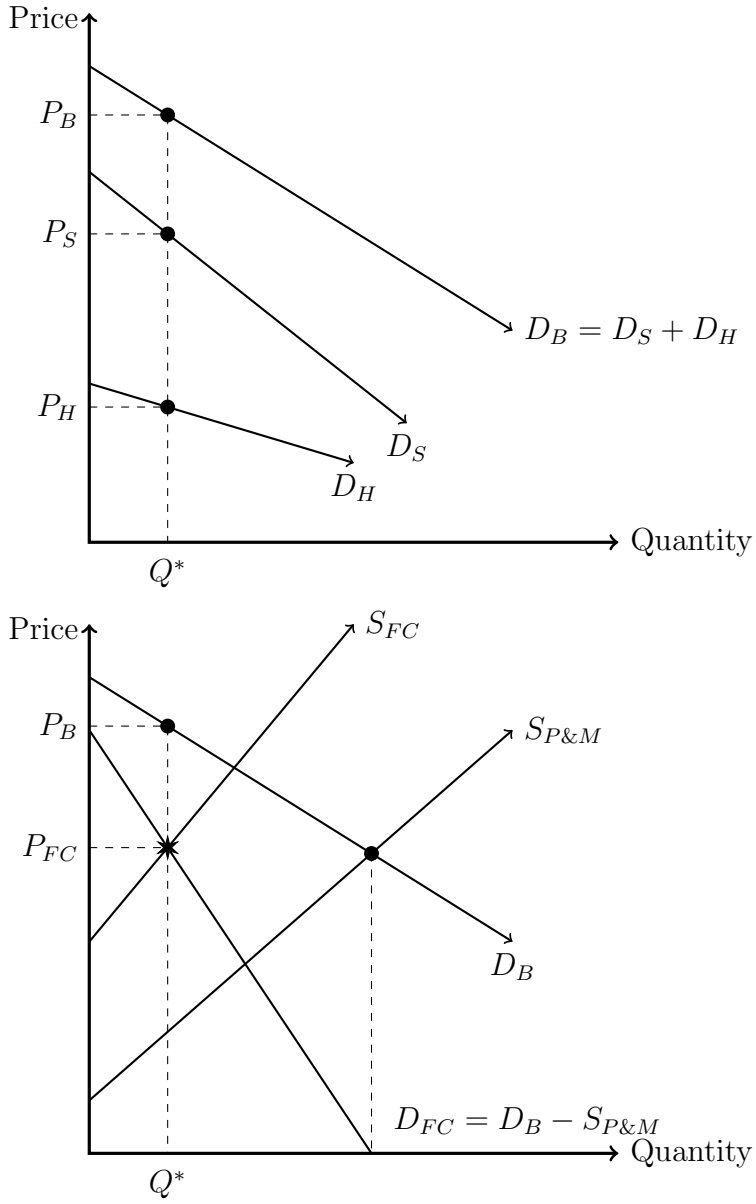
The derived demand model we have derived is extremely powerful. You can use it to get intuition into the effects of market shocks. Consider the following scenario: A case of BSE breaks out in the U.S. cattle market. This causes consumers to fear that the processed meat is inedible, and the demand for beef decreases. This scenario is shown in Figure 5.5. Analyze the following:

1. The effect on the quantity and price of fed cattle.
2. The effect on the quantity and price of beef.
3. The effect on the quantity and price of steaks and hamburgers.

5.2.1 Analysis

1. The demand for beef decreases and shifts inward.
2. Because the demand for fed cattle is derived from the from demand of beef, the demand for fed cattle will also decrease and shift inward.
3. This will change the point at which the demand and supply curves of fed cattle intersect. The result is a drop in quantity supplied and drop in price.
4. Projecting the new quantity onto the new demand curve of beef, we see that the price of beef has also decreased.
5. Projecting the new quantity onto the supply curve of P&M, we see that the price received by fed cattle processors has decreased.

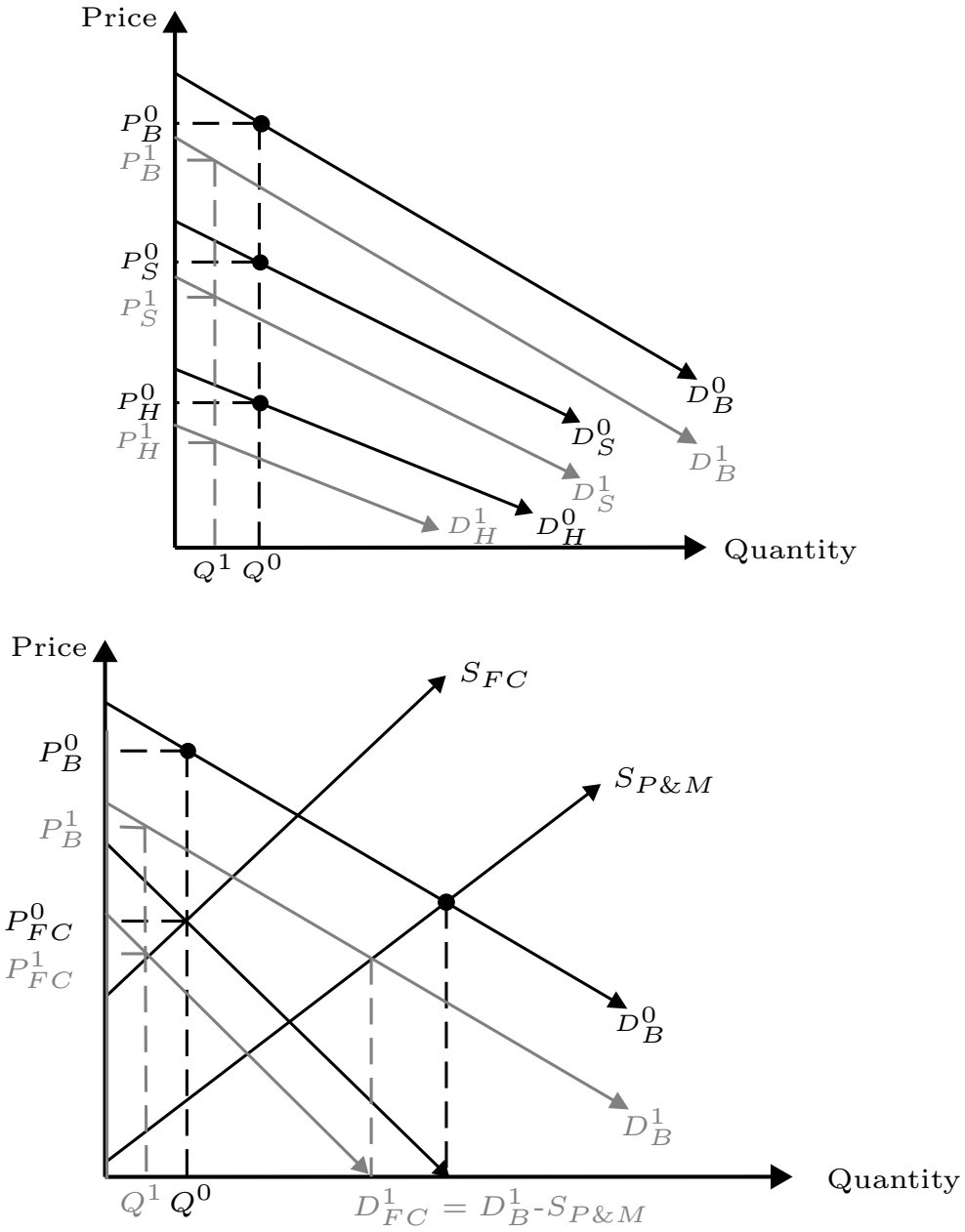
Figure 5.4: Equilibrium in the Fed Cattle and Processed Meat (Consumer) Markets



Because the demand for beef has decreased and the quantity of beef supplied has dropped, there we model the changes in the consumer market.

1. The drop in overall beef demand and quantity of beef supplied can be illustrated by the decrease in the demands of both steak and hamburger.

Figure 5.5: Effects in the Fed Cattle Market of a Negative Shock to Consumer Confidence



2. The demand for steak decreases. The price for steak drops.

3. The demand of hamburger decreases. The price for hamburger drops.

5.2.2 Additional problems – DD graphical analysis

Set up diagrams for the consumer and farm-level markets, and analyze the following market scenarios:

1. The demand for steak increases.
2. The supply of processing and marketing is reduced.
3. The supply of fed cattle increases.

5.3 Derived Demand – Numerical Analysis

Although graphical derived demand analysis helps understand the intuition of markets, as a producer, you may find it useful to mathematically determine the demand function for the farm-level commodity. By knowing this demand, you will be able to determine the equilibrium quantity and price levels.

Suppose that you know the consumer-level demand functions for the final goods, as well as the supply functions for P&M and the farm-level good. To derive the demand and equilibrium price and quantity levels, use the following steps:

1. Determine the joint demand meat: vertical summation
2. Determine the equilibrium quantity of processing: Set $D_{consumer\ level} = S_{P\&M}$
3. We know that $D_{farm\ level} = (D_{consumer\ level} - S_{P\&M})$. So, plug in for $D_{consumer\ level}$ and $S_{P\&M}$ to solve for $D_{farm\ level}$
4. Find the equilibrium quantity and price of cattle by setting demand (inverse demand) of cattle equal to the supply (inverse supply) of cattle: $D_{farm\ level} = S_{farm\ level}$
5. Solve for the equilibrium price and quantities

5.3.1 DD numerical example

Consider: you know the demand for hamburger meat and steaks, as well as the supply of meat processing and supply of fed cattle. Derive the demand for fed cattle.

$D_{hamburger}: \ P_H = 10 - 0.5 \cdot Q_H^D$

$D_{steak}: \ P_S = 20 - Q_S^D$

$S_{P\&M}: \ P_{P\&M}^S = 5 + 0.5 \cdot Q_{PM}^S$

$S_{FC}: \ P_{FC}^S = -20 + 3 \cdot Q_{FC}^S$

1. Determine the joint demand for beef: $D_B = D_{hamb} + D_{steak}$
   $D_B : P_B^D = (10 - 0.5 \cdot Q_H^D) + (20 - Q_S^D)$
   $D_B : P_B^D = 30 - 1.5 \cdot Q_B^D$

2. Solve for the derived demand of fed cattle: $D_{FC} = (D_B - S_{P\&M})$

   $D_{FC} : P^D_{FC} = (30 - 1.5 \cdot Q^D_B) - (5 + 0.5 \cdot Q^S_{PM})$

   $D_{FC} : P^D_{FC} = 25 - 2 \cdot Q^D_{FC}$

3. We have the function for the supply of fed cattle, so we can solve for equilibrium quantity: $D_{FC} = S_{FC}$

   $D_{FC} : P^D_{FC} = P^S_{FC} : S_{FC}$

   $P^D_{FC} = 25 - 2 \cdot Q^D_{FC} = -20 + 3 \cdot Q^S_{FC} = P^S_{FC}$

   $45 = 5 \cdot Q_{FC}$

   $\boldsymbol{Q* = 9}$

4. Now that we know the equilibrium quantity of fed cattle we can solve for other equilibrium values:

   (a) Equilibrium price of fed cattle: $P^D_{FC} = 25 - 2 \cdot Q*$

   $P^D_{FC} = 25 - 2 \cdot 9$

   $\boldsymbol{P^D_{FC} = \$7}$

   (b) Equilibrium price of beef: $P^D_B = 30 - 1.5 \cdot Q*$

   $P^D_B = 30 - 1.5 \cdot 9$

   $\boldsymbol{P^D_B = \$16.5}$

   (c) Equilibrium price of steak: $P_S = 20 - Q*$

   $P_S = 20 - 9$

   $\boldsymbol{P_S = \$11}$

   (d) Equilibrium price of hamburger: $P_H = 10 - 0.5 \cdot Q*$

   $P_H = 10 - 0.5 \cdot 9$

   $\boldsymbol{P_H = \$5.50}$

5.3.2 Additional problems – Deriving demand numerically

1. Now that you know the demand for fed cattle, $D_{FC} : P^D_{FC} = 25 - 2 \cdot Q^D_{FC}$, you can derive the demand for feeder cattle, as well as solve for the equilibrium price and quantity of feeder cattle.

   Suppose that "processing" of feeder cattle into fed cattle is simply feed. The supply functions for feed and feeder cattle are as follows:

   $S_{feed} : \ P_F = -25 + 3 \cdot Q$

   $S_{feeder\ cattle} : \ P_{FC} = -4 + Q$

2. Consider the market for chicken. Typically, consumers purchase chicken wings, breasts, and legs. These parts are processed in fixed proportions – each chicken yields 2 wings, 2 breasts, and 2 legs. As a poultry farmer, you are interested in determining the demand for the raw product – chicken.

   Complete the following:

   (a) Using graphs, illustrate how you would determine the demand for processed chicken.

   (b) Using the demand for processed chicken, illustrate how you would derive the demand for the raw product, chicken. Assume that the supply of processors and supply of raw chickens is known. Label the price of processed chickens, the price of raw chickens, the price of processing & marketing, and the quantity of raw chickens.

   (c) Now, consider an outbreak of avian flu, causing a decrease in the demand for processed legs, breasts, and wings. Illustrate the changes that will occur in the market for processed chickens and in the market for raw chickens.

   (d) Let's calculate the derived demand using numbers. Suppose the following:

$$
\begin{aligned}
&D_{legs}: \ P_L = 5 - 0.25Q \\
&D_{wings}: \ P_W = 10 - 0.75Q \\
&D_{breats}: \ P_B = 15 - Q \\
&S_{M\&P}: \ P_{MP} = 8 + 0.25Q \\
&S_{chicken}: \ P_C^S = -10 + 5Q
\end{aligned}
$$

      i. Calculate the demand for processed chicken.
      ii. Determine the equilibrium quantity of processing.
      iii. Solve for the demand function for raw chickens.
      iv. Determine the equilibrium price and quantity of raw chickens.
      v. Find the price of legs, wings, and breasts.

Chapter 6: Spatial Concepts in Agricultural Markets

Transportation is a crucial factor in agricultural marketing. Movement of agricultural products across geographical distances *adds value* to the product. Further, transportation costs affect trade volumes. For instance, a decrease in transportation costs will lead to more transport and trade. These spatial factors lead to the fact that location matters – placement of processing facilities is strongly influenced by transport costs.

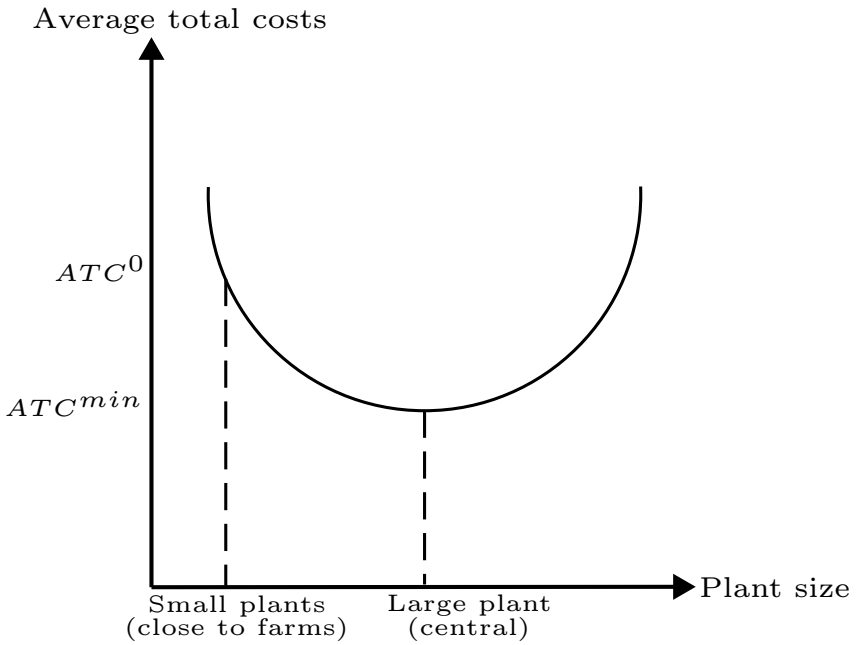
What are the factors that determine where a commodity should be processed?

- If the initial processing *reduces* weight (and transportation costs), then processing facilities are more valuable *near production sites.*
  For example, flour is lighter than wheat. Beneficial to
  process nearby.
- If processing *adds* weight (and transportation costs), then processing facilities are more valuable *near end-users.*For example, reconstituted milk is heavier than dry milk powder.

6.1 Economies of Scale

Why aren't there very many small wheat processors in Montana? The answer to this question is economies of scale. By building a larger, centralized wheat processing plant, it may be possible to significantly reduce total average costs relative to smaller, more spread out facilities (*see* Figure 6.1). *However, firms must find a balance between taking advantage of economies of scale and transport costs.* That is, as firms become more centralized, ATCs of production decrease, yet transportation costs increase, and vice versa. What models can we use to determine how to strike this balance between costs?

Figure 6.1: Average Total Costs of Processing Plants by Plant Size



6.2 The Spatial Transport Model

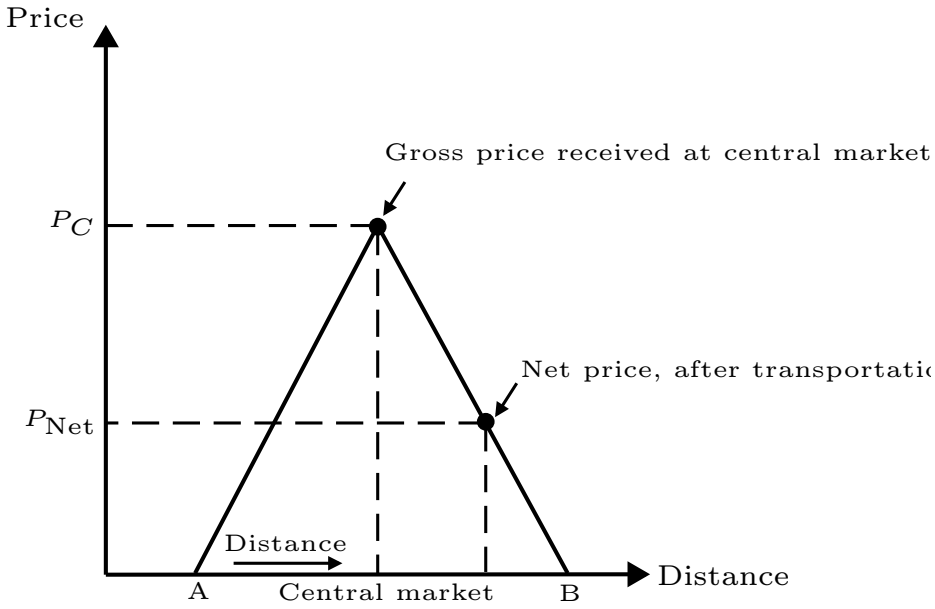
The *Spatial Transport Model* may be used to determine whether a producer should sell at a market place given given a rate of transportation costs. This model is represented graphically by the two-dimensional net price diagram in Figure 6.2.

Properties:

- Producers at a central market will receive maximum price per unit (transportation distance is zero).
- The price received per unit from any other location is: (Distance $\times$ Cost of Transport).
- Profitable region: any location that can receive a net price per unit above zero.

In Figure 6.2, suppose that a farmer at location A can sell a commodity at the central market. But, the commodity needs to transported to the central market. The price of transporting a commodity is constant, $\$c$ per mile. So, the farther away the farmer is from

Figure 6.2: Two-dimensional Net Price Diagram



the market, the more expensive it is to transport the commodity. The total transport costs are $\delta \cdot \$c$, where δ is the distance to the central market.

At the central market, a farmer can receive price P^*. So, the farmer's net price is $P_{\text{Net}} = P^* - \delta \cdot \$c$. If this net price is greater than 0, then there is an incentive for the farmer to transport the commodity to the central market. The diagonal lines indicate the net price that a farmer will receive depending on the location of the farm. Obviously, the further a farmer is from the central market, the lower the net received price.

Profitability region: this is the region on the graph between Location A and Location B. Anywhere in that region, a farmer will have incentive to transport a commodity to the central market because the net received price is above or equal to zero. Note that this analysis ignores the costs of production.

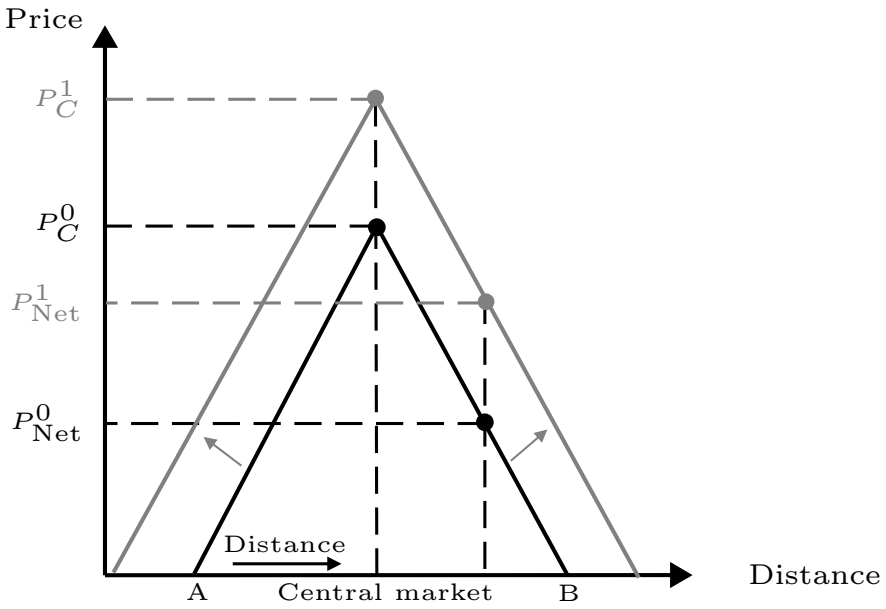
6.2.1 Scenario analysis – Spatial Transport Model

1. There is an increase in the price paid for a commodity at the central market (*see* Figure 6.3).

   Outcomes

- Producers who were already in the profitable region will now receive higher profits.
- Profitability region increases – it is now profitable for more producers, who are farther from the central market, to deliver.

Figure 6.3: Scenario Analysis Using the Two-dimensional Net Price Diagram: Increase in Price at Central Market



2. There is a decrease in the transportation costs of delivering a good to the central location (*see* Figure 6.4).

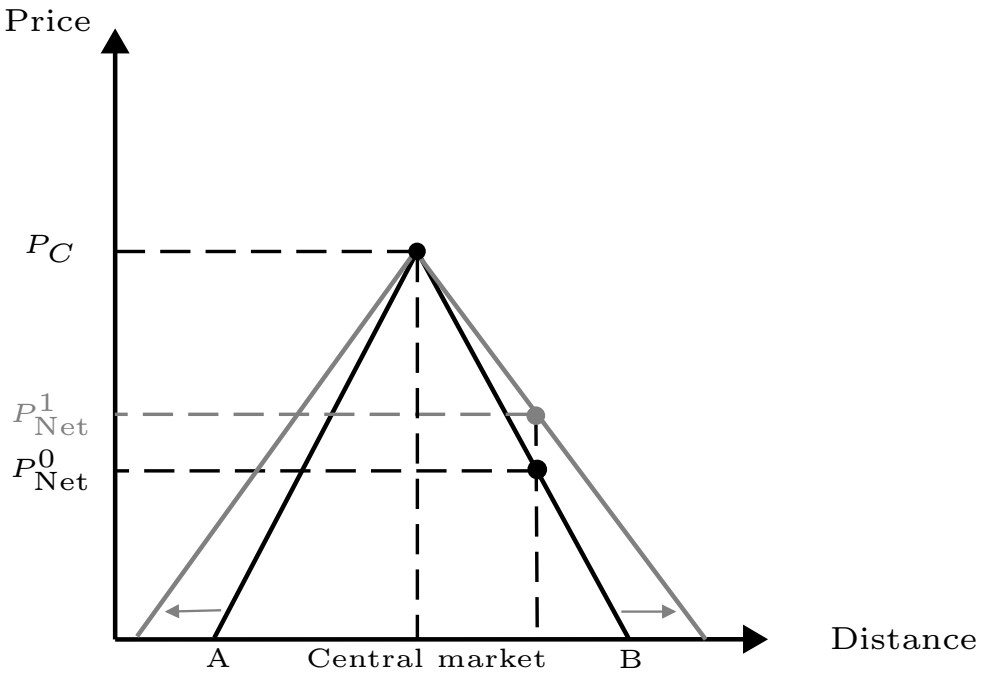
   Outcomes

   - Producers at the the central location will not be affected.
   - The slope of the *net profit* lines *expands*.
   - The profitability region expands, increasing profit for current producers and creates profit for new producers.

6.2.2 Additional problems – Spatial Transport Models

Consider that there is a new vector of delivering a good to the central location via a river. Producers that can ship downstream to the central market will have much lower

Figure 6.4: Scenario Analysis Using the Two-dimensional Net Price Diagram: Decrease in Transportation Costs



transportation costs than producers who must ship upstream. Illustrate this scenario using a one-dimensional transport model.

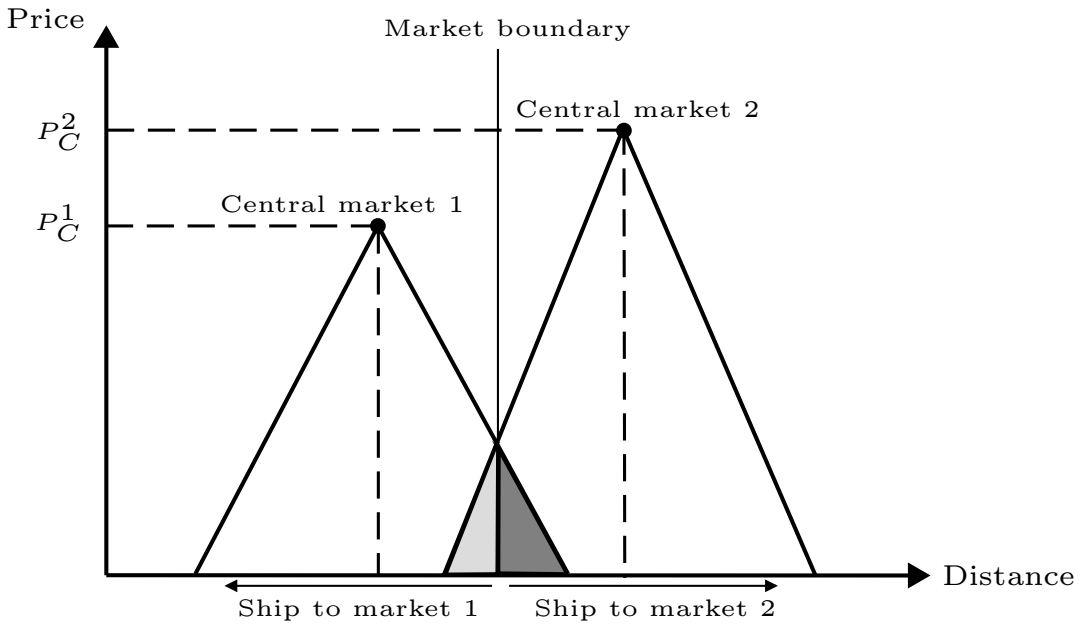
6.3 Overlapping Production Regions

What if there are two central markets where producers may deliver their goods? Which producers choose each market? This scenario is represented in Figure 6.5. When multiple central markets exists, there may be an *overlapping region* where producers in the region may profitably deliver to either market. The overlap region is divided by the *market boundary*. For producers in the overlap region, it is more profitable to deliver to the market that corresponds to their side of the market boundary.

6.3.1 Additional problems – Spatial Transport models

Suppose that one central market exists, but it is relatively small and pays a low price to producers. A new processing plant is built in nearby market, and the price that this

Figure 6.5: Two-dimensional Net Price Diagram to Illustrate Overlapping Profitability Regions



processing plant offers is substantially higher than offered in the smaller market. Suppose that the price offered in the new central market is so much higher that the profitability region overlaps the entire profitability region of the small market. What will happen to producers that delivered to the small market?

Chapter 7: Inter-regional Trade

An important aspect of agricultural production (especially for U.S. producers) is inter-regional trade. That is, moving commodities across space. To understand why and where commodities move, we need to develop a model of supply and demand that can appropriately capture relationships between regions.

Let's consider two regions in which there are production and consumption of barley. However, in region A, the resources for producing barley are low and the costs of production are high. Conversely, in region B, barley production is plentiful. Consequently, the price of barley in region A (P_A) is substantially higher than the price of barley in region B (P_B). Figure 7.1 shows a model of the two regions.

When the economy is closed (there is no trade), the prices determined in each market are known as *autarky prices*. Prices P_A^a and P_B^a are autarky prices.

Now, consider that it is possible to export from one market to another (assume that there are no transportation costs). What will be the direction of moving the commodities? That is, who will export and who will import?

To answer this question, you need to ask: In which market will it be profitable to buy a good, so that when you sell in the other market, you will make a profit?

In the scenario above, $P_B^a < P_A^a$. Thus, it is reasonable to purchase barley in market B and the resell the barley in market A for a higher price.

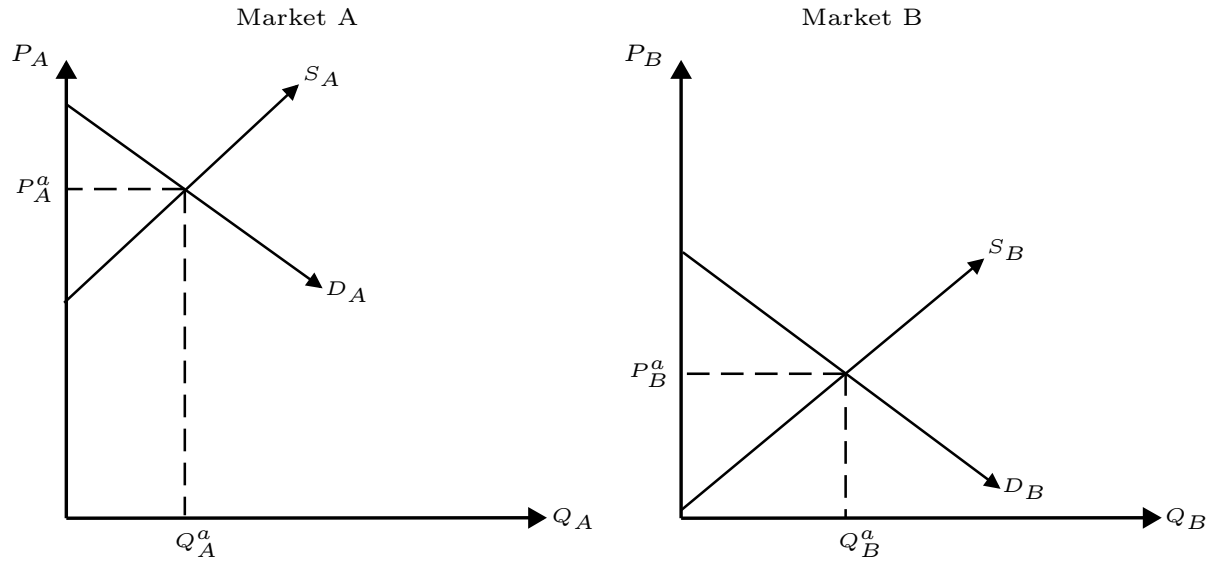
$\rightarrow$ The market in which you buy is the *exporter*.

$\leftarrow$ The market in which you sell is the *importer*.

Why does trade occur?

The opportunity to profit provides incentives for producers in regions with comparative advantage to sell to regions that are willing to pay higher prices. In other words, trade will occur if a producer can produce at a lower cost and sell in a market that will pay a higher price than the domestic market.

Figure 7.1: Two Markets with Closed Economies



7.1 Deriving the Excess Demand Curve

Properties of Excess Demand

- At autarky prices, no additional (excess) demand exists.
- When prices are *lower* than autarky prices, then:
  - Domestic producers are willing to produce less (they receive a lower price).
  - Domestic consumers want to consume more (they can buy more for a lower price).

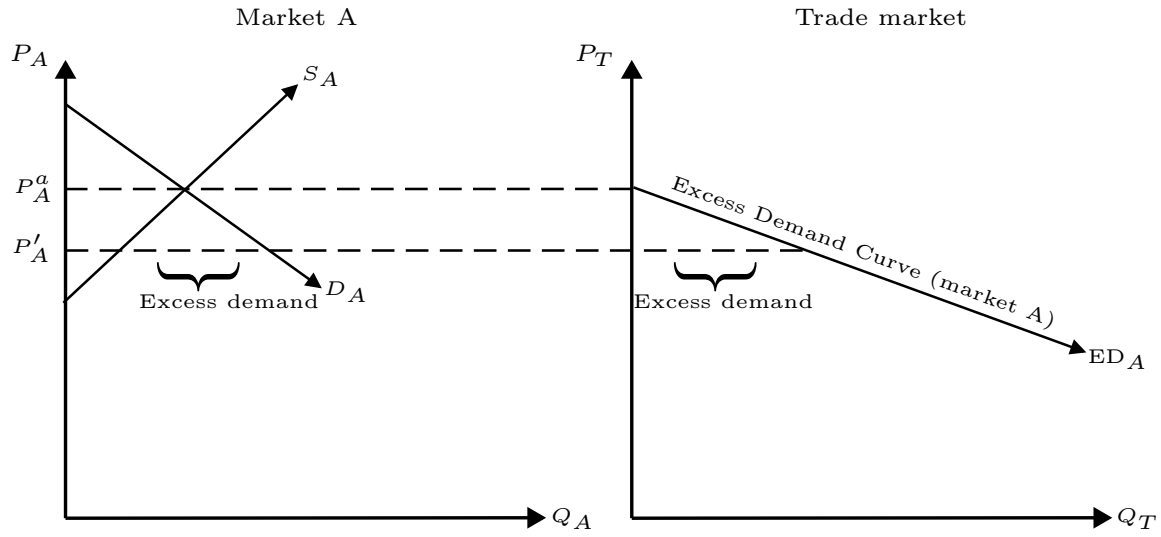
  The difference between domestic quantity demanded and domestic quantity supplied is *excess demand*.

The *excess demand* curve is derived from the horizontal difference between the consumer's quantity demanded and the producer's quantity supplied. In other words:

$$ED_A = (Q_A^c - Q_A^p)$$

The amount of excess demand is the horizontal distance between the demand and supply curves at a particular price, P'_A. At this price, the quantity that producers in the domestic market (market A) are willing to sell is Q_A^p; the quantity that consumers wish to purchase is Q_A^c.

Figure 7.2: Excess Demand in Market A, if Price is Lowered



7.2 Deriving the Excess Supply Curve

Properties of Excess Supply

- At autarky prices, no additional (excess) supply exists.
- When prices are *higher* than autarky prices, then:
  - Domestic producers are willing to produce more (they receive a higher price).
  - Domestic consumers want to consume less (they can buy less for a higher price).

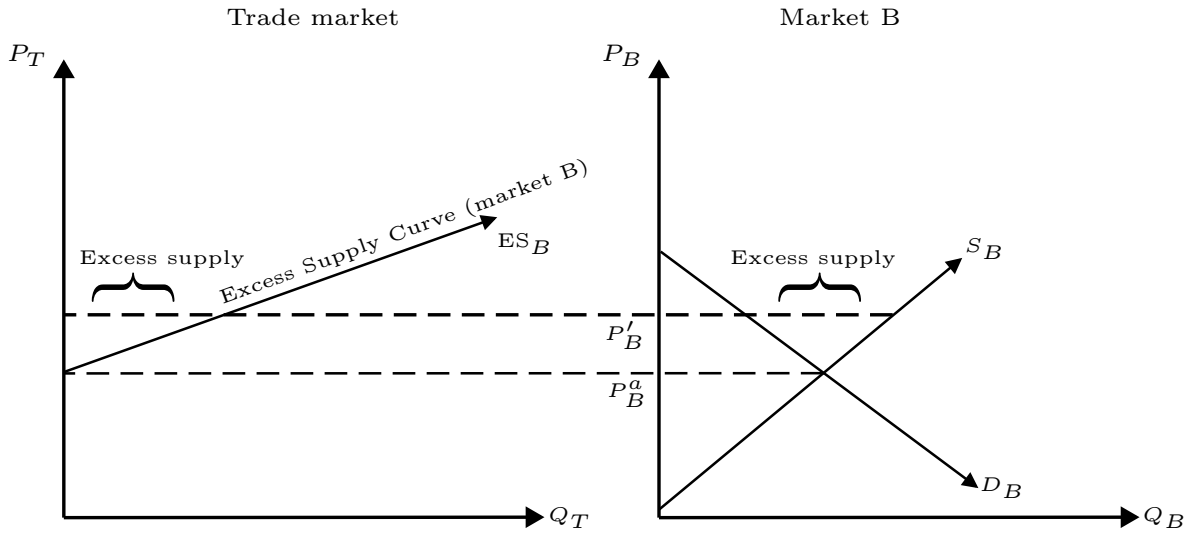
  The difference between domestic quantity supplied and domestic quantity demanded is *excess supply*.

The *excess supply* curve is derived from the horizontal difference between the producer's quantity supplied and the consumer's quantity demanded. In other words:

$$ES_B = (Q_B^p - Q_B^c)$$

The amount of excess supply is the horizontal distance between the demand and supply curves at a particular price, P'_B. At this price, the quantity that producers in the domestic market (market B) are willing to sell is Q_B^p; the quantity that consumers wish to purchase is Q_B^c.

Figure 7.3: Excess Supply in Market B, if Price is Raised



7.3 Trade

Now that we have both the excess supply and excess demand curves, we need to determine the point at which trade occurs. Once we find this point, we are able to determine the price at which trade occurs and the quantity of agricultural commodities that are traded.

Treating excess supply and excess demand curves as we typically treat supply and demand curves, we find that the equilibrium occurs where the two curves intersect.

(See next page for illustration)

- P^T is the price at which two regions trade (price received by exporters, price paid by importers).

- Q^T is the quantity that is traded (quantity that is exported is equal to the quantity that is imported).

As regions trade, there will eventually emerge a single price for a good that is paid / received in all regions.

- If the price is higher in a particular region, then producers will sell there – increasing supply and decreasing price.
- If the price is lower in a particular region, then consumers will purchases there – increasing demand and increasing price.

In global trade, the Law of One Price results in a *world price*.

Figure 7.4: Equilibrium in Market A, Market B, and the Trade Market

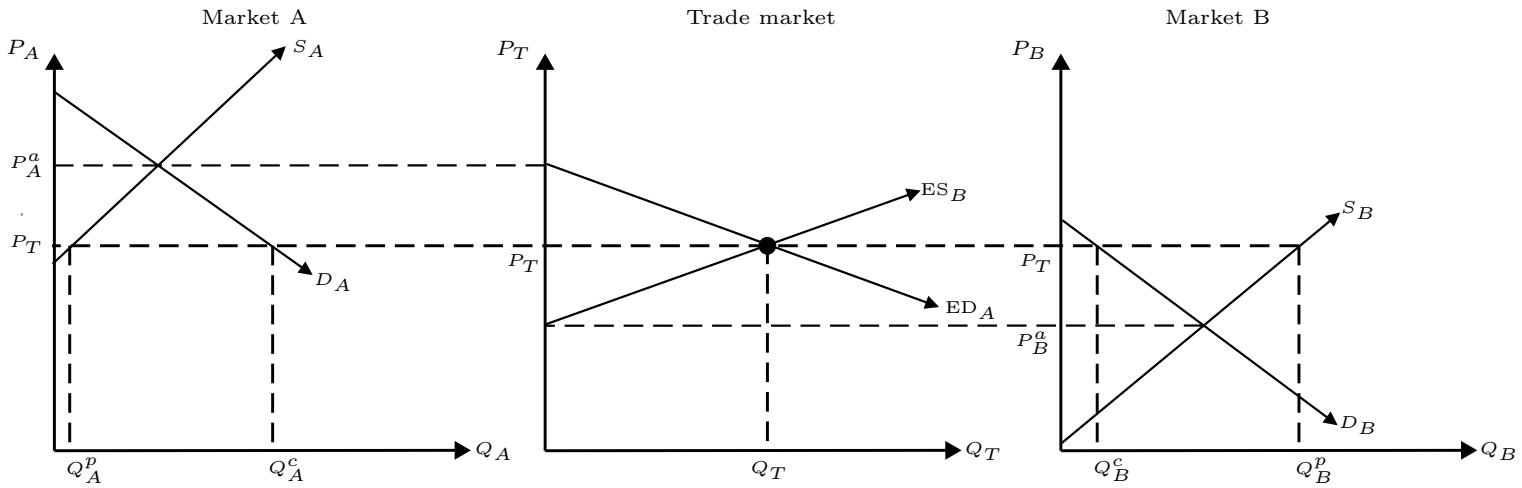
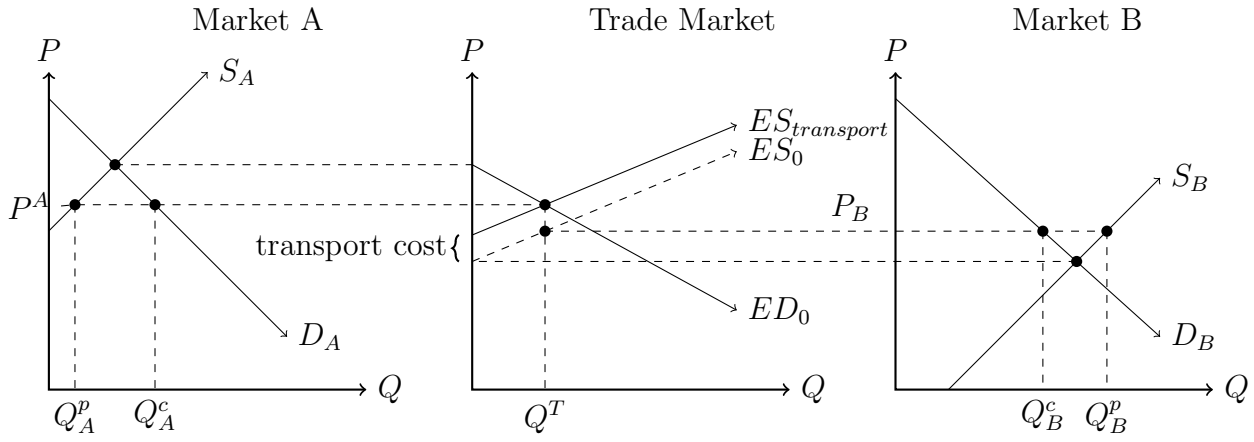


Figure 7.5: Trade with Transportation Costs



7.4 Trade with Transportation Costs

It is reasonable to assume that trade is not costless. The producer bears costs for transporting a commodity from one market to another. The effect of transportation costs is that they make it less profitable to transfer commodities across space.

Assume that the exporting producer simply adds on the cost of transporting the good onto the price that the importing consumer must pay (*see* Figure 7.5). In effect, this raises the price that the importing region must pay for the good they receive as an export. The effects of transport costs on trade, *relative to trade with free-transport*, are as follows:

- The price at which commodities are traded is higher.
- The quantity of traded commodities is lower.
- Consumers in importing market receive less of the commodity and pay a higher price.
- Producers in importing market sell more of the commodity and receive a higher price.
- Consumers in exporting market receive more of the commodity and pay a lower price.
- Producers in exporting market sell less of the commodity and receive a lower price.

When is it profitable to trade if transportation costs exist?

- Without transportation costs, it makes sense to trade if $|P_A - P_B| > 0$. In other words, when the difference in prices between two regions exceeds zero, then it would be profitable to purchase a good in one region, transfer it and sell it in another, thus making a profit.
- With transportation costs, the profitability condition is now: $|P_A - P_B| > T_{AB}$, where T_{AB} are the transport costs to transfer a commodity from region A to region B. If the difference in prices is large enough so that you can purchase a good in one region, pay the transport costs, and sell it in another region, and *still* make a profit, then trade occurs.

7.4.1 Additional problems – Illustrating changes in inter-regional trade

Illustrate the effects of the following scenarios on the trade market and the individual export and import markets using the three-diagram model:

1. An increase in production technology in the exporting market
2. A better than usual harvest in the importing market
3. An increase in fuel costs, affecting the the barge and rail transport costs

Discuss the changes in equilibrium trade price and quantity, and the changes in the prices and quantities consumed/supplied in the importing and exporting markets.

7.5 Welfare Analysis of Trade

Social Gain: total social gain is the *sum* of the producer and consumer surpluses. That is, Social Gain is the *total* gains from trade.

7.5.1 Social gains in the import market

1. Determine the consumer and producer surplus at autarky prices.
2. Once trade is allowed, the price in the import market will fall. This results in two outcomes:
   (a) The domestic producer loses some surplus because they must sell at a lower world price.
   (b) The domestic consumer gains surplus from both the domestic producer as well as trade.
3. The final outcome is that social welfare increases by the amount of consumer surplus gained from trade (*see* Figure 7.6).

7.5.2 Social Gains in the Export Market

1. Determine the consumer and producer surplus at autarky prices.
2. Once trade is allowed, the price in the export market will rise. This results in two outcomes:
   (a) The domestic consumer loses some surplus because they must incur a higher world price.
   (b) The producer gains surplus from both the domestic consumer as well as trade.
3. The final outcome is that social welfare increases by the amount of producer surplus gained from trade (*see* Figure 7.7).

Figure 7.6: Welfare Analysis in Importing Market A

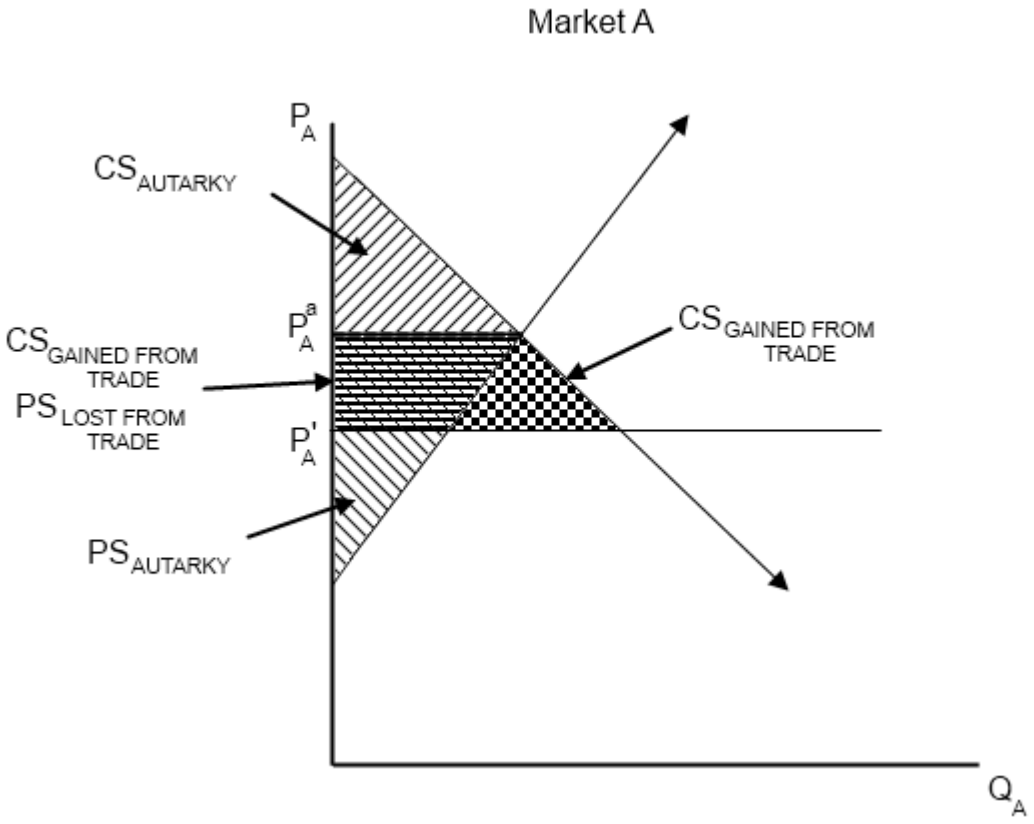
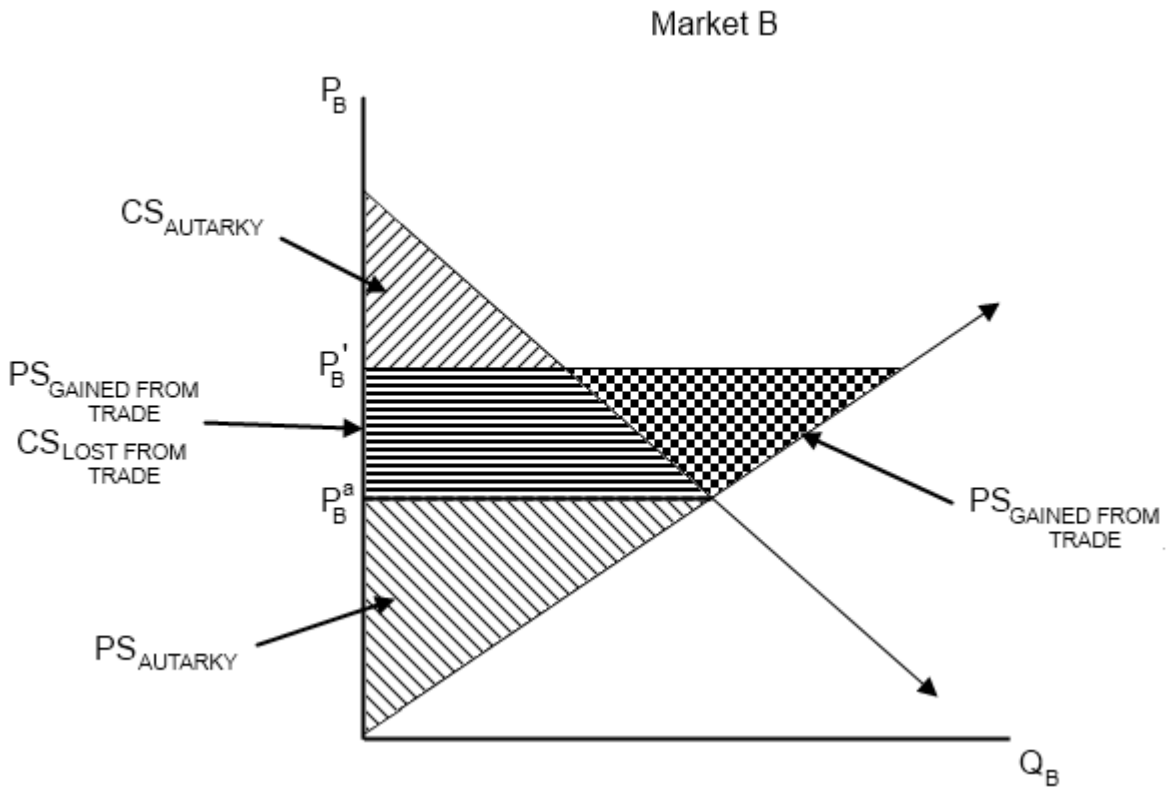
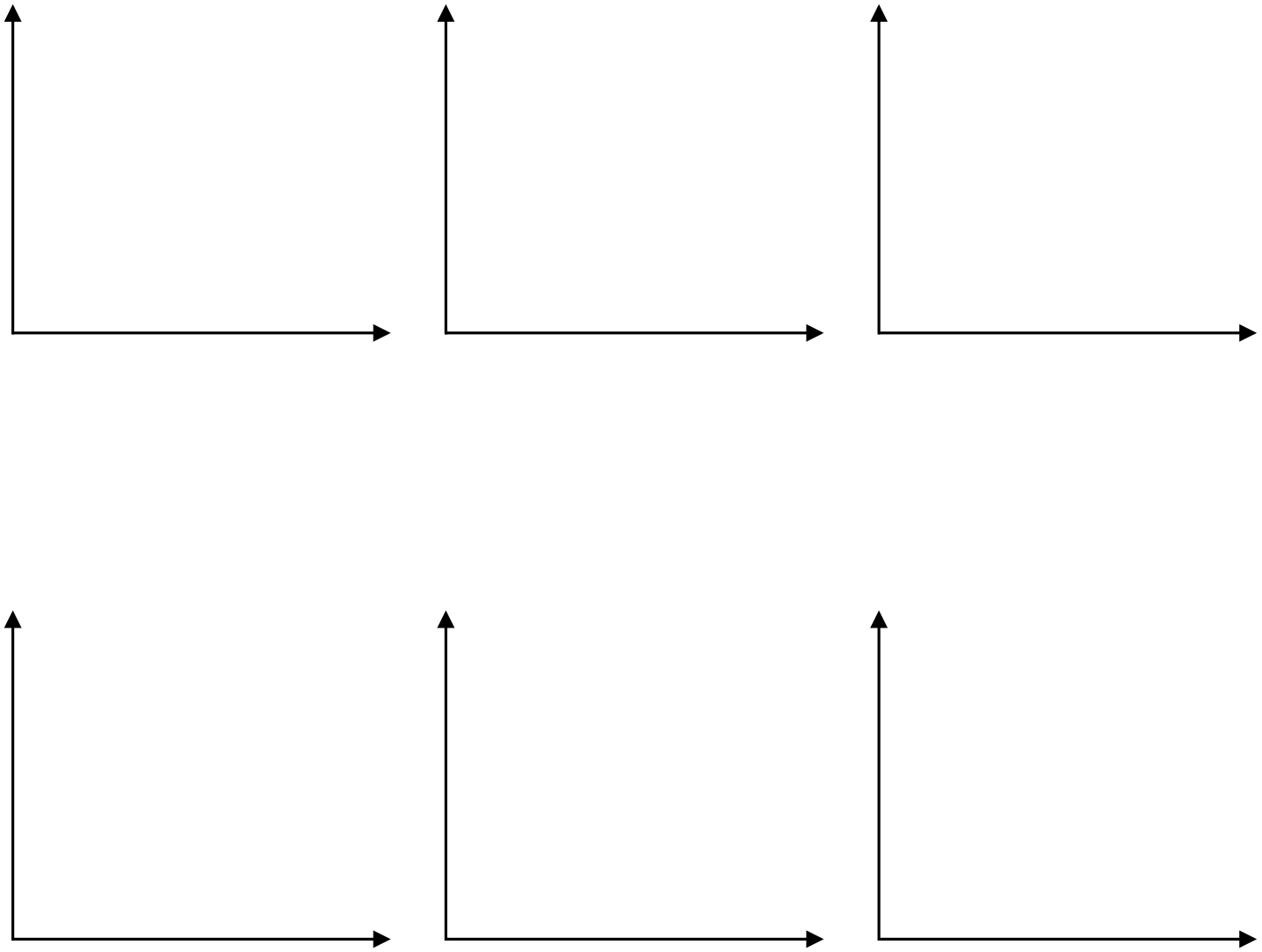


Figure 7.7: Welfare Analysis in Export Market B



Magic!!
Society gains from trade!!



Chapter 8: International Trade

International trade is an enormous part of U.S. agriculture. The U.S. is a major exporter of many commodities that are crucial the U.S. economy and the economies of other nations. For example, the U.S. is one of the largest exporters of corn, soybeans, beef, poultry, and pork. U.S. farmers depend heavily on exporting agricultural commodities to other nations, because they can receive higher prices and supply a larger quantity of the commodity. Thus, their total revenue is substantially increased with trade.

8.1 Politics of Trade

International trade is a delicate issue: there are strong proponents for free trade and against free trade. Producers and consumers are heavily invested in decisions that occur in Washington, D.C. and at the World Trade Organization (WTO).

8.1.1 Who wants free trade?

- *Consumers in importing countries* – Consumers pay lower prices for greater quantities of commodities.
- *Producers in exporting countries* – Foreign markets for agricultural commodities present greater demand for exports.
- *Governments* – Increasing the total size of the pie leads to greater tax revenues.

8.1.2 Who doesn't want free trade?

- *Consumers in exporting countries* – Consumers will be forced to pay higher prices for exported goods.
- *Producers in importing countries* – Producers face stiffer competition from imported goods and have to lower prices or shut down. Agricultural lobbies for these producers will actively resist free trade to avoid industry loss of profit and firms.
- *Politicians elected in agricultural regions* – Loss of producers in a politician's region may lead to job loss. Politicians in these regions may have a *vested interest* in resisting free trade with legislation in order to get votes (*See* vested interests *below*)

8.1.3 Stumbling blocks to trade

What might be some stumbling blocks that prevent trade from occurring?

- *Vested interests* – Actors may be said to have a vested interest when they have a financial stake in keeping agricultural products from being imported from a foreign country (i.e. the groups who don't want free trade). Consumers, producers and politicians who have vested interest in resisting free trade may form an organization to place restrictions on free trade.
- *Language and cultural barriers* – Language and cultural differences may make trading difficult or expensive. For instance, a firm that trades may require translators and experts with cultural experience to avoid offending trade partners.
- *Transportation obstacles* – Transportation obstacles may prevent trade by causing the movement of commodities too costly or risky for firms. For instance, trade with one partner may require transport through or around unfriendly territory, or pirate infested waters.
- *Different government regulations* – Differences in government regulations may require firms to employ armies of lawyers and add to the expense of trade. For instance, an importing country may require more safety checks on imported beef than an exporting country. The beef exporters may have to hire experts to understand what these restrictions are and how to implement them.
- *Exchange rates* – Exchange rates can affect the buying power a firm has in another country, and thus, harm (or benefit) trade. For instance, if the US dollar's *purchasing power* is weak once exchanged into foreign currency, then a firm may respond by instead purchasing domestically or from another country. That is, the amount of the agricultural commodity that may be purchased per exchanged U.S. Dollar is too low to justify trade for the firm.

8.1.4 Regional trade agreements (RTAs)

Regional trade agreements (RTA) are trade agreements between many countries in a specific region of the world. They specify which commodities will be traded freely within the group (i.e. without trade restrictions). Currently, there are a many RTAs around the world, along with many more bilateral free-trade agreements (FTA) for commodities on a country-by-country basis.

- RTA examples
  - NAFTA (North American Free Trade Agreement – U.S., Canada, Mexico)
  - CAFTA (Central America Free Trade Agreement – U.S., Costa Rica, Dominican Republic, El Salvador, Guatemala, Honduras, Nicaragua)
- FTA examples
  - U.S. - Australia FTA
  - U.S. - Israel FTA

Other U.S. trade agreements
(http://www.fas.usda.gov/itp/agreements.asp)

8.2 Trade Restrictions

The political process plays a large role in determine the level of freedom in trade. There are two common restrictions that many governments can use to restrict free trade:

- Tariff: a per-unit *tax* on an imported good. No quantity restrictions.
- Quotas: legal restriction on the *quantity* that can be imported.

8.2.1 Consequences of Tariffs and Quotas

- Raise prices in importing locations (who benefits? who loses?)
- Lower prices in exporting locations (who benefits? who loses?)
- Leads to a loss in total social welfare

Examples of Tariffs in the U.S. – In the United States, tariffs are placed on Argentinian honey (50% - 60%), tea (from selected locations) (6.4%) broccoli & cauliflower (2.5% - 10%), goats ($0.68/head), beef (4%), durum wheat ($0.65/kg)

Examples of Quotas in the U.S. – Quotas in the United States are placed on, among other products, peanuts, milk & dairy products, sugar, cotton imports.

8.2.2 The Winners and Losers of Tariffs and Quotas

Who likes tariffs and quotas?

- *Producers in the import-country* – A tariff or quota partially protects domestic firms from competition, allowing these firms to receive higher price.
- *Owners of quotas* – Firms that "own" quotas are allowed to export their goods. They consequently receive higher prices than if the quota did not exist.
- *Consumers in the export-country* – Foreign consumers may pay lower prices for goods that face tariffs or quotas in an importing country. Without these trade restrictions, the greater demand in the importing country would drive up the price for these export-country consumers.

Who dislikes tariffs and quotas?

- *Consumers in the import-country* – Tariffs and quotas cause import-market consumers to pay a higher price than they would under free trade.
- *Producers who don't own quotas* – Potential exporters may be unable to sell their product in an import-country because they do not own quotas. This reduces their possible profit.

8.3 Exchange Rates in International Trade

We have seen that international trade can increase social welfare. When discussing international trade, we assume that there is a simple transaction: the producer provides a commodity and the consumer pays some amount of money for the commodity. Implicitly, we also assume that there is only one currency exchanged between the consumer and the producer. Unfortunately, this simplification does not describe the real world.

To provide a more realistic description of trade, consider the following steps of a transaction:

1. *Purchase foreign currency* at the going exchange rates using local currency (money that is used in the domestic market).
2. *Purchase goods in foreign market* using the foreign currency
3. *Import the goods* to the domestic market, and sell them in exchange for local currency.

What is obvious from these steps is that consumers cannot simply use their domestic currency to purchase the commodity because (most of the time) the exporter cannot directly use another nation's currency. In addition, the burden of exchanging currency is placed on the consumer. This indicates that understanding exchanges rates and how they affect trade is a crucial aspect of international agricultural trade.

8.4 Exchange Rate Basics

Exchange rate: the ratio of the present values of two currencies.

$$XR = \frac{Currency_A}{Currency_B}$$

Another way to think about is to ask the following question:

If I have x amount of currency A, how much can I buy/receive of currency B?

8.4.1 Calculating exchange rates

To calculate an exchange rate, you take the ratio of prices of two perfect substitutes in different countries:

Using Prices of Wheat

$$XR = \frac{P_w^A}{P_w^B}$$

8.4.2 Using exchange rates

To determine the foreign price of a good with respect to local currency:

Price of Wheat in Country A

$$P_w^A = P_w^B \times XR$$

8.4.3 Examples – Calculating and using exchange rates

Using the following information, calculate the exchange rates between the two countries:

1. $P^{US}_{cell\ phone} = \$100$; $P^{China}_{cell\ phone} = 150\ yuan$ – calculate the XR.
2. $P^{US}_{chicken} = \$10/broiler$ – calculate $P^{China}_{chicken}$ using XR in (1).

1. Using the formula for the ratio of prices, we can calculate the exchange rates for both exchange directions:

$$XR_{US,China} = \frac{\$100}{150yu} = \frac{2}{3}\ \ \$/yu$$

Interpretation: for every Chinese yuan, you would receive \$0.67.

$$XR_{China,US} = \frac{150}{\$100} = 1.5\ \ yu/\$$$

Interpretation: for every U.S. dollar, you would receive 1.5 yuan.

2. Using the exchange rate in (1), we can calculate the price that we would need to receive in China in order to have the equivalent revenue as if we were to sell the chicken in the U.S. for \$10/broiler.

$$P^{Yuan}_{broiler} = (XR_{China,US}) \cdot (P^{US}_{broiler})$$

$$P^{Yuan}_{broiler} = \left\{1.5 \ \frac{yu}{\$} \cdot 10 \ \$\right\}$$

$$P^{Yuan}_{broiler} = (1.5 \cdot 10) \cdot \left\{\frac{yu}{\$} \cdot \$\right\}$$

$$P^{Yuan}_{broiler} = 15 \ yuan$$

8.4.4 Additional problems – calculating and using exchange rates

Using the following information, calculate the exchange rates between the two countries:

1. $P^{US}_{Wii} = \$200$; $P^{G.B.}_{Wii} = £125$ – calculate the XR.
2. $P^{US}_{cocoa} = \$325/ton$ – calculate $P^{G.B.}_{cocoa}$ using XR in (1).
3. $P^{US}_{beef} = \$5/lb$; $P^{czech}_{beef} = 45krona$ – calculate the XR.
4. $P^{US}_{stapler} = \$3$ – calculate $P^{czech}_{stapler}$ using XR in (3).
5. $P^{US}_{bike} = \$100$; $P^{Mexico}_{bike} = 325peso$ – calculate the XR.
6. $P^{US}_{hog} = \$50/cwt$ – calculate P^{Mexico}_{hog} using XR in (5).

8.5 Trade with Exchange Rates

Suppose that a Chinese importer wishes to purchase and import U.S. wheat. We know the following:

$$P^{US}_{wheat} = \$5.50/bu$$

$$XR_{China,US} = 6.50 \ \frac{yuan}{\$}$$

What are the steps that the importer must take to bring 1,000 bushels of wheat into China?

1. Determine how much they must pay for wheat in U.S. dollars: $1,000/bu \times \$5.50/bu = \$5,500$
2. Exchange local yuan for U.S. dollars: $\$5,500 \times 6.50 \ \frac{yu}{\$} = 35,750 \ yu$
3. Purchase the wheat in the U.S. and deliver it to China.

8.5.1 Arbitrage Conditions

Arbitrage is the simultaneous purchase and sale of an asset in order to profit from a difference in the price. For instance, suppose that the local Chinese price for wheat is 30 yuan/bu, while the domestic U.S. price for wheat is \$5.50/bu. *Is there opportunity to profit?* It depends on the exchange rate.

1. Determine whether the difference in price per bushel is solely due to the exchange rate:
   - Price per U.S. wheat bushel in yuan: $\$5.50/bu \times 6.50 \ \frac{yu}{\$} = 35.75 \ yu/bu$
   - Price per Chinese wheat bushel in yuan: $30 \ yu/bu$
2. Exchange U.S. dollars to purchase a bushel of wheat in China: $30yu \times \frac{1}{6.50 \frac{yu}{\$}} = \$4.61$
3. Sell the wheat in the U.S. for \$5.50/bu.

Profit: (\$5.50/bu - \$4.61/bu) = \$0.89/bu

This sounds like a great deal! Although, do you think these conditions are sustainable in the long run? Consider what will happen:

1. U.S. importers will flood the Chinese market attempting to purchase wheat.
2. The increase demand for Chinese wheat will cause the price of wheat in China to rise.
3. The price will rise until it reaches 35.75 yu/bu, which is exactly the price of wheat in the U.S. (after accounting for the exchange rate conversion).

When the price per bushel has risen in China, we have reached a point where Arbitrage Condition 1 holds.

Arbitrage Condition 1

No arbitrage occurs when: $P^A_{good} = P^B_{good} \times XR$

If this condition does not hold, then profit maximizing individuals will continue to exploit the non-equilibrium exchange rates until convergence of the XR occurs such that Arbitrage Condition 1 holds.

Also, when Arbitrage Condition 1 hold, it is said that the exchange rate correctly reflects *Purchasing power parity (PPP)*. PPP is an economic theory suggesting that the exchange rates between two different currencies will be equal to the ratio of prices for any good. That is, the currency's purchasing power is not affected by it's denomination and country of use.

8.5.2 Arbitrage Condition 2

The second arbitrage condition is grounded in the fact that trade is more complex than a unidirectional flow of goods. Typically, countries produce commodities for which they have a comparative advantage, and exchange for goods for which other countries have a comparative advantage.

- U.S. is the world's leader in soybean production.

- China produces electronics, such as cell phones, with small costs.

- Opportunity for trade: U.S. exports soybeans to China and imports cell phones from China.

The first arbitrage condition states that: $P^A_{good} = P^B_{good} \times XR$

We can apply this to a two good scenario to determine the second arbitrage condition:

$$P^{US}_{soybeans} = P^{China}_{soybeans} \times XR_{US,China}$$

$$P^{US}_{phones} = P^{China}_{phones} \times XR_{US,China}$$

Solving for $XR_{US,China}$ in each of the equations and setting them equal to other yields:

$$\frac{P^{US}_{soybeans}}{P^{China}_{soybeans}} = \frac{P^{US}_{phones}}{P^{China}_{phones}}$$

We can divide both sides by P^{US}_{phones} and multiply both sides by $P^{China}_{soybeans}$ to retrieve the second arbitrage condition.

Arbitrage Condition 2

$$\frac{P^{US}_{soybeans}}{P^{US}_{phones}} = \frac{P^{China}_{soybeans}}{P^{China}_{phones}}$$

No arbitrage occurs when the ratio of exchange of any two goods is the same in *both* participating countries. This is known as *purchasing power parity.*

8.5.3 Example – purchasing power parity

Suppose:

$$P^{US}_{soybeans} = \$9.00/bu \qquad P^{US}_{phones} = \$100/phone$$

$$P^{China}_{soybeans} = 60.00\ yu/bu \qquad P^{China}_{phones} = 600\ yu/phone$$

1. Will arbitrage occur?
2. If the relationship between U.S. and Chinese soybean prices represents the correct exchange rate, what is the arbitrage opportunity in the cell phone market?

1. Using Arbitrage Condition 2, we know that arbitrage will not occur if:

$$\frac{P^{US}_{soybeans}}{P^{US}_{phones}} = \frac{P^{China}_{soybeans}}{P^{China}_{phones}}$$

   Thus, we have to check if:

$$\frac{\$9.00/bu\ soybeans}{\$100/phone} \ ?=? \ \frac{60\ yu/bu\ soybeans}{600\ yu/phone}$$

$$0.09 \neq 0.1$$

   This indicates that Arbitrage Condition 2 does not hold, suggesting that arbitrage will occur.

2. To determine the profit opportunity from selling cell phones, we first need to calculate the true exchange rate using arbitrage condition 1 and the ratio of soybean prices.

$$XR_{US,China} = \frac{P^{US}_{soybeans}}{P^{China}_{soybeans}} = \frac{\$9.00}{60\ yu} = \mathbf{0.15\ \$/yu}$$

   Now, let's determine how much U.S. dollars are necessary to purchase a Chinese cell phone:

$$P^{US}_{phone} = P^{China}_{phone} \times XR_{US,China}$$

$$P^{US}_{phone} = (600\ yuan/phone) \cdot (0.15\ \$/yuan)$$

$$P^{US}_{phone} = (600 \cdot 0.15) \cdot \left(\frac{yuan}{phone} \cdot \frac{\$}{yuan}\right)$$

$$P^{US}_{phone} = 90\ \$/phone$$

So, cell phones can be purchased in China for \$90/phone. This means that if cell phones are sold in the U.S. for \$100, there is a \$10/phone profit opportunity.

8.5.4 Additional problems – purchasing power parity

1. Suppose:

$$P^{US}_{soybeans} = \$6.00/bu \qquad P^{US}_{phones} = \$200/phone$$

$$P^{China}_{soybeans} = 50.00\ yu/bu \qquad P^{China}_{phones} = 1000\ yu/phone$$

   (a) Will arbitrage occur?

   (b) If the relationship between U.S. and Chinese *phone* prices represents the correct exchange rate, what is the arbitrage opportunity in the soybean market? In other words, where should you buy soybeans, where should you resell soybeans, and how much profit can you earn per bushel?

2. Suppose a wheat storage operator in Montana has the ability to buy wheat in either the U.S. or Canada. The current exchange rate between U.S. and Canada is 0.95 $\frac{USD}{CAD}$.

   - In the U.S., the storage operator can purchase wheat at \$6.00/bu.
   - In Canada, the storage operator can purchase wheat at 6.75 CAD/bu.

   (a) Is there opportunity for arbitrage for buying wheat in Canada and reselling in the U.S., or vice versa?

   (b) If there is this opportunity, how much per bushel gain is there from arbitrage?

   (c) What will happen in the long-run?

8.6 Modeling Trade with Exchange Rates (XRs)

Changes in the exchange rate can have substantial impacts on the equilibrium values of trade. Understanding how to appropriately model international trade that accommodates exchange rates can help us better grasp changes that occur in agricultural markets if exchange rates fluctuate.

8.6.1 Definitions

Currency appreciates (exchange rate *increases*): the event during which it becomes more expensive to purchase the particular currency.

Example: If the yuan appreciates relative to the dollar, then it will require more dollars to purchase one yuan ($\uparrow XR_{\$,yu}$ and $\downarrow XR_{yu,\$}$).

Currency depreciates (exchange rate *decreases*): the event during which it becomes cheaper to purchase the particular currency.

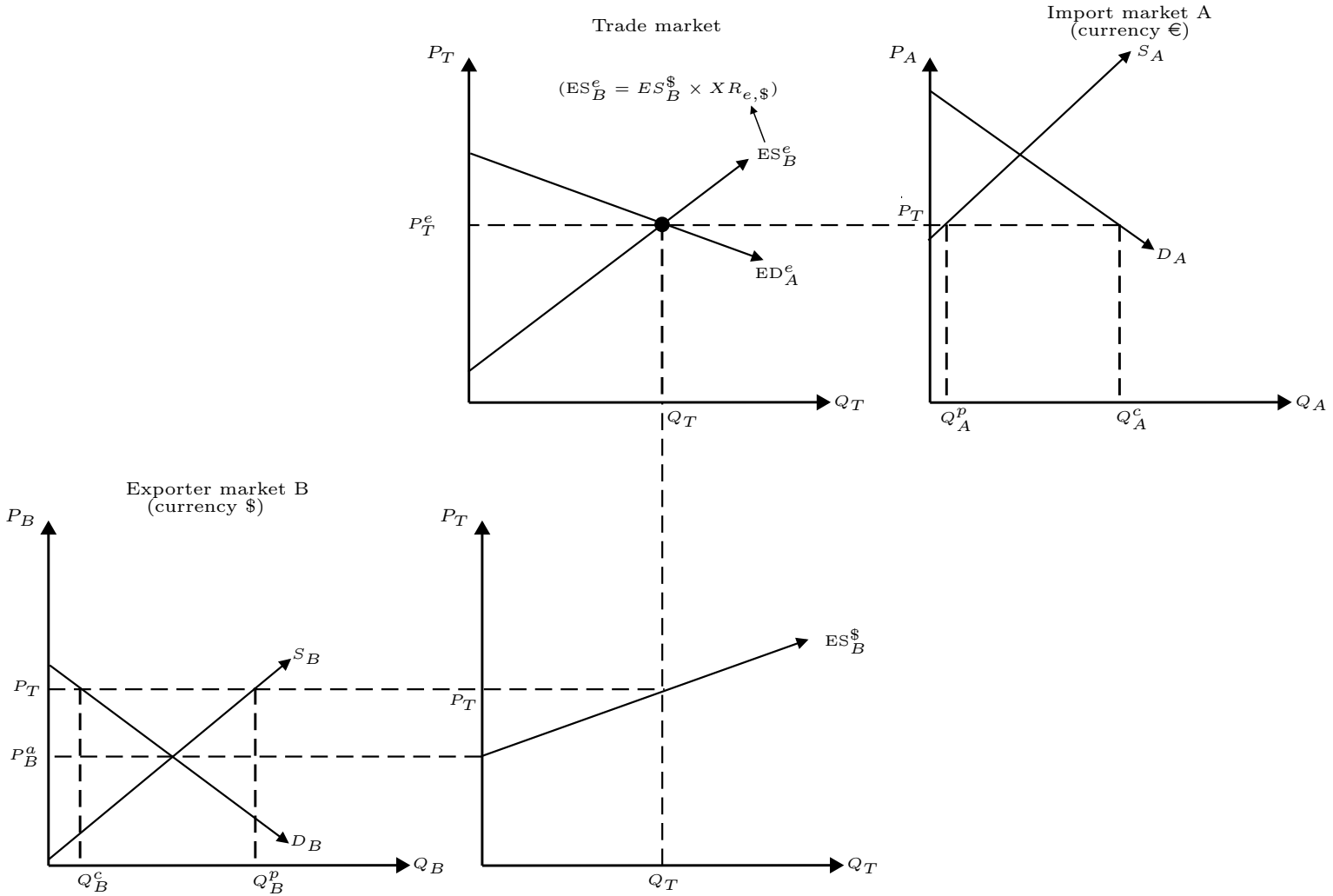
Example: If the yuan depreciates relative to the dollar, then it will require less dollars to purchase one yuan ($\downarrow XR_{\$,yu}$ and $\uparrow XR_{yu,\$}$).

8.6.2 Graphing trade with XRs

To properly model trade with exchange rates using supply and demand diagrams, it is necessary to use a four-panel approach. That is, we need to explicitly account for the excess supply (or excess demand) curves being altered because of the exchange rate.

In Figure 8.1, you can see that the slope of the excess supply is made more steep by the exchange rate. After converting the ES curve into the currency of the importer, we can appropriately plot the trade market and determine the equilibrium price and quantity of traded commodities. Then, we can project the quantity traded onto the un-adjusted excess supply curve, and determine the price received by exporters using domestic currency.

Figure 8.1: Model of Trade Between Markets with Different Currencies



8.6.3 Scenario analysis using trade with XR models

1. Model a change in exchange rates on B's exports. What if the dollar ($) appreciates?

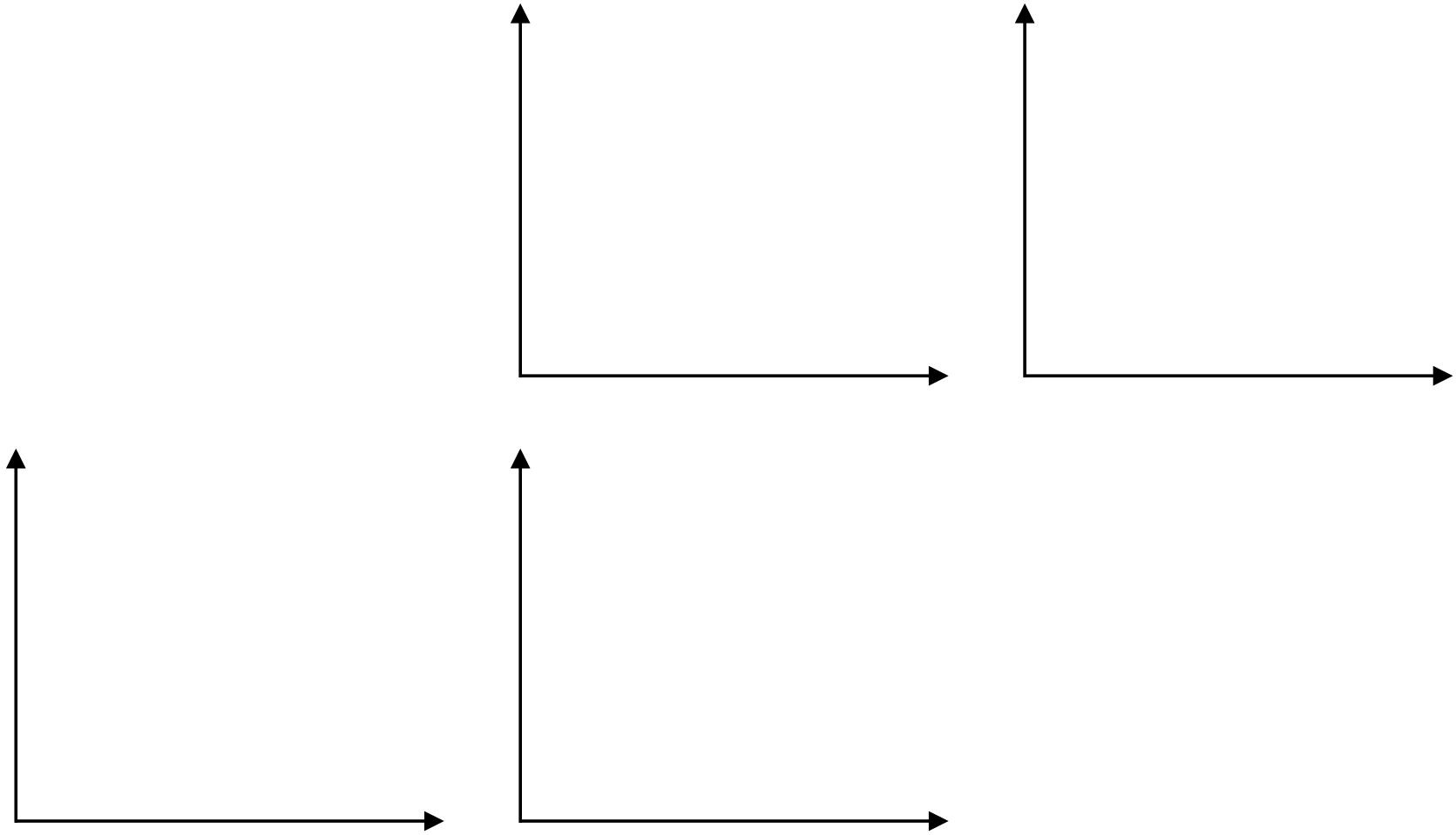
   Thinking logically:

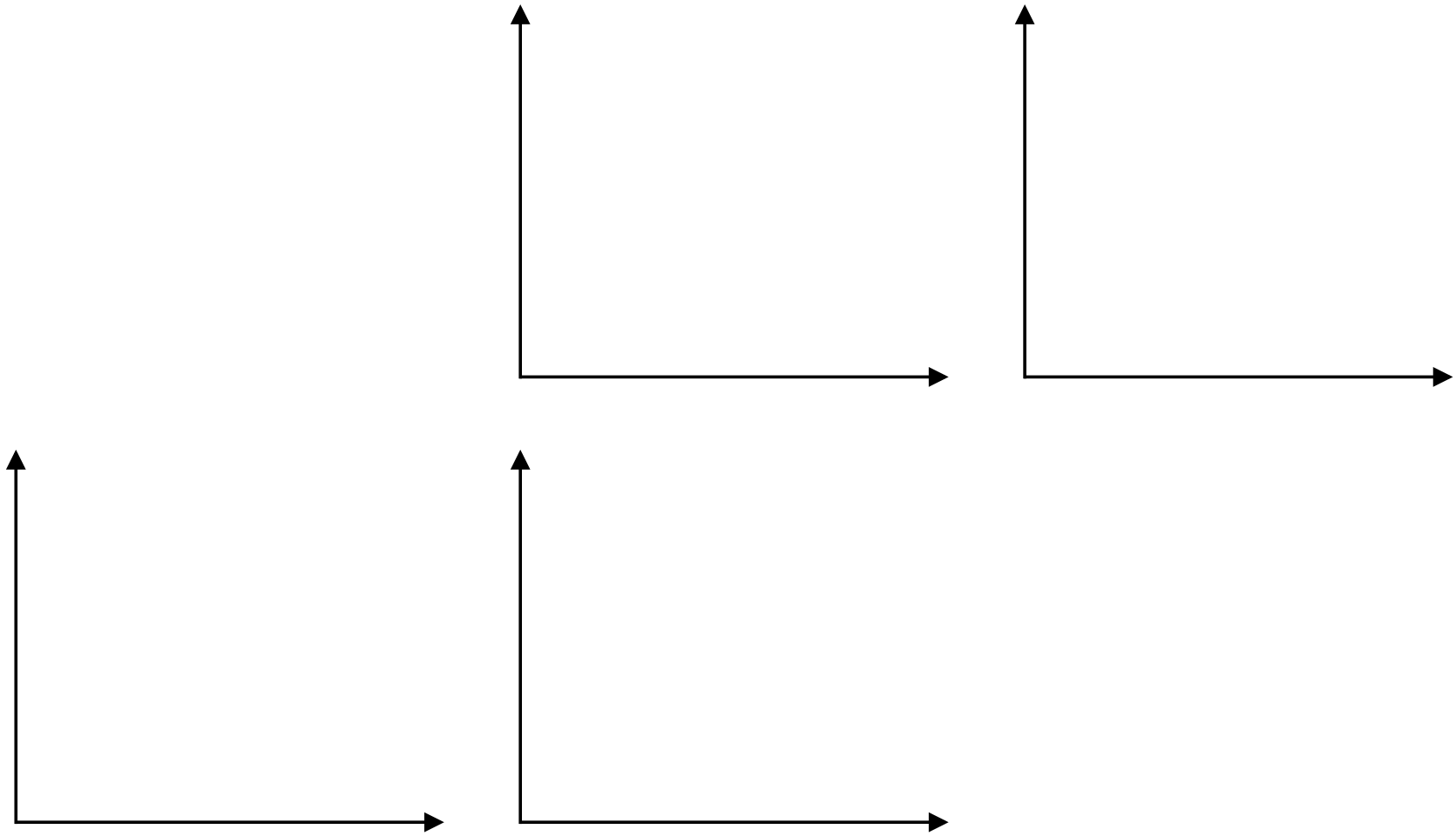
   - An appreciation of the dollar implies that A faces *higher* prices. (Why?)
   - The slope of the U.S. excess supply curve (converted into yuan) is now *steeper* – a higher $XR_{yu,\$}$ (lower $XR_{\$,yu}$) implies that the slope increases.
   - The rotation of B's excess supply curve implies a drop in the quantity of A's excess demand, a lower quantity traded, higher prices paid by consumers in A, and lower prices received by exporters in B.

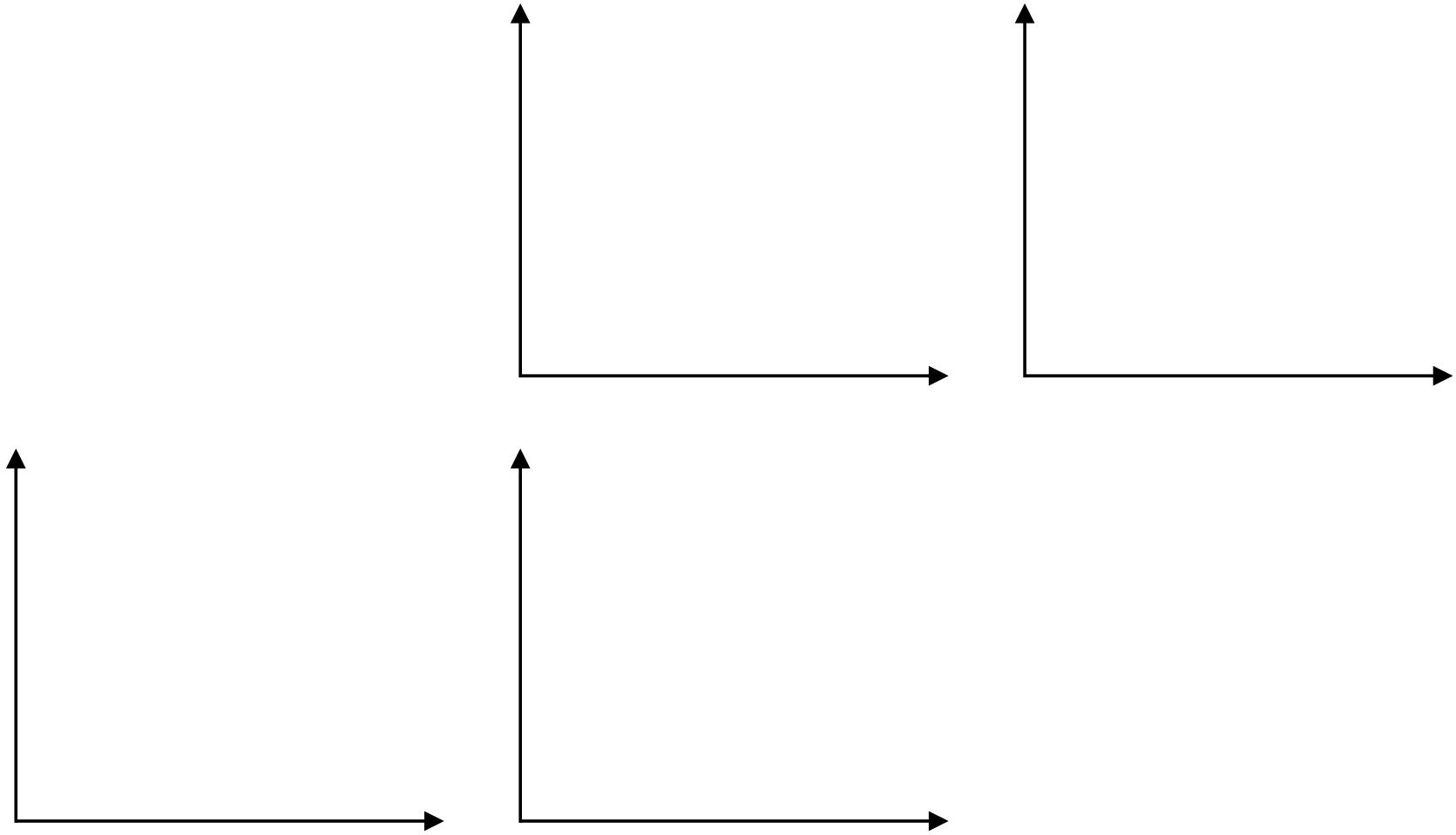
2. Model an improvement in productivity in the importing nation.

   Thinking logically:

   - An improvement in productivity implies an outward shift of the supply curve in A. This reduces prices and shifts the ED curve downward.
   - The downward shift of the ED curve results in lower quantity and price at which commodities are traded.
   - A lower quantity results in producers in the exporting nation B to receive lower prices for their exports.
   - Because prices for exports are now lower, consumers in B can now consume more of the commodity at lower prices.







Chapter 9: Introduction to Agricultural Futures Markets

Futures markets for commodities have been an important method for agricultural producers to hedge revenue risk, which can be very high. Not only do agricultural producers face the fluctuations of demands for their goods, but they also face significant risks of events that can substantially affect their output. Both of these can affect commodity prices. Futures markets allow producers to "lock in" a sale price far in advance of actually selling the commodity. In this way, futures markets can be used to remove the risk of fluctuating and unknown sale prices.

Futures markets provide a venue for trade of *futures contracts*. A futures contract is a legally binding promise to conduct a future transaction at a specified price and quantity between a seller and a buyer. A futures contract specifies the following:

- An obligation of the seller to deliver a commodity to a specified point-of-delivery at a future time
- An obligation of the buyer to pay a fixed price and pick up the commodity at the pre-specified point-of-delivery
- An expiration date (time of delivery)
- Standard measured amounts of the commodity to be traded

For any traded commodity, all contracts are perfect substitutes for each other (except for price).

9.0.4 Commodity futures markets – contract price information

Information regarding current and previous futures contract prices may be found at the following addresses:

- Chicago Board of Trade (CBOT)
  http://www.cmegroup.com/trading/commodities/
- Minneapolis Grain Exchange (dark northern spring wheat)
  http://www.mgex.com/
- Kansas City Board of Trade (KCBT) (hard red winter wheat)
  http://www.kcbt.com/
- Wall Street Journal - Market Data
  http://online.wsj.com/mdc/public/page/marketsdata.html

These can be found on the class website under the "Futures Markets" heading.

9.1 A Brief History of Agricultural Futures Markets

A futures market is a designated location used to assist agribusiness and farmers in discovering prospective prices for a commodity. Agricultural markets first appeared in the mid 1800's. The Chicago Board of Trade (CBOT) was opened in 1848 and the Chicago Mercantile Exchange (CME) opened in 1874 (formally known as Chicago Egg and Butter Board). The first corn futures contract was written in 1851.

Why did futures markets come about?: As the U.S. expanded, transportation distances increased. This led to higher price volatility due to the uncertainty and costs of transportation. Futures markets created a much needed source of information regarding future prices as well as encouraged standardized trading rules and measures.

9.2 Introduction to Futures Contracts

Futures contracts provide a very structured and standardized method for buyers and sellers to determine the terms of an exchange. Each futures contract is exactly the same *except* for the price of exchange established by the buyer and seller. The following describe the standardizations for various types of futures contracts:

- Measures
  - 5,000 bushels wheat, corn, soybeans, etc.
  - 40,000 lbs. live cattle.
  - 50,000 lbs. feeder cattle.
- Quality
  - *Wheat*: #2 Soft Red Winter Wheat (SRW) @ the CBOT; #2 Hard Red Winter Wheat (HRW) @ the KCBT; #2 Hard Red Spring Wheat (HRS) @ Minneapolis Grain Exchange
  - *Live cattle*: 55% Choice, 45% Select, Yield Grade 3 live steers
  - *Feeder cattle*: 650-849 pound steers, medium-large #1
- Delivery location
- Contract end date
  - *Wheat*:15th day in the contract month.
  - *live cattle*: Last day of the contract month
  - *feeder cattle*: Last Thursday of the contract month
- Pricing units
  - Cents per bushel (tick: 0.25 cents)
  - Cents per pound (tick: 0.00025 cents per pound)

9.2.1 Purchasing a futures contract

Every contract requires two parties – a buyer and a seller.

- Seller: a party that promises to deliver the designated quantity of a commodity. In exchange, they will receive a fixed price.
  - Selling a contract is known as taking a *short position*. If delivery date comes and the seller can't deliver, they are *short* of the commodity.
- Buyer: a party that promises to take delivery of a specified quantity of commodity. In exchange, they will pay a fixed price.
  - Buying a contract is known as taking a *long position*.
    If delivery date comes and the buyer has a commodity they may not want (or too much of it), they are *long* in the commodity.

9.2.2 Offsetting contracts

Typically, only relatively few contracts have sellers and buyers who can actually deliver or take on a commodity. Instead of delivering or taking on a commodity, a party can offset a short or long position by purchasing an opposite contract.

- Short position → offset by buying a contract (long position).
- Long position → offset by selling a contract (short position).

By offsetting a futures contract with another opposite-position futures contract, an individual is released of the responsibility to either buy or sell the physical commodity. The only obligation that the individual is required to meet is any difference the price of the two contracts. For example, if one contract was bought at \$5.00/bu and another was sold at \$4.50/bu, the individual would be responsible to pay \$0.50/bu (more on this later).

9.3 Mechanics of a Futures Market

The day-to-day operations of a futures market are described below:

1. *Hours of Operation* – Times vary, but usually markets are open between 9 a.m. and 2 p.m. Hours may depend on the markets use of open outcry (i.e. verbal and hand signal bids and offers) to make trades versus electronic exchange.
2. *Trades* – Buying and selling occurs simultaneously. **But**: Each contract must have exactly one buyer and one seller.
3. *Two Types of Participants:*
   (a) Exchange members – Members are allowed to buy and sell in the market. Members have *margin accounts* for payment or receipt of adjustments to contract values. There is more on this below.
   (b) Nonmembers – Only able to participate in the market either through members or through a broker.
4. *Clearinghouse* – The clearinghouse overlooks positions and obligations. It has two primary tasks: notifying buyers and sellers of contract obligations and matching open positions (i.e. matching buyers with sellers).

9.3.1 Margin Requirements

Futures contracts are a *promise* to pay a fixed price at some future time. However, buying or selling a contract is not free. Any time a transaction takes place, a *margin requirement* is necessary. A margin requirement is an amount of money required as a payment in order to purchase or sell a contract.

- Typically, 5% - 20% of a contract's value.
- Provides assurance of ultimate contract fulfillment and collateral in case of fraud
- Provides coverage for potential losses when price fluctuations occur

Margin requirements may differ for speculators versus those that actually have the commodity. At daily market closing, all participants are marked-to-market (more on this later).

9.4 Example of Futures Market Participation

Consider the following scenario: The current date (t_0) is November 1. A July SRW wheat futures contract is \$5.50/bu. However, You believe that the *actual* price in July will be \$4.00/bu.

9.4.1 Deciding what position to take

Knowing the information that you know, which position should you take?

Short Position – sell a contract
Long Position – buy a contract

Properties of Market Positions:

- A *short position* benefits when the price *drops*:

  Suppose you take a short position by selling a contract at \$5.00/bu. This implies that at the delivery date, you have agreed to sell 5,000 bushels of a commodity at \$5.00/bu. If in July the price of the commodity drops to \$4.00/bu, you can buy that commodity at \$4.00/bu and sell it at \$5.00/bu because that is the price at which you established the original futures contract. Thus, a drop in price benefits you if you have a short position.

  Conversely, if you took a short position and the price rises, then you are worse off. You lose money because you now have to buy a commodity at a higher price than you will receive by selling at the established contract price.

- A *long position* benefits when the price *rises*:

  Suppose you take a long position by buying a contract at \$5.00/bu. This implies that at the delivery date, you have agreed to buy 5,000 bushels of a commodity at \$5.00/bu. If in July the price of the commodity rises to \$6.00/bu, you can buy the commodity at \$5.00/bu using your futures contract, and then sell at \$6.00/bu. Thus, a rise in price benefits you if you have a long position.

  Conversely, if you took a long position and the price drops, then you are worse off. Because you now have to sell a commodity at a lower price than at which you have agreed to purchase the commodity, you lose money.

So, the best strategy is to take a short position because you believe that seven months (July) the price per bushel will be *lower* than it is today. Thus, you are counting on the fact that you will be able to buy the commodity at \$4.00/bu in July, and then sell at \$5.50/bu using your futures contract.

9.4.2 Entering the market

Now that you have decided which contract is likely to be the most profitable, you need to enter the futures market. Suppose you want to sell ten (10) July contracts (i.e., agree to deliver 50,000 bushels in July). To do so, you would take the following steps:

1. Call a broker or exchange member and inform them of your intentions.
2. Pay a commission fee – typically 1 cent per bushel ($\$0.01 \cdot 50,000 = \$500$)
3. Put up a margin deposit – 10%
   Margin deposit: $10\% \times 10 \times 5,000 \times \$5.50 = \$27,500$

So, the total funds needed to sell 10 contracts in November: **$28,000**.

9.4.3 Actions at delivery time

After seven months, you are near the delivery time in July. At this point, you have two options:

1. Deliver on the contract
   Find someone who is selling wheat, purchase the wheat and deliver the wheat to the delivery location.
2. Take a long position on an off-setting contract by buying a July contract at the going price.

Suppose that you don't actually have the wheat, so you are required to choose option 2. In July, you discover that a better than usual harvest leads to excess supply of wheat and a drop in the price of wheat. This is reflected in the price of the July futures contracts being offered in July at $4.00/bu. This outcome is exactly what you had anticipated!

You purchase (take an off-setting long position) July contract at $4.00/bu and realize the following profit:

$$(\$5.50 - \$4.00) \times 10 \times 5,000 = \mathbf{\$75,000}$$

9.4.4 Additional problems – Market participation

Consider the following scenarios:

1. You believe that the price of corn will rise in September to \$4.50/bu. It is currently July and the price of futures contracts is \$4.25.
2. The USDA comes out with a report that the soybean harvest in September will be well below expectations. Using an EDM calculation, you find that prices will change by 25%. One soybean contract is 5,000 bushels and the current price is \$8.00/bu.
3. From a friend working in the U.S. Senate, you found out that there is a policy in the works that will place a tax on feedlot operators. This policy will go into effect in December. You know that this policy will change the price of fed cattle by \$10. A fed cattle contract is 40,000 pounds, and the price in June is \$1.00/lb.

For each scenario, do the following:

- Decide which position you should take given that you know the information.
- Decide how much you will profit per unit (bushel or pound).
- Decide how many contracts you should buy/sell in order to profit by at least \$20,000.

9.5 Market Risks - Price Variability

In the example above, you predicted exactly what would happen to the price of corn in July. Unfortunately, doing so on a regular basis (or even once) can be extremely difficult because prices are established by thousands of people acting to maximize their own welfare. Thus, prices are subject to many unexpected fluctuations.

Suppose that instead of prices dropping to \$4.00/bu, prices actually rose to \$6.50/bu. As mentioned above, if you took a short position and the price rose, you will lose money. In this example, your loss would be:

$$(\$5.50 - \$6.50) \times 10 \times 5,000 = \mathbf{-\$50,000}$$

So, small, unpredictable price movements can make a substantial difference in whether you lose or win and by how much.

9.6 Market Risks – Placed Out of the Market

When entering the futures market, you are required to pay a margin requirement – usually 5% – 20% of the futures contract value. The margin account provides assurance that there exists a line of credit that can be used to finance changes in the value of the futures contract. The margin account is recalculated at the end of each trading day to accurately reflect price changes.

What if price changes?

Each day, the probability is high that the closing price for a particular futures contract will be different than the opening price. How do the losses and profits get paid?

Marking-to-market: The process of determining the financial positions of all market participants after the market closes. All remaining futures contracts are recalculated to reflect the closing price.

9.6.1 Example – Marking-to-market

Let's consider an example of typical futures market day-to-day operations:

Day 1

You sell (take a short position) a July futures contract for 100,000 bushels of wheat at \$3.50/bu. You pay 10% into the margin account: \$35,000.

Day 2

July wheat futures prices fall to \$3.40/bu. Since you are short, a decrease in price implies that you profit by \$0.10/bu. In other words, your futures contract is now worth
(\$0.10/bu $\times$ 100,000) = \$10,000 more.

So, \$10,000 is deposited into your margin account at the end of Day 2. However, this implies that your contract has been *marked to market* – it is now a contract that would require you to sell at \$3.40/bu, not \$3.50/bu.

Day 3

July wheat futures prices rise to \$3.45/bu. Since you are short, an increase in prices implies that you lose
by \$0.05/bu. In other words, your futures contract is now worth
(\$0.05/bu $\times$ 100,000) = \$5,000 less.

So, \$5,000 is taken out of your margin account at the end of Day 3. However, this implies that your contract has been *marked to market* – it is now a contract that would require you to sell at \$3.45/bu, not \$3.40/bu.

9.6.2 Price paths matter

Suppose that in December you sell a July wheat contract at \$3.50/bu. Through extrasensory abilities, you know that the actual wheat price in July will be \$3.00/bu. This implies that you should profit by \$0.50/bu!

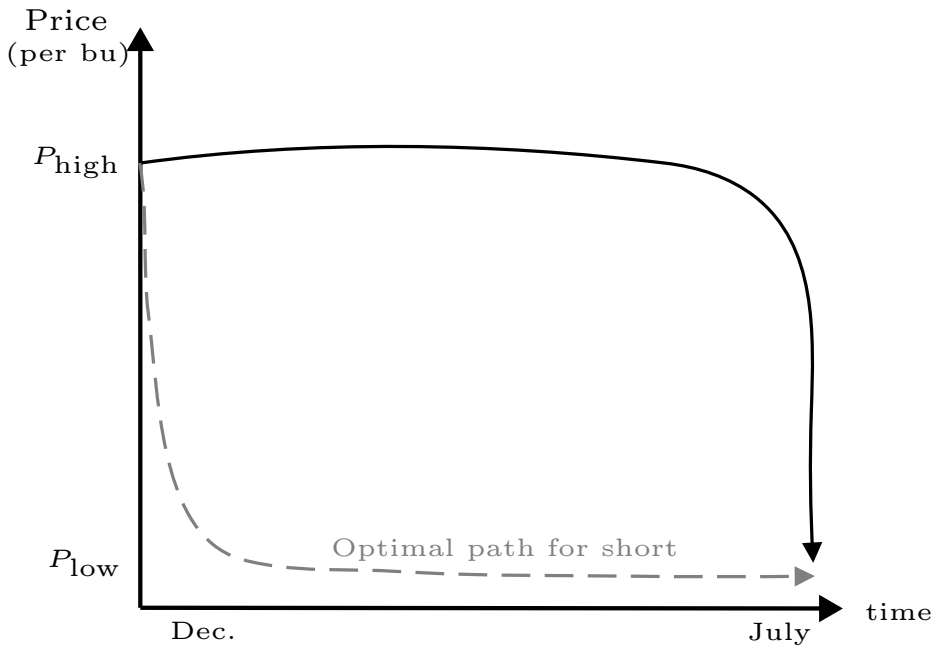
But: A lot will depend on what path the prices will take between December and July.

Two scenarios

- Prices will drop to \$3.00/bu immediately → money is placed in your margin account → price stays at \$3.00/bu until the contract expiration in July. (This is the desired path for a short position)

- Prices remain at \$3.50/bu until early July → prices drop to \$3.00/bu near the expiration date → money is placed into your margin account.

Figure 9.1: Possible Futures Price Paths Over Time

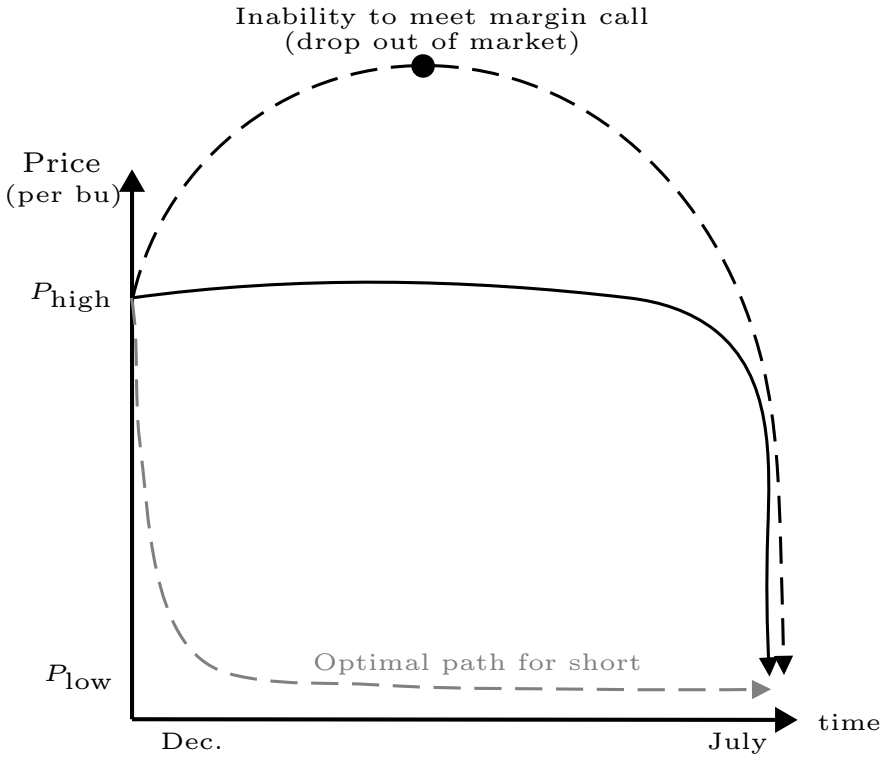


What if the following happens?

Short position in Dec. on a 100,000 bushel July wheat contract.

	Open Price	**Close Price**	**Margin account**
Day 1	\$3.50	\$3.55	- \$5,000
Day 2	\$3.55	\$3.65	- \$10,000
Day 3	\$3.65	\$4.05	- \$40,000
Day 4	\$4.05	\$4.20	- \$15,000
Day 5	\$4.20	\$4.50	- \$30,000
.			
.			
.			
Day 26	\$3.45	\$3.20	\$25,000
Day 27	\$3.20	\$3.05	\$15,000
Day 28	\$3.05	\$3.00	\$5,000

Figure 9.2: Futures Price Path That Can Force a Short Position Out of Market



Liquidity for farmers is extremely important – if farmers are unable to pay into the margin, then they are forced out of the market and are unable to use futures to hedge risk.

Chapter 10: Hedging Risk Using Futures Markets

Markets can be very risky. So why use them?

For many agricultural producers, futures markets can be important tools for reducing risk. Futures markets can be used to reduce risk through the process is known as hedging: taking the opposite positions in a commodity futures market as a producer would take in a *local market* in order to guarantee a certain profit.

10.1 Local vs. Futures Markets

In the basic example of participating in futures markets, we assumed that the participant was a *speculator*. Typically, speculators do not have the actual commodity and participate in futures markets for one reason: profit.

When we discuss the use of futures markets as a hedging tool, we are typically talking about agricultural producers who are either involved in producing the commodity (e.g., growing wheat; raising cattle) or purchasing the commodity (e.g., grain elevators; feedlot operators). For these producers, there are two markets in which participation can occur:

- Local market (e.g., Billings, Great Falls)
- Futures market (e.g., MGEX, KCBT, CBOT)

There is an important distinction between these markets:

• *Local Market* – used primarily to sell or buy the physical commodity. Most farmers deliver their commodities to the local market and *sell at the price offered in that local market*. For agricultural producers, it is the fluctuation of prices in the local market that are source of risk.

• *Futures Market* – used to hedge the risk that can exist due to the fluctuation of prices in local markets. Typically used to offset the position that the agricultural producer has in the local market.

The price that you observe in a local market is the price at which an agricultural producer can sell a commodity. The price observed in a futures market is the price at which the "market" expects the commodity to be sold at the time that the futures contract expires. Typically, the local price and the futures contract price are *not the same*.

One exception to this is at the expiration date of a futures contract. We will assume that *at delivery time* (i.e., the date that a futures contract expires), the price of a commodity in the local market and the futures market is exactly the same.

10.1.1 Positions in the local market

When you want to figure out what position you are in your local market, ask yourself this question: If the price in the local market drops, do I benefit or do I lose?

- If you *own* (or are producing) the commodity, then a drop in price is *not* beneficial, because you will not be able to sell it for as much as you could before the price drop. So, if you don't benefit when the local market price drops, then you are naturally long. Conversely, you benefit if price rises.
- If you *consume* the commodity, then a drop in price *is* beneficial, because you will be able to purchase it for a lesser price and reduce your costs. So, if you do benefit when the local market price drops, then you are naturally short. Conversely, you lose if price rises.

10.2 Hedging Local Market Price Risk

Suppose that in November, an operator of a grain storage facility buys 100,000 bushels of wheat from a farmer at $4.00/bu. You now own the wheat and will sell it to processors at the local market price in July. You worry that by the time July comes around, the price of wheat might drop below $4.00/bu, meaning that you will lose money. How do you hedge this price risk?

Well, if there is a July wheat futures contract that has a price above $4.00/bu, you can lock in a profit!

Because you own the commodity and wish to sell it at the highest price possible, you *do not* benefit if the price drops. So, you are naturally long. To hedge the risk of a price drop, you will need to take an off-setting short position (short hedge) in the futures market.

Remember that if you are a short position in the futures market, every drop in the price of the commodity is a gain for you. So, if the price drops in the local market, it will also drop in the futures market. Thus, even though you lose in the local market, you exactly offset those losses by gaining in the futures market. Let's see how this works.

10.2.1 Offsetting price risk

Suppose that the price of a July wheat futures contract in November is $4.50/bu. To hedge the risk of price drops, the operator sells (goes short) 20 July contracts at $4.50/bu. In July, the operator will sell the wheat on the local market at the July price and buy back (goes long) the 20 contracts at the July futures contract price.

Let's analyze the operator's equity under various July price scenarios. Here are a few tips on calculating revenues in the local and futures markets:

- Local market – the per unit *equity* is the difference between the price at which a commodity was sold on the local market and the cost.

$$Equity_{local} = Local\ Cash\ Price - Cost$$

- Futures market – the per unit equity calculation depends on which position was taken in the futures market:

- *Short position* – the difference between the price at which a futures contract was sold and the price at the time that the futures contract was offset.

  For example, if a July futures contract was sold in November, it has a price of F_{July}^{Nov}. An offsetting July contract was bought in July and has a price of F_{July}^{July}.

  The per unit equity is: $(F_{July}^{Nov} - F_{July}^{July})$

- *Long position* – the difference between the price at which a futures contract was offset and the price at which a contract was bought.

  For example, if a July futures contract was bought in November, it has a price of F_{July}^{Nov}. An offsetting July contract was sold in July and has a price of F_{July}^{July}.

  The per unit equity is: $(F_{July}^{July} - F_{July}^{Nov})$

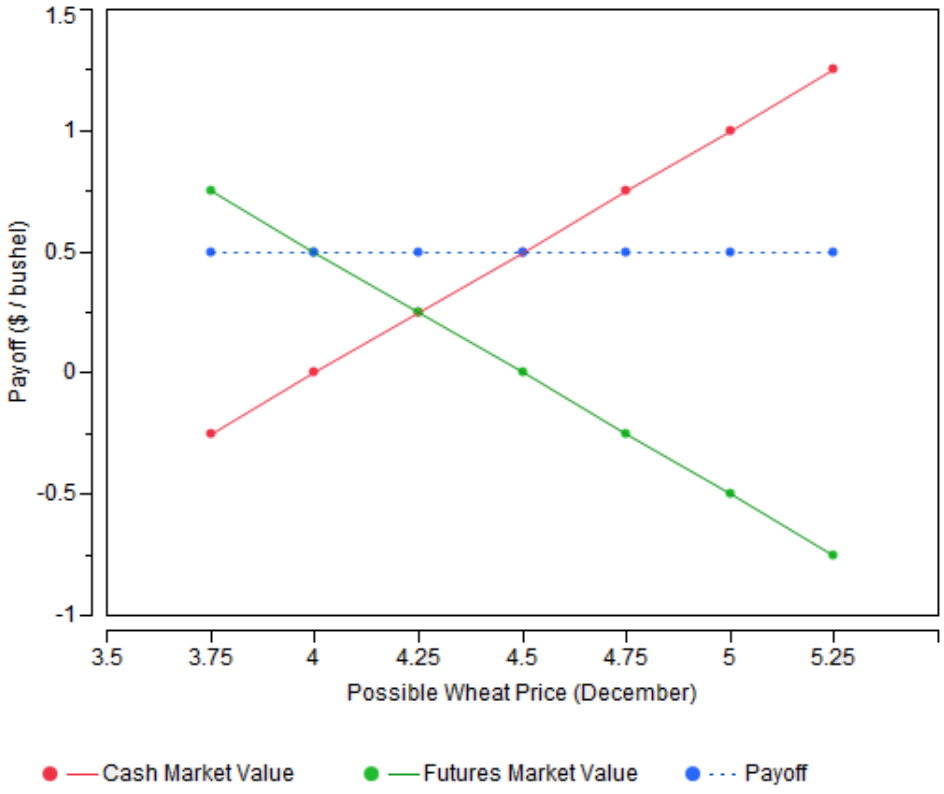
Consider that there are five possible prices in July: \$4.00, \$4.25, \$4.50, \$4.75, \$5.00 (each price is per bushel). A way to analyze possible outcomes from hedging is to set up a table as follows:

Price in July	\$4.00/bu	\$4.25/bu	\$4.50/bu	\$4.75/bu	\$5.00/bu
Local Equity $(P - Cost)$	(\$4.00 - \$4.00) 0	(\$4.25 - \$4.00) \$0.25	(\$4.50 - \$4.00) \$0.50	(\$4.75 - \$4.00) \$0.75	(\$5.00 - \$4.00) \$1.00
Short Futures Position $(F_{July}^{Nov} - F_{July}^{July})$	(\$4.50 - \$4.00) \$0.50	(\$4.50 - \$4.25) \$0.25	(\$4.50 - \$4.50) \$0.00	(\$4.50 - \$4.75) -\$0.25	(\$4.50 - \$5.00) -\$0.50
Total per Unit	\$0.50	\$0.50	\$0.50	\$0.50	\$0.50

You can see that in each case, the operator gets a \$0.50/bu payoff. This is regardless of the price fluctuating in the local and futures markets. Thus, by hedging the local price risk with a futures contract, the operator guarantees a positive net equity.

An illustration of this is presented below. The red line indicates what happens to equity if the price of wheat rises. The green line indicates what happens to equity when the price of the futures contract rises. The blue line indicates the equity when futures contracts are used to offset local markets – your equity is constant. Risk is minimized!

Figure 10.1: Returns to Hedged and Unhedged Market Strategies



10.2.2 Additional problems – Futures market hedging

Consider the following scenarios and analyze your per unit equity:

1. Assume that you are employed by the Grains Galore Exporting Company (GGEC), and you have just negotiated to sell 10 million bushels of corn to India at a price of $4.25/bu. However, the delivery will not occur until September, six months from now. You will sell the grain to a transporter at a local port at the September local market price.

   How can you guarantee a profit for GGEC if the September corn futures contract is currently trading at $4.00/bu? Describe how you can use the futures market, your position in the futures market, and the number of contracts you would need to sell or buy. In September, describe how you would fulfill your obligations in the futures market and those regarding your negotiated deal with India. What would be your per unit equity? How much will you earn in total?

2. You are feedlot operator. You will need to purchase feeder cattle in June and you will do so on the local market at the going price. Suppose you know that you can sell the fed cattle at \$1.50/lb, but you want to offset any price risks. To do so, you use the futures market. Answer the following:

   (a) What position are you in the local market?

   (b) What position should you take in the futures market to offset the price risk?

   (c) Suppose the current futures contract price for feeder cattle is \$1.25/lb. Construct a table that illustrates your per pound equity if the June contract price is one of the following: \$1.05/lb., \$1.15/lb., \$1.25/lb., \$1.35/lb., \$1.50/lb.

Chapter 11: Basis

In analyzing how to hedge price risk, we assumed that at the time that a futures contract expires, the price in the local and futures markets is exactly the same. This is known as *perfect convergence* of prices.

In reality, perfect convergence is rare, because there are always factors that can contribute to differences between local and futures contract prices. Some of these factors include:

- Locational differentials.
- Delivery point locations.
- Storage costs.
- Unforced load out provisions.
- Speculators in the market.

We need to analyze how imperfect price convergence affects an agricultural producer's ability to hedge risk. To do so, we introduce the concept of basis.

11.1 Introduction to Basis

Basis is the uninsurable changes in price that may prevent creating a perfect risk hedge using a futures market.

$$Basis = Local\ Cash\ Price - Nearby\ Contract\ Price$$
$$B = P - F$$

Basis can be used to determine several important pieces of information that are useful to agricultural producers:

- *Forecasting Local Prices* – The expected value of commodity price, P_{t+1}, in the month $t+1$ is the price of the $t+1$ futures contract plus the historical basis.[1]

$$\mathrm{E}\left[P_{t+1}\right] = F_{t+1} + (Historical\ Basis)$$

- *Forecasting Expected Equity per Unit* – The expected value of the equity

$$\mathrm{E}\left[Equity\right] = \mathrm{E}\left[B_2\right] - B_1$$

Where B_i is the basis in time $i = 1, 2$. In addition, basis can be used to determine whether it is profitable to store a commodity or sell it today. In other words, is it profitable to store until some future selling date, or is it profitable to sell at the current local price?

Market price for storage

$$Market\ price\ for\ storage = Futures\ Price_{month} - Local\ Price$$

Expected local price in a particular month

$$\mathrm{E}\left[Local\ Price\right]_{month} = Futures\ Price_{month} + \mathrm{E}\left[Basis\right]_{month}$$

Profitable to store

$$\mathrm{E}\left[Local\ Price\right]_{month} - Current\ Local\ Price > Market\ price\ for\ storage$$

Profitable to sell

$$\mathrm{E}\left[Local\ Price\right]_{month} - Current\ Local\ Price \leq Market\ price\ for\ storage$$

[1] The expected value function, $\mathrm{E}\left[(\cdot)\right]$, is the sum of all possible values of $(\cdot)$, each multiplied by the probability of the value occurring. The most common expected value metric is the average of a set of numbers, in this case, prices (P_{t+1}).

11.1.1 Properties of basis

Many locations in the U.S. do not have the climate to produce or capacity to store commodities for the entire year. This implies that basis has a large seasonality component:

- Periods when **positive** basis are observed imply that the location is a **net importer**.

  Local prices exceed futures prices → higher value is placed on commodities that are imported.

- Periods when **negative** basis are observed imply that the location is a **net exporter**.

  Local prices are lower than futures prices → higher value is placed on the commodities elsewhere.

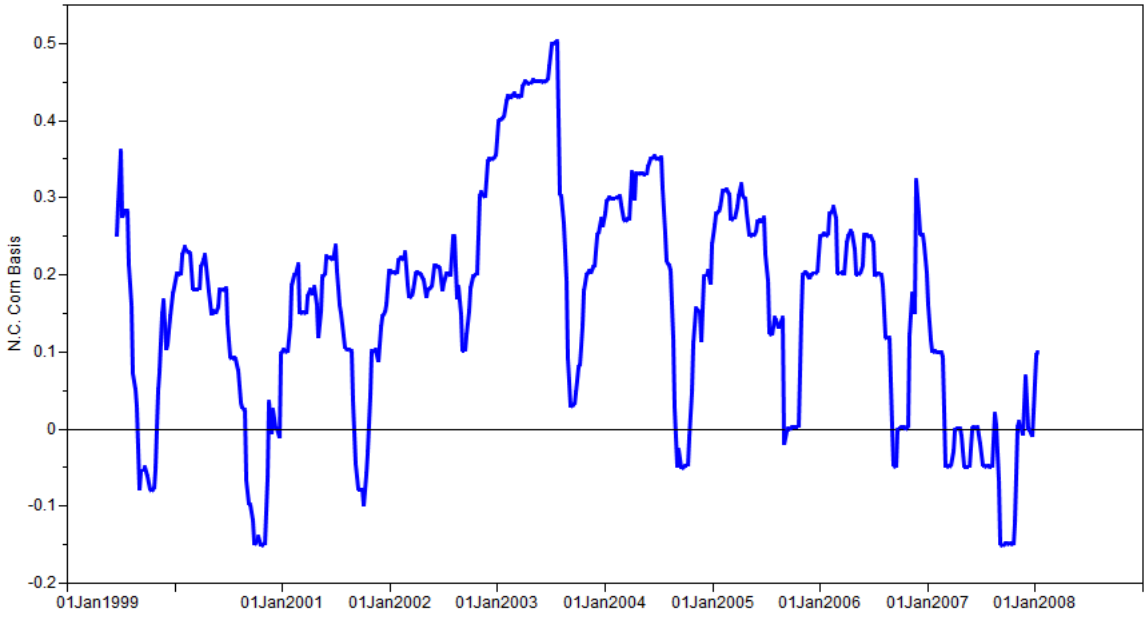


Figure: North Carolina Corn Basis, 1999-2008

As the figure above indicates, North Carolina was a net importer of corn between 2002 and 2004, while the state was a net exporter of corn between 2007 and 2008.

11.2 Example of Hedging with Basis

Typically, basis incorporates transaction costs that have to do with transporting a commodity from a contractual delivery location to the final destination. For example, suppose that you are an operator of a milling company in St. Louis, MO. The grain that you purchase on the local market is SRW wheat, which is sold on the CBOT, and barged from Toledo, OH at a price of \$0.50/bu. To calculate the price you will pay for the wheat in July, simply add the July futures price to the basis that encorporates transportation costs:

$$Spot\ Price = CBOT\ July\ Futures\ Price + Basis$$

$$(P_{july} = F + B)$$

Where, the spot price is the that which you will pay at the point of purchase in St. Louis. If the July contract price of wheat is \$5.00/bu, then you can guarantee paying \$5.50/bu for the wheat in July by establishing a long contract for wheat in July.

11.2.1 What happens in July?

The futures price in July rose to \$5.30/bu.

Local cash market

You pay: $\$5.30 + \$0.50 = \$5.80$/bu

Futures market

Long hedge: $Equity = \$5.30 - \$5.00 = \$0.30$/bu

Total Paid for Wheat

$\$5.80 - \$0.30 = \$5.50$/bu

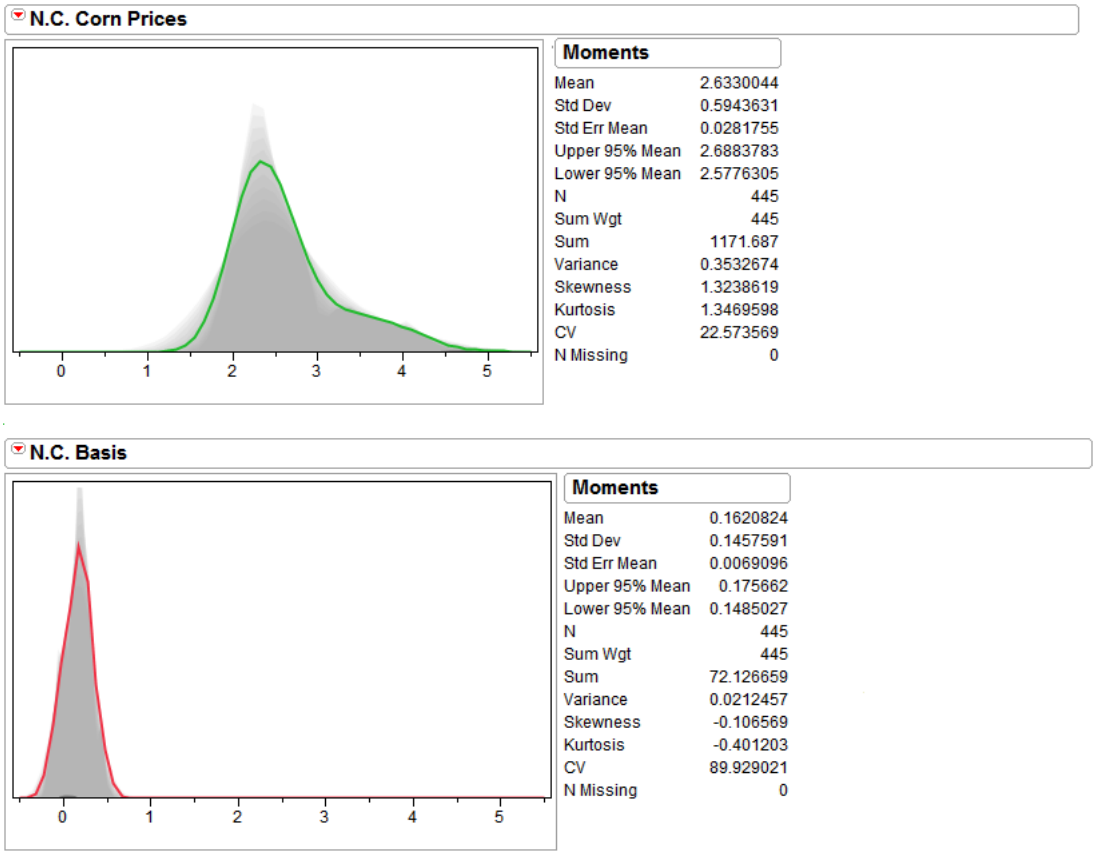
11.3 Basis Risk

Basis still has variability:

- Increase in basis → increase local price → increase net costs.
- Decrease in basis → decrease local price → decrease net costs.

Good news!

Basis variability is less than price variability (see figure below)! Due to this lower variation, basis risk is less than price risk. Thus, assuming basis risk instead of price risk by hedging in the futures market greatly reduces the chance of loss. Furthermore, the expected value of future basis is better known than the expected value of future prices, allowing better business forecasts. For both of these reasons, you should still use futures markets to hedge price risk!



N.C. Corn: Price Risk vs Basis Risk

Chapter 12: Futures Market Practice

12.1 Speculator Approach

As a speculator, you can either make or lose quite a bit in the commodity futures market. Consider the scenario:

It is currently November. The July wheat futures contract is trading at $3.50/bu. Answer following:

1. You believe that the price of wheat will fall. What position should you take? Ignoring commission, calculate your rate-of-return on investment for 10 contracts if the margin requirement is 10% and the July prices are:
   - $3.25
   - $2.00
   - $4.50
2. What if on Nov. 1 you decide to go short for 10 contracts. But, on Nov. 2, prices rise to $3.55/bu. Realizing this, you decide to partial hedge your risk by taking a long position for 7 contracts. Calculate the market equity (ignoring commission and margin requirements) for the following July price scenarios:
   - $3.50
   - $3.00
   - $4.00

12.2 Hedger Approach

You are a hog farmer in Iowa that plans on selling 1,000 hogs at 200 lbs. each to the local processor in October. Currently, it is March and lean hog futures contracts (40,000 lbs per contract) on the CBOT are trading at $0.50 per pound. Your cost of raising hogs to weight is $95 per hog. You are not a speculator and you just want to guarantee yourself a profit. Answer the following:

1. Suppose that you don't know how to use futures markets – you simply take the local October price. In other words, you are *taking on* ***price risk***. Calculate your local market equity using these three October price scenarios (prices per pound):
   - \$0.45
   - \$0.75
   - \$0.30
2. Now, suppose that you know how to use the futures markets. At the current futures price, would using the futures market guarantee you a profit?
3. What position are you in the local market? (Hint: If prices increase, do you better or worse off?) What position should take in the futures market to hedge the local price risk?
4. How many futures contracts would you sell in March? In October, explain your actions in the futures and local cash markets. How much market equity would you earn in each of these markets? What is your total market equity? Calculate equity using these three October price scenarios (assume perfect convergence of futures and local prices):
   - \$0.45
   - \$0.75
   - \$0.30

12.3 Basis

Basis is a great tool to forecast an agricultural producer's potential profits/losses. Consider that in Billings, the basis for wheat is currently -\$0.30/bu. The current price of a nearby wheat futures contract is \$5.50/bu. Answer the following:

1. What is the current local price?
2. If basis changed by -\$0.10/bu and the local price changed by \$0.20/bu, by how much did the futures price change?
3. It is currently February and the September HRS wheat futures contract is trading at \$5.25/bu. If the historical September basis for your location is -\$0.25, what is your expected local September price?
4. How much is the market willing to pay for you to store wheat from February to September? (Use the price you calculated in 1).
5. Is it profitable for you to store the wheat until September or sell in February?

12.4 Basis Risk vs. Price Risk

We saw that if you take on pure price risk (decide to sell at the local price without a futures hedge), you can lose quite a bit of money if the price moves against you. So, it is better to hedge by taking an opposite the position in the futures market.

But, when you take hedge using the futures market, you know that the price in the month of the contract expiration will almost never be the same as your local cash price. The difference is the *basis*. If you knew what the basis will be with 100% certainty, you could still fully hedge and avoid all risk. However, there is *basis risk* that occurs because basis in the month of the contract expiration will not always be equal to the historical basis in that month. Economic factors that affect storage and transportation prices, for example, will affect the movement of basis. This is called *basis risk*, and when you use the futures markets to offset your local position, you *exchange price risk for basis risk*.

Nevertheless, basis risk is **much less than** price risk. That is why it is still a much better idea to take on basis risk in exchange for price risk.

Consider the following

You are a grower of oats. Currently, it is March, and you will want to sell your 100,000 bushel harvest in December. The cost of growing oats is \$2.00/bu. The current December futures price is \$2.50/bu and the historical December basis is -\$0.35/bu. Answer the following:

1. *Price risk*: calculate your market equity if you decide not to hedge your risk in futures market, and simply sell on the local market. Consider these three scenarios of prices in December:
   - \$1.85
   - \$2.00
   - \$2.20
2. *Hedging*: now, you decide to use the futures market to hedge the price risk. What position are you in the local market? What position should take in the futures market? How many contracts should you exchange (5,000 bushels per contract)? What is the expected price that you will receive for the oats at your local market in December?
3. Calculate how much you will receive in December for your oats if the actual basis in December is equal to the expected December basis, and the December price of a December futures contract is as follows: (Hint: Don't forget to include the basis when calculating local prices)
   - \$1.85
   - \$2.00
   - \$2.20

4. *Basis risk*: a lot of the times, the expected basis will not equal the actual basis. However, the variation will be quite small. When you use the futures market, you exchange the high variability in prices for the small variability in basis. Calculate how much you will receive for your oats in December if the December futures contract price in December is \$2.10 and the actual basis is one of these three:
   - -\$0.30
   - -\$0.32
   - -\$0.40

Practice Problem Sets

Problem Set #1

Partially from **Producers celebrate first anniversary of marketing freedom**
(August 13, 2013; Dan Jensen, CamroseBooster.com)

The Canadian Wheat Board was permanently established in 1935 and given the authority in the 1940s to be a single-desk purchaser and marketer of malt barley and wheat from the Great Plains Provinces, both for domestic human consumption and for all exports of malting barley and wheat. In November 2011, the Conservative Party of Canada, whose platform partly focused on market deregulation, succeeded in obtaining legislation to end the CWB's single-desk authorities, which went into effect on August, 2012. This represented a major change in how North American malting barley and wheat markets could function and is likely to have important impacts on market participants and Canadian grain exports.

A Canadian Federation of Independent Business study conducted over the first year of marketing freedom found that the vast majority of agri-businesses (81 per cent) were positively impacted by marketing freedom. More than three-quarters said they had greater control of the decision-making for their products and two-thirds said marketing freedom has delivered better market signals, better access to competitive prices and increased cash flow.

"Marketing freedom has reinvigorated our grain industry as never before," said the Canadian Minister for Finance Kevin Sorenson. "In year one we saw good movement of grains throughout our system. Organic farmers can now sell their crop to the customers with no red tape, with no fees, with no sale or force to the Canadian Wheat Board, and then with no need to buy it back from the Canadian Wheat Board. Malt barley producers here in Alberta are contracting daily with U.S. breweries, something that would not have happened, would have been unthinkable under the monopoly."

Sorenson said marketing freedom couldn't have come at a better time. "World demand for food is growing as never before, as we have seen China and India develop more and more of an appetite for our grains and for our commodities. It has brought real results to our farm businesses in Alberta and I am convinced the best is yet to come."

Steven Snider, from Little Red Hen Mills, noted that he "moved out 160 metric tonnes of barley that got milled for organic dog food going states side. Before with the wheat board we would never have had a chance with that market. It would have been an uphill battle. Now everything is normal. I sell my barley like I sell my oats, like I sell my hay. I phone up a contractor, a broker, and we talk price and there is nobody meddling with us. It is just up to me and them to do a business transaction and move forward."

In problems 1–3, discuss and illustrate using supply and demand diagrams

1. Explain and graph what has occurred in the market for Canadian barley after the Canadian Wheat Board was removed.
   (a) Has there been a change (shift) in the demand for Canadian grain, a change (shift) in the supply, or both? Or neither? You must illustrate the phenomena and then justify your answers.
   (b) What does your analysis suggest about the resulting quantities and prices of Canadian barley?
   (c) What are the possible factors driving these changes? You are not required to provide any graphs for this question, but your answers must be supported by facts (i.e., citations).
2. Given your prediction of what will occur to prices from problem #1, describe the effect on Canadian beer production (assuming that malt barley, an ingredient necessary for beer production, was sourced by Canadian brewers from Canadian farmers).
   (a) Has there been a change (shift) in the demand for Canadian beer, a change (shift) in the supply of Canadian beer, or both? Or neither? You must illustrate the phenomena and then justify your answers.
   (b) What does your analysis suggest about the resulting quantities of Canadian beer and its prices?
   (c) Are Canadian and American beers substitutes or complements? Illustrate the potential impact on the markets for American beer within Canada.

3. Consider the possible implications on barley producers in Montana, who have traditionally contracted with U.S. brewers to supply malt barley.

   (a) Why would Montana barley farmers even be affected by the Canadian Wheat Board deregulation?

   (b) Explain and graph what, if anything, may occur in the markets for Montana barley.

   (c) What does your analysis suggest about the resulting quantities of Montana barley produced and price of the grain?

In problems 3–5, you will need to solve for equilibrium market conditions. Please carefully illustrate every step of your work and circle your final answers. Failure to do so will result in point deductions.

4. Suppose that a number of larger U.S. brewers commissioned you to study the issue described above. Primarily, you want to analyze the U.S. beer market before and after the Canadian Wheat Board deregulation. Your first task is to determine the equilibrium conditions of the beer market prior to the Canadian policy change. Through preliminary research, you were able to determine that the demand for beers is defined by the function: $P_D = 720 - 20Q$. Production of beer requires malt, hops and yeast, and labor. Assume that the supplies of the other three ingredients are upward sloping and are characterized by the functions:

   $P_{malt} = -500 + 6Q$
   $P_{hops/yeast} = -500 + 1.5Q$
   $P_{labor} = -50 + 2Q$

   Lastly, breweries incur a fixed cost of \$775 associated with the building and equipment operation for producing the beer. Solve for the following:

   (a) Equilibrium quantity of beer (in millions of gallons).

   (b) Equilibrium price of beer (in dollars per gallon).

   (c) Equilibrium price of labor.

   (d) Equilibrium quantity of labor.

5. Now suppose that two things changed: the demand for beer grew and breweries needed to incur additional transportation costs for getting barley from Canada. The new demand function is characterized as $P_D = 725 - 20Q$ and the transportation

supply function is $Q^S_{trans} = -80 + 4P$. We will assume that no other factors have changed from problem #4, so refer to the above problem for the remaining pieces of information. Solve for the following:

(a) Equilibrium quantity of beer (in millions of gallons).

(b) Equilibrium price of beer (in dollars per gallon).

6. Suppose that the Canadian brewers lobby convinces the Canadian government to tax U.S. brewers who purchase barley from Canadian farmers. Let's assume that this would only affect a brewer's fixed costs (a flat tax) and that this would increase a brewer's total fixed costs by \$150. Solve for the following.

   (a) Equilibrium quantity of beer (in millions of gallons).

   (b) Equilibrium price of beer (in dollars per gallon).

   (c) There are 128 ounces in a gallon of beer. Assuming that a beer is sold in 16 ounce units, what would a brewery charge per served unit?

   (d) Discuss the implication of your answer in (c) on a U.S. breweries' potential for selling beer. What might this imply for continued contracting between U.S. brewers and Canadian barley farmers?

Montana is well known for its feeder cattle production, although there are a few small feedlots located around the state. A notable exception is a large feedlot operation in central Montana, which has a capacity of 15,000 head of cattle. While this feedlot has been a relative mainstay in that area, it had undergone changes in ownership leading to several years when the feedlot was not as productive. Recently, however, the feedlot has grown substantially.

Typically, when we think of feedlots, we almost immediately think of corn. However, Montana's dry climate and relatively short growing season is not suitable for any substantial corn production. As a result, barley is used as the primary crop for livestock feed. The resurgence of the central Montana feedlot may have altered the feeder cattle and barley markets in the region, leading to important and interesting economic implications. You are tasked with developing key insights into the changes associated with the large feedlot.

7. Your first goal is to understand the initial equilibrium market conditions for the regional fed cattle market. You know that the demand for central Montana fed cattle is described by the function: $Q_D = 300 - 0.25P$. The production of fed cattle requires that the feedlot buys feeder cattle, barley for feed, has regular veterinary

care, and maintains storage bins that contain a sufficient supply of feed. The supplies of these inputs are characterized by upward sloping functions:

$Q_{feeders} = 10 + 0.02P$
$Q_{barley} = 0.1P$
$P_{vet} = 100 + 4Q$

The costs of maintaining storage facilities is relatively constant and is approximately \$600 per year. Please solve for the following:

(a) Equilibrium quantity of fed cattle (in thousands of head).

(b) Equilibrium price of fed cattle (in dollars per head).

(c) Equilibrium price of veterinary care (in dollars per hour).

(d) Equilibrium quantity of veterinary care (in number of visits per year).

8. Suppose that the growth of the revived feedlot began in 2010. In 2013, this growth has likely impacted the regions barley markets.

   (a) Illustrate using a supply and demand diagram the effect of the feedlot's growth on barley markets.

   (b) Summarize the impacts on the price and quantities of barley as that market transitioned between 2010 to 2013.

   (c) In 2-3 sentences, please discuss the dynamics of the transition in the barley markets. Did the changes you show in (a) occur instantaneously? If not, what is your hypothesis of how the markets adjusted between 2010 and 2013?

9. Now, examine the central Montana fed cattle market equilibrium in 2013, after changes in the barley market. Suppose that the supply function for barley is now $Q_{barley} = 0.07P$. The fed cattle demand, feeder cattle supply, and veterinary services supply remain the same as they did in #1. However, changes in the barley market have also impacted the fixed costs, causing them to increase to \$650.

   Please solve for the following:

   (a) Equilibrium quantity of fed cattle (in thousands of head).

   (b) Equilibrium price of fed cattle (in dollars per head).

   (c) Equilibrium price of veterinary care (in dollars per hour).

   (d) Equilibrium quantity of veterinary care (in number of visits per year).

10. Lastly, you are interested in understanding the impacts on nearby wheat markets. Prior to the expansion of the feedlot, central Montana's barley was sourced from areas near central Montana and satisfied residual demands by acquiring barley from nearby regions, such as that around Great Falls.

    (a) As barley markets transition to a new equilibrium in central Montana, what do you expect to happen to barley demand in Great Falls? Ensure that your explanation uses economic logic and terminology.

    (b) Illustrate the impacts on the Great Falls wheat markets as a result of what you discussed in (a).

    (c) Summarize the impacts on the price and quantities of Great Falls wheat as the central Montana barley market transitioned between 2010 to 2013.

Problem Set #2

Big Beer dresses up in craft brewers' clothing
(November 15, 2012; Denis Wilson, CNNMoney.com)

Perhaps you've ordered a beer at a restaurant recently. Maybe you even perused the craft beer list, looking for something different. If you're like me, your decision was based on something other than price – otherwise you could've ordered a Coors Light or Budweiser for two or three bucks less. So what was it? Was it the possibility of finding a unique, even superior flavor? Or was your decision based on the idea that a craft beer is one that's made by a small, independently owned brewery and not by the same makers of Coors or Bud? If it was the latter, you may want to find out who's really making your beer before your next round.

Big, global breweries have taken notice of the craft beer movement—mostly because that's where actual growth exists in the otherwise stagnant beer industry. In 2011, craft brewing saw growth of 13% by volume while overall U.S. beer sales were down an estimated 1.3% by volume. And even though craft beer still accounts for less than 6% of all beer sales, anyone remotely connected to the business knows it will play a big part in the industry's future. Craft beer delivers higher profit margins, it attracts consumer spending, sought-after clientele for bars and restaurants, and many people are passionate about craft beer, similar to the same way people are passionate about wine.

Everybody wants in. And so the macro-breweries have launched beers that approximate the craft taste profile (the popular Coors brand, Blue Moon), purchased stakes in some craft breweries (southeastern Terrapin Beer Company by MillerCoors), and snatched up others entirely (such as the recent acquisition of Goose Island Brewing by Anheuser-Busch). What's noteworthy about these forays into the craft segment is the way these brands are purposely distanced from their Big Beer parents. You won't find the Coors name on a bottle of Blue Moon. Rather, you see the name Blue Moon Brewing Company. The same goes for a bottle of Anheuser-Busch's Shock Top. To distance their craft products from their billion-dollar household brands, the big brewers have gone so far as to create separate divisions to house their specialty brands: MillerCoors has created Tenth & Blake Beer Company while Anheuser Busch (BUD) has the Green Valley Brewery.

In many industries, this wouldn't raise an eyebrow. But craft beer is defined as much by its underdog culture and at-times contentious relationship to the greater beer market as its actual products. Some craft brewers and drinkers see these beers as imitators, donning a craft beer costume—bold label designs and quirky names—in an attempt to deceive customers. On craft beer forums and blogs, the debate rages on. Consumers in

general have grown increasingly concerned with who makes the products they buy and how products are made. More and more, our purchases have come to feel like endorsements of a company's practices. "There are two types of consumers," says Anat Baron, the director of the documentary Beer Wars, which explores the battle between micro- and macro-breweries. "Consumers who shop by price and just don't care who makes the stuff that they buy, and other consumers, which are a minority, but I think a growing minority, that actually care about who makes what they buy."

In the following problems, you will need to solve for elasticities and changes in market conditions. In interpreting the elasticities, please provide a response such as, "For a ___% change in price (or quantity), there is a ___% change in quantity (or price)."

1. Consider the following demand functions for craft beer. Determine the own-price elasticity of demand when $P = 5$. Then interpret what each elasticity implies.

   (a) $P = 80 - 4Q$

   (b) $Q = 9 - 0.2P$

2. For each of the following macrobrew beer demand functions, find the own-price flexibility of demand when $Q = 5$. Interpret what the flexibility implies.

   (a) $5Q = 100 - 5P$

   (b) $P = 100 - 10Q$

3. Consider these supply functions and determine the *own-price* and *cross-price* elasticities of supply. For each of the then, interpret what the elasticity implies.

   (a) $Q_{beer} = 500 + 4P_{beer} - 5P_{hops} - 2P_{barley}$

   $P_{beer} = 5 \qquad P_{hops} = 20 \qquad P_{barley} = 10$

   (b) $P_{barley} = 10 + 0.25Q_{barley} - 2P_{wheat}$

   $P^{barley} = 10 \qquad P^{wheat} = 7$

4. Consider the following demand function describing the potential interaction between the craft and macrobrewery markets.

$$Q_D^{craft\ beer} = 4000 - 4P_{craft\ beer} + 5P_{wine} - 0.25Q_{macro\_beer} + 2Q_{farmers\ markets}$$

You know that $P_{craft\_beer} = \$5$, $P_{wine} = \$10$, $Q_{macro\_beer} = 10000$, $Q_{farmers\ markets} = 500$.

Determine/respond to the following:

(a) Quantity of craft beer.

(b) Own-price demand elasticity of craft breweries.

(c) Cross elasticities of breweries and (i) wine prices, (ii) macrobeer production (in 1,000 units), and (iii) number of farmers markets where craft brewers can advertise.

(d) Given your findings in part (c), are craft beer producers more responsive to changes in macrobrewery beer production or advertisements at local farmers' markets? Why?

5. You wish to analyze how macrobreweries' expansion of craft beer brands may impact the prices and quantities of Montana barley. Suppose that the demand and supply functions of Montana barley are as follows:

$$D^{barley}: \; Q_D^{barley} = 140 - 5P^{barley} + 4P^{craft\_beer} + 10P^{macro\_beer}$$

The supply of barley is a function of its market price, the wheat, and the price of fertilizer (f).

$$S^{barley}: \; Q_S^{barley} = 310 + 10P^{barley} - 5P^{wheat} - 0.25P^{f}$$

Prices for these commodities and income are as follows:

P^{barley}	=	\$10/bushel
P^{craft_beer}	=	\$35/gallon
P^{macro_beer}	=	\$7/gallon
P^{wheat}	=	\$7/bushel
P^{f}	=	\$300/ton

(a) Calculate the own- and cross-price elasticities of demand and supply. Interpret the cross price elasticity between barley supply and the price of wheat. Why is wheat in the supply function of barley?

(b) Assume that the increased demand for barley through the macrobreweries' product line expansion will alter the demand for barley by 5%. Quantitatively determine the impacts on the percent change in the price, quantity demanded, and quantity supplied of barley. Neatly outline the steps and logic of solving the problem.

(c) Now assume that the change is more modest—a 2.5% increase. Recalculate the impact on the percent change in price and quantities.

While Montana does not currently have a large dairy production market, the United States produces a significant amount of dairy products. Major dairy production areas include Wisconsin, New York, California, Oregon, and Arizona, among others. The dairy sector is interesting, because cow milk can be used to produce a number of commodities, based on the fat level of the milk. For example, Class I milk—the highest quality—is used for direct consumption (the milk you pour on your cereal). Class II is an input in the production of various yogurts and ice creams. Classes III and IV are used to produce cheeses and butter, respectively. Furthermore, there are by-products of dairy products. For example, whey (and dry whey) are a by-product of cheese production from Class III milk. Furthermore, dairy products are often combined with other inputs in order to produce a final good.

The numerous interactions make the dairy market interesting to study. Primarily, this is because shocks and changes to one part of the market may have significant ripple effects throughout the numerous other portions of this market. Throughout the 20th and 21st centuries, a number of large changes to the U.S. dairy markets resulted from the enactment of various policies to protect dairy farmers from adverse market conditions. These policies have at times led to unexpected economic implications, which ultimately affected many more than just a single, "intended" market.

6. Consider first the markets for cream (Class II milk) and corn syrup, which are combined by manufacturers to make ice cream. This implies that changes in one of these markets (Class II milk and/or corn syrup) will likely have impacts on the other market.

   (a) Describe how the Class II milk and corn syrup markets are related (i.e., Do you expect there to be substitution effects? Complementarity effects? Neither?) and why you believe this relationship between the markets to hold.

   (b) Suppose that a dairy policy change decreases the incentives for the production of Class II milk, therefore reducing its supply. Using your response in 1(a) about the relationship between Class II milk and corn syrup, illustrate the impacts on both the Class II milk and corn syrup markets. If you do assume that there is a relationship between these two products, make sure to illustrate any feedback effects that may occur.

   Please ensure that all axes, curves, and points of equilibrium are labeled and that you specify the market that you're illustrating.

7. Suppose that you analytically examine the market for ice cream (IC). Assume that the demand for ice cream is a function of the price of ice cream and the price of frozen yogurt (froyo). The supply is a function of Class II milk and corn syrup. These are described as follows.

$$Q_{IC}^{D} = 575 - 10P_{IC} + 5P_{Froyo}$$

$$Q_{IC}^{S} = 510 + 5P_{IC} - 15P_{Milk} - 6P_{Corn\ syrup}$$

The associated prices for these markets are in hundredweights (cwt):

$$P_{IC} = \$50, \qquad P_{Froyo} = \$35, \qquad P_{Milk} = \$20, \qquad P_{Corn\ syrup} = \$35$$

(a) Determine the cross-price elasticity of demand between ice cream and frozen yogurt. Interpret and describe whether the goods are substitutes or complements.

(b) Determine the cross-price elasticity of supply between ice cream and milk. Interpret and describe why an increase in the price of milk leads to the calculated change.

8. Assume that the ice cream market is independent of all other markets. Suppose that there is a 2% supply increase and 3% demand increase in the ice cream. While we know that the equilibrium quantity in this market will increase, the effect on price is ambiguous. Using the functions and information from the previous problem, determine the $\%\Delta P_{IC}$ and $\%\Delta Q_{IC}$ between the original and the new equilibriums.

9. For the previous problem, you assumed that the ice cream market was independent of all other markets and solved for changes in that market as a result of a 2% supply increase and 3% demand increase in the ice cream. However, we know that the market independence assumption is not likely to be realistic. That is, it is likely that the impacts of changes in the ice cream market will have an effect on the frozen yogurt market, which will lead to a series of feedback effects in both markets.

As before, the demand for ice cream is assumed to be a function of the price of ice cream and the price of frozen yogurt (froyo). The supply is a function of Class II milk and corn syrup. These are described as follows.

$$Q_{IC}^{D} = 575 - 10P_{IC} + 5P_{Froyo}$$

$$Q_{IC}^{S} = 510 + 5P_{IC} - 15P_{Milk} - 6P_{Corn\ syrup}$$

The demand of frozen yogurt is assumed to be a function of the price of frozen yogurt and the price of ice cream. The supply is a function of Class II milk, natural cultures (NC), and beet sugar (S). These are characterized as follows.

$$Q^D_{Froyo} = 210 - 16P_{Froyo} + 10P_{IC}$$

$$Q^S_{Froyo} = 385 + 15P_{Froyo} - 8P_{Milk} - 10P_{NC} - 4P_S$$

The associated prices for these markets are in hundredweights (cwt):

$$P_{IC} = \$50, \qquad P_{Froyo} = \$35, \qquad P_{Milk} = \$20, \qquad P_{Corn\ syrup} = \$35$$

$$P_{NC} = \$40, \qquad P_S = \$50$$

Your objective is to determine changes in both the ice cream and frozen yogurt markets as a result of the changes in the ice cream market. That is, determine the $\%\Delta P_{IC}$, $\%\Delta Q_{IC}$, $\%\Delta P_{Froyo}$, $\%\Delta Q_{Froyo}$.

Problem Set #3

An increasing demand for locally grown and malted barley has independent maltsters on the rise—but is it sustainable?
(Adrienne So, BeerWestMag.com)

As anyone who has ever taken a brewery tour knows, beer is composed of four simple ingredients: water, barley, yeast, and hops. While each component is essential, hops have gotten a disproportionate share of the attention. They're sexy, aromatic flowers, free for the plucking in many a backyard. They're accessible and understandable, in a way that an arguably more important ingredient—barley—is not. It's hard to develop a personal, emotional relationship with a commodity that's grown thousands of miles away, malted in large factories, and shipped to your doorstep in tidy little bags. But a handful of research scientists, farmers, maltsters, and brewers across the country are working hard to deconstruct and rebuild the long, complex supply chain that begins in a distant field and ends in the beer packaged and consumed by each of us at home.

Malting is the process of germinating grain in order to convert the seed's starches into usable sugars. It's also a process that requires a fair bit of time, space, and engineering skill. First the grain has to be soaked, or steeped, in order to start the germination process. Once the seed has just barely begun to sprout, the germination is halted and the green malt is converted into toasty brewing malt by heating, or kilning for a particular length of time at a particular temperature. For a society and industry that places an increasing emphasis on locavorism, it's shocking that we haven't paid more attention to barley. The questions pile up on top of one another: When we say that we're drinking a locally produced beer, is anything in it more local than the water? Where does the grain come from, and does its quality affect the beer's taste at all? And shouldn't we pay a little more attention to the most important ingredient in the sudsy beverage that we all know and love? Nowadays, a grain of barley that is destined to be malted and mashed into your favorite craft beer is probably grown in the American Midwest or somewhere in the Dakotas, Idaho, Montana, or eastern Washington. Economies of scale in transportation dictate that most large-scale maltsteries, like Cargill, Rahr, and Briess, are built near the grain they're malting. It's easier, and far cheaper, to transport malt than it is to transport raw grain.

In order to start a small, local maltstery, then, you need to find grain that's grown near your home. And since most people don't own 40 acres of farming land that's sitting fallow, you need to persuade a farmer to grow it for you. But what kind of barley do you plant? Will it grow in your local climate or succumb helplessly to some mysterious disease? Most importantly, how can we justify all this effort if we don't even know whether the barley will be suitable for brewing? Plant scientists in agricultural programs, like those

at North Dakota State University, the University of Idaho, and Oregon State University, are working to answer these basic questions in order to better serve the craft brewing industry. Although craft beer only accounts for about six percent of the beer sold in the United States, craft brewers account for 21.4 percent of the malt that's purchased. The Brewers Association estimates that craft brewers might use as much as one-third of malt produced in the United States.

"Beer is an agricultural product," Andrea Stanley, a small maltster from Massachusetts, concluded in her talk at the 2013 Craft Brewers Conference. Supporting the growth of local maltsteries also supports the livelihoods of the family farms that supply them with grain. "When you can connect a brewer with the farmer that grew his grain, that's something special."

In the following problems, you will be solidifying your knowledge of marketing channel models. In problems 2–4, please illustrate your solutions using marketing channel diagrams and then discuss the dynamics that you've graphed. Practice labeling all axes, curves, and points of equilibrium. Specifically, don't forget to label all original and new quantities, prices, and curves. In problems 5–7, you will be asked to solve for equilibrium behaviors analytically.

1. In your own words, explain how *derived demand* is found. That is, knowing the demand for products in the retail market and the supply of marketing and processing services, how do you determine the derived demand for the farm-level commodity? Explain the concepts of a marketing channel and derived demand as if you're talking to someone who has never taken an economics course.

2. Your goal is to analyze the farm level demand for malt. Let's consider that the related retail market is one for beer that is either a craft beer or one that is a macrobrew (typically produced by large brewers such as Anheuser-Busch or Coors).

   (a) Illustrate the demands for the craft beer and macrobrews. Show each individual retail-level demand and also the final demand for all beer products. Explain your intuition for arranging the demands from top to bottom. That is, why is a particular demand curve above or below another demand curve. Carefully label each curve.

   (b) Using the information in (a), illustrate the market for malt. Assume that the supply of processing & marketing services and the supply of barley are known. Carefully label each curve.

(c) What might be the "processing & marketing" services in this scenario? That is, barley can't be magically turned into beer; so what needs to happen? (Some research may be required to answer this question.)

(d) Illustrate the equilibrium quantity and price in the malt market, as well as the equilibrium quantity and price of retail beer. Using the latter quantity, illustrate the prices of macrobrews and craft beers.

(e) Why are we able to use the malt quantity at the farm level as a proxy for the quantity of beer at the retail level?

3. Now let's examine the underlying barley market. Remember that malt is produced from barley, so the malt market may be seen as the "retail" market for barley.

   (a) In the barley farm market, what would be the corresponding "retail" demand curve?

   (b) Assuming that we know the supply of processing & marketing services in the barley market, graphically derive the demand for barley.

   (c) Illustrate the equilibrium quantity and price of barley in the farm market.

   (d) How does the quantity in the barley market relate to the quantity in the malt market and the quantity in the retail beer market?

4. Let's now examine what has happened in the previous 10–15 years within the retail beer markets. Assume that the demand for craft beer increased, while the demand for macrobrews remained the same.

   (a) First, without illustrating anything, carefully layout the logic of the resulting changes in the retail, malt, and barley farm markets. What change occurs first? What is the next event to happen? Etc.

   (b) Using a new three-diagram figure, illustrate what occurs in all three markets.

   (c) Create a table that describes what occurs to the quantity and price in each of the three markets.

   (d) Using economic intuition, explain why the changes that you've outlined occur in each of the markets. Who is likely better off and who is likely worse off?

5. Your next goal is to determine quantitatively the equilibrium values in the barley malt market and the retail beer market. Suppose that the individual demands for craft and macro beer are as follows:

$$D^{craft\ beer}: \quad P_D^{craft} = \quad 100 - 0.4Q$$
$$D^{macro\ beer}: \quad P_D^{macro} = \quad 50 - 0.6Q$$

You also know that the processing and marketing of beer is characterized by the function:

$$S^{PM}: \quad P^{PM} = \quad -300 + 4Q$$

Lastly, the supply of malt is represented by the function $P_S^{malt} = 100 + 2Q$.

Calculate the following:

(a) The demand function for total retail level beer.

(b) The derived demand function for malt.

(c) The equilibrium quantity of malt (in hundred tons).

(d) The equilibrium price of malt (in dollars per ton).

(e) The equilibrium price of the craft beer (dollars per gallon) and the price of macrobeer (dollars per gallon).

6. Now, repeat the exercise above, but this time you will need to calculate the supply function of malt.

$$D^{craft\ beer}: \quad P_D^{craft} = \quad 100 - 0.4Q$$
$$D^{macro\ beer}: \quad P_D^{macro} = \quad 50 - 0.6Q$$

You also know that the processing and marketing of beer is characterized by the function:

$$S^{PM}: \quad P^{PM} = \quad -300 + 4Q$$

Lastly, barley production requires fixed and variable costs. The variable costs are characterized by the function $P_V = 25 + Q$ and the fixed costs are 175.

Calculate the following:

(a) The demand function for total retail level beer.

(b) The derived demand function for malt.

(c) The supply function for malt.

(d) The equilibrium quantity of malt (in hundred tons).

(e) The equilibrium price of malt (in dollars per ton).

(f) The equilibrium price of the craft beer (dollars per gallon) and the price of macrobeer (dollars per gallon).

7. Now, let's quantify the scenario in problem #4. Suppose that the demand for craft beer is now $P_D^{craft} = 110 - 0.4Q$. Assume that all other conditions are as in problem #6. Calculate the following:

(a) The demand function for total retail level beer.

(b) The derived demand function for malt.

(c) The supply function for malt.

(d) The equilibrium quantity of malt (in thousand tons).

(e) The equilibrium price of malt (in dollars per ton).

(f) The equilibrium price of the craft beer (dollars per gallon) and the price of macrobeer (dollars per gallon).

(g) Smell test: Do the price and quantity values intuitively correspond to the graphs in problem #3?

In the late 2000s, corn prices rose rapidly and were closely followed by prices of other major agricultural commodities. A widespread explanation for these market changes is an increased demand for corn in the production of ethanol, prompted by the introduction of programs intended to encourage biofuels production in the United States. Specifically, the Renewable Fuel Standard (RFS) program introduced in the Energy Policy Act of 2005 and the Energy Independence and Security Act of 2007 prompted significant changes in agricultural markets. The latest RFS program mandates that 36 billion gallons of renewable fuels be blended into gasoline by 2022, with a maximum of 15 billion gallons from corn-based ethanol by 2015 (Renewable Fuels Association 2012).

Currently, excessive production costs and technological constraints limit the quantity of noncorn-based biofuels, placing a greater burden on the use of corn to fulfill the mandated ethanol production requirement and precipitating substantial reallocation of corn from its traditional uses in feed. For example, 53.4% of U.S. corn produced was used in livestock and poultry feed and 12.5% was used in ethanol production during the 2004–2005 marketing year; in the 2011–2012 marketing year, however, only 38% of the corn was used for feed, while 40% was an input to biofuel production. Technological advances that allowed a corn-ethanol byproduct—distillers' dried grains (DDGs)—to be used as a supplement to livestock feed was a partial saving grace during this market transformation. The result was a quickly emerging domestic market (and more recently, an international market) for DDGs.

Recently, there have been many discussions and lobbying efforts in Congress to significantly reduce or fully eliminate the Renewable Fuel Standard. This would substantially change the market structure and could lead to important shocks at all levels of the biofuels marketing channel. An analysis of these changes would provide important insights about the future of U.S. agriculture.

8. Illustrate the retail market for products related to corn-based biofuels production and the farm-level market for the input, corn.

   (a) Illustrate the retail and farm-level markets associated with corn-based biofuel production. Please ensure that all axes, curves, and points of equilibrium are labeled and that you specify the market that you're illustrating.

   (b) Illustrate the impacts of removing the RFS program in both the retail market for corn-based biofuels and the farm-level market for corn. In a table, describe the changes in prices and quantities of corn and each good in the retail market.

   (c) In 2-3 sentences, hypothesize what would happen to the prices and quantities of wheat and discuss why you think these changes will occur.

9. Recall that in our discussion of elasticities, we saw that depending on economic conditions, markets may be operating on an inelastic portion of the supply curve, the elastic portion of the curve, or somewhere in the middle. Your task in this problem is to replicate #8(b), but explicitly consider that the corn supply is either very inelastic or very elastic. That is:

   (a) On separate graphs, illustrate the impacts of removing the RFS program in both the retail market for corn-based biofuels and the farm-level market for corn when the corn supply curve is highly inelastic. (Ensure that you draw your curves in a way that I can clearly tell the elasticity of the curve.)

   (b) On separate graphs, illustrate the impacts of removing the RFS program in both the retail market for corn-based biofuels and the farm-level market for corn when the corn supply curve is highly elastic. (Ensure that you draw your curves in a way that I can clearly tell the elasticity of the curve.)

   (c) For each scenario (inelastic and elastic), hypothesize the *magnitude of effect* on wheat prices. That is, don't simply tell me what the impact will be, but rather, tell me whether you expect prices of wheat to change by a lot or a little under each supply elasticity scenario in the corn market. (This is the "think like an economist" question.)

10. Now, determine the market conditions analytically. Suppose that you know the following about the corn-based biofuel market.

$$\begin{array}{lrcl} D_{ethanol}: & P_{eth} & = & 160 - Q \\ D_{DDG}: & Q_{ddg} & = & 60 - 2P \end{array}$$

    You also know that processing and marketing corn into the corn-based biofuel products requires transporting corn to an ethanol plant, and incurring both variable and fixed costs for operating the facility. The supply of these processes are as follows:

$$\begin{array}{lrcl} S_{transport}: & P_{tran} & = & -2000 + 3Q \\ S_{variable}: & P_{var} & = & -5000 + 2Q \\ S_{fixed}: & P_{fix} & = & 7100 \end{array}$$

    Lastly, the corn supply function is: $S_{corn}: \; Q_{corn} = -10 + 5P$.

   (a) Determine the equilibrium quantity (in millions of bushels) and price (in dollars per bushel) of corn.

   (b) Determine the equilibrium prices of ethanol (in dollars per thousand gallons) and DDGs (in dollars per ton).

Problem Set #4

From **Montana tavern owners battling with beer brewers** and **Fight over craft beer brews with 2 bills at Montana Legislature**
(March 27, 2013; Associated Press and March 16, 2013; Jenna Cederberg, Missoulian.com)

Brewery battles are heating up again in Helena as the Montana Tavern Association and the Montana Brewers Association prepare to put separate, vastly different bills before state legislators as they consider how best to regulate the growing craft brew industry. The groups have routinely failed to compromise on the issue of microbrewery regulation. This year has been no different. Montana Brewers Association executive director Tony Herbert said that microbreweries here operate under some of the most restrictive regulations in the country. His members want a way to continue to grow what has become a $50 million-a-year industry in Montana. But Montana Tavern Association spokesman John Iverson said the successful brewery taprooms have become "virtually indistinguishable" from bars.

Both sides packed a state House Business and Labor Committee hearing looking at two bills. One brought by the tavern owners, House Bill 616, would put new licensing requirements on the brewing industry. The tavern owners argue that some breweries have grown into full-scale retail establishments not envisioned by the original law that allows tasting rooms. Another bill to study the issue, House Joint Resolution 18, was backed by brewers who said more conversation is needed to fairly reconcile differences.

A compromise had been reached in 1999 by brewers, when tavern owners and distributors changed state law to allow microbreweries to sell their beer out of "sample rooms," but restricted it to 48 ounces per person per day and limited hours of service to 10 a.m. to 8 p.m. That law was intended to let wholesale breweries offer a little taste to retail customers. Supporters of taverns argue that some breweries now sell almost all their product to customers and resemble bars. House Bill 616 proposed to require many retail breweries to buy a new state license for $100,000. Wholesale operations would not need the license.

Most Montana brewers opposed the law. They argued it would stifle growth in the industry. The brewers are instead suggesting a two-year study with the aim of producing new rules that everyone can support. They said House Bill 616 is being wrongly sold as a way to help the industry expand with new licensing rights. Farmers who sell grain to the breweries and customers who enjoy the beer also opposed the bill. "It was crafted by the Tavern Owners Association, and it is meant to benefit the Tavern Owners and it will crush many of the small-town mom-and-pop breweries in Montana," said Helena attorney David Hull,

who said he enjoys the breweries.

In the following problems, you will be investigating spatial issues in agricultural markets. In all diagrams, ensure that all axes, curves, and points of equilibrium are labeled. Specifically, don't forget to label all original and new quantities, prices, and curves.

1. Consider a tavern that can acquire beer from either large macrobreweries or from local microbreweries. Suppose that we consider a tavern in Bozeman, MT that can purchase beer from MillerCoors (in Golden, CO, located to the south) or from Montana microbreweries across different parts of the state. In the past 10–20 years, there has been increasing pressure on the transportation infrastructure associated with delivering beer from the south. That is, the demand for trains has continued to rise and trains are more scarce.

   Using a spatial diagram, illustrates the impacts of these changes on the net price received by MillerCoors. Then, discuss what you expect to happen with respect to the type of beer sold in Montana taverns.

2. Now consider an alternate scenario. Legislative actions increase the transactions costs associated with local breweries producing and delivering beer to Montana taverns. Using a spatial diagram, illustrate the impacts of these changes on the net prices received by Montana microbrewers. Discuss the potential effects on the type of beer sold in Montana taverns.

3. Using a three-diagram trade model, illustrate a market that imports beer (such as Bozeman), a market that exports microbrewed beer (such as Belt, MT), and the trade market.

4. Replicate the model in #3 and illustrate the impacts of an increase in the demand for Montana-brewed beer in the import market. Discuss the economic implications for consumers and producers in all markets.

5. Replicate the model in #3 and illustrate the effects of a restriction (in terms of a tariff) imposed on microbrewers due to new legislation. Discuss the implications for consumers and producers in all markets.

Canada and the European Union tentatively agreed to a sweeping trade agreement some time ago. But while billed as a free-trade pact, the limited information released about its terms suggests that the details of any final deal may focus on adjusting import-export quotas and fine-tuning regulations as much as the easing of tariffs. Dairy farmers, who enjoy tight controls on imports, have been critical, as have some groups fearing the pact may increase the cost of drugs.

Once the agreement is put into effect, the European Commission expects trade between Canada and the European Union to increase nearly 23 percent, or 25.7 billion euros ($35 billion). As a result of the pact, Canada said that 98 percent of European tariffs on Canadian goods would be lifted, though neither Canada nor Europe offered a similar statistic for Canadian tariffs. Some tariffs are more significant than others. Several sectors of Canada's agricultural industry—dairy, poultry, eggs and pork—are protected by tariffs as high as 300 percent, as well as by import quotas. Groups representing dairy farmers and cheese makers in Canada said they had been told that while the tariffs would remain, Europe would be allowed to export about 33,000 tons of cheese a year to Canada duty-free, an increase from about 14,000 tons.

In completing the problems below, please ensure that all axes, curves, and points of equilibrium are labeled and that you specify the market that you're illustrating.

6. First, let's analyze the effects of the free trade agreement on trade markets.
   (a) Using a three-diagram trade model, illustrate the expected impacts of the trade agreement between Canada (export) and the European Union (import). Consider the information in the article above to determine the supply, demand, and/or policy changes that will occur.
   (b) What could be an impact on the trade market between Europe (import) and the United States (export) as a result of the Canada–EU trade agreement? Discuss the economic intuition and illustrate in a three-diagram trade model.
7. Consider replacing the current dairy tariffs in Canada with an equivalent quota. That is, the quantity traded will not change, but the policy restricting that trade quantity will change. Illustrate and describe the welfare impacts of this change, and comment on the losers and winners of the change.
8. Consider a malt barley producer in Manitoba, Canada. She can deliver the barley to two equidistant elevators, Elevator A and Elevator B. Elevator A can then market the grain either in domestic markets or for export. Elevator B can only market the grain in domestic markets. Using a spatial net price diagram, illustrate the impacts of the Canada–EU trade agreement and discuss the implications for both elevators and the farmer.

Problem Set #5

1. In your own words (i.e., in a manner that you would explain it to someone who has not taken this course) explain the concept of offsetting futures contracts. When/why would you offset a futures contract? How would you offset a particular futures market position?

2. What is the difference between a futures contract price and a local cash price? What is the relationship among these two prices? Which price would a Montana farmer/rancher care most about? Why?

3. In your own words (i.e., in a manner that you would explain it to someone who has not taken this course) explain the concept of margin accounts and why they are necessary.

Consider the following charts describing December soft red wheat futures prices and December corn prices, both contracts traded on the Chicago Mercantile Exchange.

Source: Chicago Mercantile Exchange.

4. Provide economic intuition for the similar *price movements* and their *timing* observed between August and October. Remember that futures contracts reflect rational expectations about the supply and demand of the commodity.

Source: Chicago Mercantile Exchange.

5. Why doesn't the price of wheat contracts exactly mirror reflection of corn futures prices?

6. Explain the apparent break in similar price movements after October. If you have not been following these markets, then you will need to do some research to determine the market events that have caused these divergences to occur.

Suppose that you are a speculator betting on the hard red winter wheat market. You wish to take on a short position with five (5) futures wheat contracts at the price \$7.30/bu. The associated margin requirement is 15%. Respond to the following:

7. Why would it make sense to take on a short position in the HRW wheat market?

8. Argue that taking a short position is the wrong decision.

9. What would be the margin requirement for this transaction? That is, how much money would you be required to deposit into your margin account?

10. Currently, you have \$10,000 in liquid assets. Using the margin requirement from before, *Reproduce* the following table to describe the following:

    (a) How much money will be added (+) or subtracted (–) from your margin account when the futures contract is marked-to-market (margin call).

(b) How much is in the margin account after the margin call (assume that you must either get the margin account back to the margin requirement level or maintain all of the positive market returns in the margin account).

(c) How much money you will have to add from your liquid assets into the margin account to maintain the original margin requirement.

(d) What the new price of the futures contract when it is marked-to-market.

(e) At which point, if any, will you be placed out of the futures market and why.

Make sure to show your work when determining each of the values in the table.

Day	**Price when market opens**	**Price change**	**Margin call**	**Margin account**	**Liquid assets used to replenish margin account**	**Liquid assets remaining**	**Price after marking-to-market**
1	\$7.30	+ \$0.10					
2		– \$0.20					
3		– \$0.15					
4		+ \$0.25					
5		+ \$0.30					
6		+ \$0.05					
7		– \$0.25					
8		– \$0.40					

11. Repeat the above exercise, but assume that you have \$25,000 in available liquid assets and the market behaves is as following:

Day	**Price when market opens**	**Price change**	**Margin call**	**Margin account**	**Liquid assets used to replenish margin account**	**Liquid assets remaining**	**Price after marking-to-market**
1	\$7.30	+ \$0.10					
2		+ \$0.20					
3		– \$0.15					
4		– \$0.10					
5		+ \$0.30					
6		– \$0.05					
7		– \$0.25					
8		– \$0.15					

12. Futures markets intuition.

(a) Consider two markets—a malt barley market and a spring wheat market. Malt barley does not have an associated futures contract while spring wheat does have a well-established contract traded on the Minneapolis Grain Exchange. This

implies that there are no speculators participating in the malt barley market and many speculators affecting spring wheat prices. Which market, malt barley or spring wheat, do you expect to have more price variability/volatility? That is, which market has more uncertainty about prices in the future? Discuss the economics behind your intuition.

(b) Discuss the benefits and costs of partial hedging. When would a partial hedging strategy be appropriate?

(c) True or false: basis is easier to predict than local cash or futures prices? Justify your answer.

13. You are a miller. It is currently November and you have forward contracted to deliver 450,000 pounds of flour at $25 per hundredweight (per 100 lbs.) in March. The extraction rate of flour from wheat is approximately 75%, implying that you will need 600,000 pounds of wheat. There are approximately 60 pounds in each bushel of wheat. After you sell the contracted flour, you wish to immediately replace the wheat for continuing your operations. You will purchase the wheat in your local market, but you wish to hedge away the possible price risk associated with waiting to purchase wheat in March. In November, the March spring wheat futures contract is priced at $8.10/bu and there is a 5% margin requirement to enter the market.

    (a) If the March spring wheat futures price was the same as in November with 0 basis differential, calculate your expected revenue, costs, and profit.

    (b) What position are you in the local wheat market? Why?

    (c) What position would you need to take in the futures market to offset our local market position?

    (d) How much money would you need to pay into the margin account?

    (e) Suppose that the price of the March spring wheat futures contract in March is $9.55/bu and the local basis is –$0.95/bu. Determine:

        i. Local market conditions (revenues, costs, net local returns).

        ii. Futures market conditions (net gains or losses).

        iii. Overall net returns from the local and futures markets.

14. You're a corn farmer. Assume that average corn yields are 134 bushels per acre and you have a 5,000 acre corn farm. You will store 12% of your harvest and sell the remaining crop to your nearby elevator. Your cost to produce a bushel of corn is $4.00/bu, which you incur on all produced bushels, regardless of whether you decide to sell them immediately or store for later sales. You wish to hedge the expected price risk using futures markets. Respond to the following.

(a) Even though you can use futures markets to hedge away some price risk, you are unable to hedge all of it away. Why are you still subject to some uncertainty?

(b) It is currently December, and the September 2015 corn futures contract is trading at \$4.80/bu. The following table describes local and futures prices in September, the month during which you will sell your crop, and the current month, December.

Month	**Year**	**Futures Price**	**Local Price**
September	2008	\$ 3.25	\$ 3.14
September	2009	\$ 4.10	\$ 3.98
September	2010	\$ 4.20	\$ 4.01
September	2011	\$ 5.89	\$ 5.77
September	2012	\$ 5.24	\$ 5.11
September	2013	\$ 4.75	\$ 4.61
September	2014	\$ 5.61	\$ 5.48

If the December price of a September 2015 futures contract reflected the *true* price of corn in September 2015, what are your expected total revenues, total costs, and total profits?

(c) Suppose that you take a position in the futures market to hedge price risk. What position would you take? Why?

(d) When you are ready to sell the corn in September 2015, you offset your futures position at the price of \$4.75. The actual basis in September is –\$0.19/bu. Calculate your actual total net revenues in the local market, total equity in the futures market, and your overall profit.

(e) If you had not hedged, what would have been your net revenues?

Problem Set #6

1. In your own words (i.e., in a manner that you would explain it to someone who has not taken this course) explain how local price risk can be hedged using futures markets?

2. Suppose that you are a Montana farmer growing winter wheat. You intend to sell the wheat to local elevators after it's harvested, but you don't know the price you will be quoted by the elevator at the time of sale (many things can change in the span of several months). It costs you \$6.00/bu to produce the wheat and you are only interested in earning a profit on your product (that is, you're not interested in using the futures market to speculate on prices). Respond to the following:

   (a) What position would you take in the futures market to offset local price variability risk? Why?

   (b) What is the lowest futures contract price you would need to observe in order to guarantee a per bushel profit?

   (c) Suppose that in May you take a position on a July futures contract that is priced at \$7.50/bu. Explain what you would do in July just before the contract expires.

   (d) Assume that futures and local prices converge (are exactly the same in July). Given that you took a May-July futures contract priced at \$7.50, calculate your per bushel profits *in the local* and *in the futures* markets if the price in July was one of the following (construct a table to summarize your results):

      i. \$5.50/bu
      ii. \$6.75/bu
      iii. \$7.50/bu
      iv. \$9.25/bu

3. Consider the scenario in problem (2). In addition to the given information, you know that you operate a 2,500 acre farm that, on average, yields 45 bushels per acre. However, there is also yield risk, and you know that you typically observe production on 2,200 of the 2,500 acres. You are risk averse and wish to hedge as much risk as possible. Additionally, you wish to sell your wheat in August, rather than July. Respond to the following:

   (a) How much wheat (in bushels) do you expect to produce?

   (b) How much wheat can you hedge using futures markets? Is there any wheat that will not be hedged?

(c) How many futures contracts will you need to establish?

(d) What position would you take in the futures market to offset local price variability risk? Why?

(e) Given that you want to sell the wheat in a local market in August, which futures contract month will you choose? Why?

(f) Explain what you would do just before the contract expires in order to offset your futures contract obligations. 6b2‘

i. Local: \$5.50/bu; Futures: \$6.25/bu

ii. Local: \$6.75/bu; Futures: \$7.20/bu

iii. Local: \$9.15/bu; Futures: \$9.50/bu

iv. Local: \$9.75/bu; Futures: \$10.25/bu

4. You are a feedlot operator that purchases feeder cattle. You will purchase 2,000 head of feeders in August, and each feeder is on average 700 lbs. You will raise these cattle to a weight of 1,200 lbs. and the variable feed costs are \$0.70 per pound of weight gain. Feed acquisition has been forward contracted and, therefore, feed price will not change. It will take four months to raise the cattle to weight and you will sell them in December. Assume that all of the cattle will be raised to weight.

   You wish to hedge both the input (feeder cattle) price and the output (fed cattle) price. The current feeder cattle futures contract is trading at \$1.45/lb. and the fed cattle futures contract is trading at \$1.30/lb. You will purchase feeder cattle at a stockyard for the established price and you will sell the fed cattle to a local processing plant at the going local market price. Respond to the following:

   (a) What are the contract specifications for feeder and for fed cattle? That is, how many pounds are contracted using a futures contract?

   (b) How many pounds of fed cattle do you expect to produce with the acquired feeder cattle? What is the expected net revenue (profit) if current conditions do not change?

   (c) How much (in pounds) of the feeder cattle can you hedge? How many contracts will be required?

   (d) How much (in pounds) of the fed cattle can you hedge? How many contracts will be required?

   (e) What positions would you take in the futures market to offset local price variability risk for feeder cattle and for fed cattle? Why?

   (f) Explain what you would do in just before the contracts expire in order to offset your futures contract obligations.

(g) Calculate your net profits *in the local* and equity *in the futures* markets for the following price scenarios:

i. Local feeders: \$1.00/lb; Futures feeders: \$1.05/lb Local fed: \$0.95/lb; Futures fed: \$0.90/lb.

ii. Local feeders: \$1.15/lb; Futures feeders: \$1.20/lb Local fed: \$1.10/lb; Futures fed: \$1.05/lb.

iii. Local feeders: \$1.45/lb; Futures feeders: \$1.55/lb Local fed: \$1.30/lb; Futures fed: \$1.30/lb.

iv. Local feeders: \$1.55/lb; Futures feeders: \$1.60/lb Local fed: \$1.40/lb; Futures fed: \$1.25/lb.

5. In your own words (i.e., in a manner that you would explain it to someone who has not taken this course) explain the intuition behind basis. Why does a basis occur? (Provide some specific factors in answering the latter question.)

6. Using the table below, calculate the basis for the first week of April in the Great Falls, MT region for ordinary winter hard red wheat (HRW). Then, using these calculations, predict the local prices in the Great Falls region in 2015, 2016, and 2017 based on the known April futures contract prices.

Market	**Month**	**Year**	**July KCBT Contract**	**Local HRW \$**	**Basis**
Great Falls	April	2003	3.11	2.90	
Great Falls	April	2004	2.83	2.96	
Great Falls	April	2005	4.12	4.06	
Great Falls	April	2006	4.09	3.74	
Great Falls	April	2007	3.39	3.11	
Great Falls	April	2008	3.63	3.05	
Great Falls	April	2009	5.24	4.67	
Great Falls	April	2010	9.18	8.95	
Great Falls	April	2011	5.18	4.01	
Great Falls	April	2012	5.65	4.20	
Great Falls	April	2013	7.30	4.95	
Great Falls	April	2014	7.14	5.65	
Great Falls	April	2015	7.28		
Great Falls	April	2016	7.89		
Great Falls	April	2017	6.19		

You are a Montana winter wheat farmer who will seek to sell the wheat in July 2015 at the local cash price. You know that the historical July basis for your region is –$0.30/bu. In April, the July 2015 futures contract price is $7.55/bu. Your total production costs are $5.25/bu.

Complete the following:

7. Calculate the price at which you expect to sell in your local market.
8. Suppose that you don't hedge. That is, you fully take on price risk. Assuming that the historical basis holds, calculate your profits if the price of a July 2015 futures contract at expiration when prices are:
   (a) $4.25
   (b) $8.75
   (c) $10.50
9. Now, suppose that you do hedge, and therefore exchange price risk for basis risk. That is, you establish a futures hedge in April using the July 2015 contract. In April 2015, calculate your local market profit, futures equity, and total profit under the following scenarios (there are 9 total scenarios—3 basis scenarios associated with a particular futures price):
   (a) Futures: $4.25; Actual basis: –$0.15, –$0.25, –$0.30
10. Is basis risk *less* or *more* risky than price risk?

You are a feedlot operator who raises feeder cattle up to weight (1,200 lbs.) and then sells them to a processing facility. Each time that you sell a pen of animals to the processor, you need to replenish your feedlot with a new set of feeder cattle. When you replenish your feedlot, you also need to purchase enough feed (corn) to bring the new set of animals up to weight. The production of fed cattle requires labor, the costs of which you will have to incur at the time that you sell the fed cattle to the processing facility.

Because you purchase feeder cattle and corn on the local markets, you worry that price volatility in the price of these inputs can cause you to forgo profits. Because feeder cattle and corn futures contracts exist, you wish to hedge local price risk using futures markets. Feeder cattle contracts are sold in 50,000 pound increments and corn contracts are sold in

5,000 bushel increments.

It is now December 2014 and you will sell one of your fed cattle in May 2015. At that point, you will replenish your feedlot with the same number of animals. The number of animals that you will sell and replenish is determined by equilibrium market conditions.

The following list provides several additional assumptions and information (which may be relevant or irrelevant):

- In May, you will sell 200 steers to the processing plant at an agreed \$1.60/lb.
- Assume that each feeder steer weighs 750 lbs. when it enters the feedlot.
- Assume that the number of pounds of feed necessary for a steer to reach weight is 2,750 lbs.
- Each bushel of corn weights 55 pounds.
- Assume that labor costs are \$160 per steer.
- The current price of a May feeder cattle futures contract is: $F_{may}^{feeder} = \$1.60/lb.$
- The current price of a May corn futures contract is: $F_{may}^{corn} = \$4.75/bu.$
- The current price of an June fed cattle futures contract is: $F_{june}^{fed} = \$1.22/lb.$
- The margin requirement for hedgers is 8%.
- Historical price information is as follows:

Date	Corn Cash	Corn Futures	Feeders Cash	Feeders Futures	Fed Cash	Fed Futures
May 2008	\$3.25	\$3.10	\$0.95	\$0.90	\$0.75	\$0.85
May 2009	\$6.50	\$5.90	\$0.85	\$0.80	\$0.75	\$0.90
May 2010	\$7.20	\$6.80	\$0.95	\$0.95	\$0.80	\$0.95
May 2011	\$6.80	\$6.25	\$1.10	\$1.00	\$0.90	\$1.00
May 2012	\$7.10	\$7.20	\$1.15	\$1.05	\$0.95	\$1.00
May 2013	\$6.10	\$5.55	\$1.30	\$1.25	\$1.10	\$1.25
May 2014	\$5.25	\$5.00	\$1.75	\$1.70	\$1.40	\$1.55

11. Determine your expected profit in May. That is, the profit that you would expect to obtain (given the current market information) after you sell the fed cattle to processing plant, purchase feeder cattle and feed to replenish the feedlot, and pay for the labor.

12. Explain how you will use the futures market to hedge the price risks. Be specific in discussing which commodities you will want to hedge and what costs you would need to incur in order to be able to use futures markets for hedging price risk.

13. Determine what your actual May 2014 profits (or losses) if the following scenario occurs:

    - Actual feeder cattle basis in May is: $B_{may}^{feeder} = 0.02/lb.$
    - Actual corn basis in May is: $B_{may}^{corn} = 0.30/bu.$
    - Actual fed cattle basis in May is: $B_{may}^{fed} = -0.15/lb.$
    - The May price of a May feeder cattle futures contract is: $F_{may}^{feeder} = \$1.50/lb.$
    - The May price of a May corn futures contract is: $F_{may}^{corn} = \$4.20/bu.$