

## 2. SUPPLY AND PROFIT

### LEARNING OBJECTIVES

1. What is supply?
2. What are gains made by sellers called?
3. What assumptions are commonly made about supply?
4. What causes supply to rise or fall?
5. What are goods produced together called?
6. How do the prices of one good influence supply for other goods?

#### Supply

The function that gives the quantity offered for sale as a function of price.

The term **supply** refers to the function that gives the quantity offered for sale as a function of price. The supply curve gives the number of units that will be supplied on the horizontal axis, as a function of the price on the vertical axis; Figure 2.1 illustrates a supply curve. Generally supply is upward sloping, because if it is a good deal for a supplier to sell 50 units of a product at a price of \$10, then it is an even better deal to supply those same 50 at a price of \$11. The seller might choose to sell more than 50, but if the first 50 aren't worth keeping at a price of \$10, then it remains true at \$11.<sup>[5]</sup>

The seller with cost  $c(q)$  of selling  $q$  units obtains a profit, at price  $p$  per unit, of  $pq - c(q)$ . The quantity that maximizes profit for the seller is the quantity  $q^*$  satisfying  $0 = \frac{d}{dq}pq - c(q) = p - c'(q^*)$ .

Thus, "price equals marginal cost" is a characteristic of profit maximization; the supplier sells all the units whose cost is less than price, and doesn't sell the units whose cost exceeds price. In constructing the demand curve, we saw that it was the inverse of the marginal value. There is an analogous property of supply: The supply curve is the inverse function of marginal cost. Graphed with the quantity supplied on the horizontal axis and price on the vertical axis, the supply curve is the marginal cost curve, with marginal cost on the vertical axis.

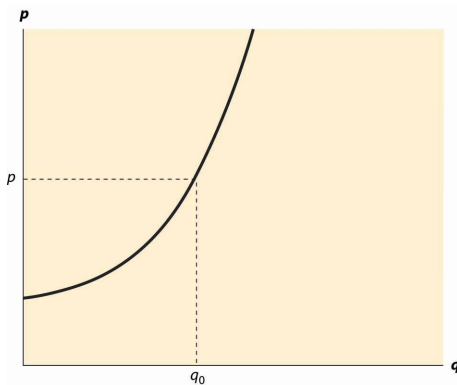
Analogous to consumer surplus with demand, profit is given by the difference of the price and marginal cost

$$\text{Profit} = \max_q pq - c(q) = pq^* - c(q^*) = \int_0^{q^*} (p - c'(x)) dx$$

This area is shaded in Figure 2.2.

The relationship of demand and marginal value exactly parallels the relationship of supply and marginal cost, for a somewhat hidden reason. Supply is just negative demand; that is, a supplier is just the possessor of a good who doesn't keep it but, instead, offers it to the market for sale. For example, when the price of housing goes up, one of the ways people demand less is by offering to rent a room in their house; that is, by supplying some of their housing to the market. Similarly, the marginal cost of supplying a good already produced is the loss of not having the good; that is, the marginal value of the good. Thus, with exchange, it is possible to provide the theory of supply and demand entirely as a theory of net demand, where sellers are negative demanders. There is some mathematical economy in this approach, and it fits certain circumstances better than separating supply and demand. For example, when the price of electricity rose very high in the western United States in 2003, several aluminum smelters resold electricity that they had purchased in long-term contracts; in other words, demanders became suppliers.

FIGURE 2.1 The supply curve



However, the “net demand” approach obscures the likely outcomes in instances where the sellers are mostly distinct from the buyers. Moreover, while there is a theory of complements and substitutes for supply that is exactly parallel to the equivalent theory for demand, the nature of these complements and substitutes tends to be different. For these reasons, and also for the purpose of being consistent with common economic usage, we will distinguish supply and demand.

An increase in supply refers to either more units available at a given price or a lower price for the supply of the same number of units. Thus, an increase in supply is graphically represented by a curve that is lower or to the right, or both; that is, to the southeast. This is illustrated in Figure 2.3. A decrease in supply is the reverse case, a shift to the northwest.

Anything that increases costs of production will tend to increase marginal cost and thus reduce the supply. For example, as wages rise, the supply of goods and services is reduced because wages are the input price of labor. Labor accounts for about two-thirds of all input costs, and thus wage increases create supply reductions (a higher price is necessary to provide the same quantity) for most goods and services. Costs of materials of course increase the price of goods using those materials. For example, the most important input into the manufacture of gasoline is crude oil, and an increase of \$1 in the price of a 42-gallon barrel of oil increases the price of gasoline about two cents—almost one-for-one by volume. Another significant input in many industries is capital and, as we will see, interest is the cost of capital. Thus, increases in interest rates increase the cost of production, and thus tend to decrease the supply of goods.

Analogous to complements in demand, a complement in supply to a good  $x$  is a good  $y$  such that an increase in the production of  $y$  increases the supply of  $x$ . In demand, a **complement in supply** is a good whose cost falls as the amount produced of another good rises. Complements in supply are usually goods that are jointly produced. In producing lumber (sawn boards), a large quantity of wood chips and sawdust are also produced as a byproduct. These wood chips and sawdust are useful in the manufacture of paper. An increase in the price of lumber tends to increase the quantity of trees sawn into boards, thereby increasing the supply of wood chips. Thus, lumber and wood chips are complements in supply.

It turns out that copper and gold are often found in the same kinds of rock—the conditions that give rise to gold compounds also give rise to copper compounds. Thus, an increase in the price of gold tends to increase the number of people prospecting for gold and, in the process, increases not just the quantity of gold supplied to the market but also the quantity of copper. Thus, copper and gold are complements in supply.

The classic supply-complement is beef and leather—an increase in the price of beef increases the slaughter of cows, thereby increasing the supply of leather.

The opposite of a complement in supply is a **substitute in supply**. This is a good whose cost rises as the amount produced of another good rises. Military and civilian aircraft are substitutes in supply—an increase in the price of military aircraft will tend to divert resources used in the manufacture of aircraft toward military aircraft and away from civilian aircraft, thus reducing the supply of civilian aircraft. Wheat and corn are also substitutes in supply. An increase in the price of wheat will lead farmers whose land is well-suited to producing either wheat or corn to substitute wheat for corn, thus increasing the quantity of wheat and decreasing the quantity of corn. Agricultural goods grown on the same type of land usually are substitutes. Similarly, cars and trucks, tables and desks, sweaters and sweat-shirts, horror movies and romantic comedies are all examples of substitutes in supply.

Complements and substitutes are important because they are common and have predictable effects on demand and supply. Changes in one market spill over to the other market through the mechanism of complements or substitutes.

FIGURE 2.2 Supplier profits

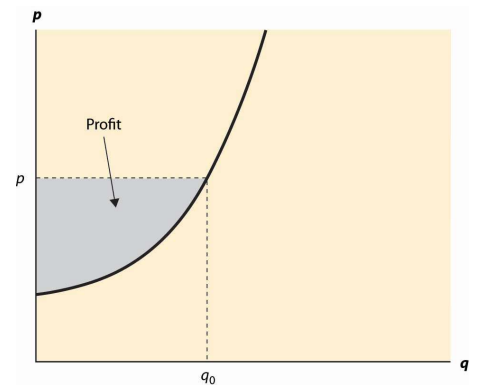
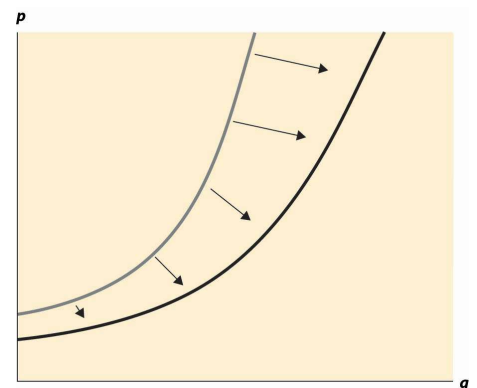


FIGURE 2.3 An increase in supply



#### Complement in supply

A good whose cost falls as the amount produced of another good rises.

#### Substitute in supply

A good whose cost rises as the amount produced of another good rises.

## KEY TAKEAWAYS

- The supply curve gives the number of units as a function of the price that will be supplied for sale to the market.
- Price equals marginal cost is an implication of profit maximization; the supplier sells all the units whose cost is less than price, and doesn't sell the units whose cost exceeds price.
- The supply curve is the inverse function of marginal cost. Graphed with the quantity supplied on the horizontal axis and price on the vertical axis, the supply curve is the marginal cost curve, with marginal cost on the vertical axis.
- Profit is given by the difference of the price and marginal cost.
- Supply is negative demand.
- An increase in supply refers to either more units available at a given price or a lower price for the supply of the same number of units. Thus, an increase in supply is graphically represented by a curve that is lower or to the right, or both; that is, to the southeast. A decrease in supply is the reverse case, a shift to the northwest.
- Anything that increases costs of production will tend to increase marginal cost and thus reduce the supply.
- A complement in supply to a good  $x$  is a good  $y$  such that an increase in the price of  $y$  increases the supply of  $x$ .
- The opposite of a complement in supply is a substitute in supply.