



The horizontal axis measures the amount of *air pollution reduction*, as exemplified by a level of nitrogen oxides (NOX) of 10 parts per 100 million (pphm); the vertical axis measures the increased value of a home associated with those reductions. Consider, for example, the demand for cleaner air of a homeowner in a city in which the air is rather dirty. If the family were required to pay \$1000 for each 1 pphm reduction in air pollution, it would choose A on the demand curve in order to obtain a pollution reduction of 5 pphm.

How much is a 50-percent, or 5-pphm, reduction in pollution worth to this same family? We can measure this value by calculating the consumer surplus associated with reducing air pollution. Because the price for this reduction is \$1000 per unit, the family would pay \$5000. However, the family values all but the last unit of reduction by more than \$1000. As a result, the yellow-shaded triangle in Figure 4.16 gives the value of the cleanup (above and beyond the payment). Because the demand curve is a straight line,

the surplus can be calculated from the area of the triangle whose height is \$1000 ($\$2000 - \1000) and whose base is 5 pphm. Therefore, the value to the household of the nitrogen oxide pollution reduction is \$2500.

A more recent study that focused on suspended particulates also found that households place substantial value on air pollution reduction.⁹ A one-milligram per cubic meter reduction in total suspended particulates (from a mean of about 60 milligrams per cubic meter) was valued at \$2,400 per household.

A complete cost-benefit analysis would use a measure of the total benefit of the cleanup—the benefit per household times the number of households. This figure could be compared with the total cost of the cleanup to determine whether such a project was worthwhile. We will discuss clean air further in Chapter 18, when we describe the tradeable emissions permits that were introduced by the Clean Air Act Amendments of 1990.

4.5 Network Externalities

So far, we have assumed that people's demands for a good are independent of one another. In other words, Tom's demand for coffee depends on Tom's tastes and income, the price of coffee, and perhaps the price of tea. But it does not depend on Dick's or Harry's demand for coffee. This assumption has enabled us to obtain the market demand curve simply by summing individuals' demands.

For some goods, however, one person's demand also depends on the demands of *other* people. In particular, a person's demand may be affected by the number of other people who have purchased the good. If this is the case, there exists a **network externality**. Network externalities can be positive or negative. A *positive* network externality exists *if the quantity of a good demanded by a typical consumer increases in response to the growth in purchases of other consumers*. If the quantity demanded decreases, there is a *negative* network externality.

• **network externality**
Situation in which each individual's demand depends on the purchases of other individuals.

Positive Network Externalities

One example of a positive network externality is word processing. Many students use Microsoft Word in part because their friends and many of their professors do as well. That allows us to send and receive drafts without the need to convert from one program to another. The more people use a particular product or participate in a particular activity, the greater the intrinsic value of that activity or product to each individual.

Social network websites provide another good example. If I am the only member of that site, it will have no value to me. But the greater number of

⁹Kenneth Y. Chay and Michael Greenstone, "Does Air Quality Matter? Evidence from the Housing Market," *Journal of Political Economy* 113 (2005): 376–424.

• **bandwagon effect** Positive network externality in which a consumer wishes to possess a good in part because others do.

people who join the site, the more valuable it will become. If one social networking site has a small advantage in terms of market share early on, the advantage will grow, because new members will prefer to join the larger site. Hence the huge success of personal website Facebook and professional website LinkedIn. A similar story holds for virtual worlds and for multiplayer online games.

Another example of a positive network externality is the **bandwagon effect**—the desire to be in style, to possess a good because almost everyone else has it, or to indulge a fad. The bandwagon effect often arises with children's toys (video games, for example). In fact, exploiting this effect is a major objective in marketing and advertising toys. Often it is the key to success in selling clothing.

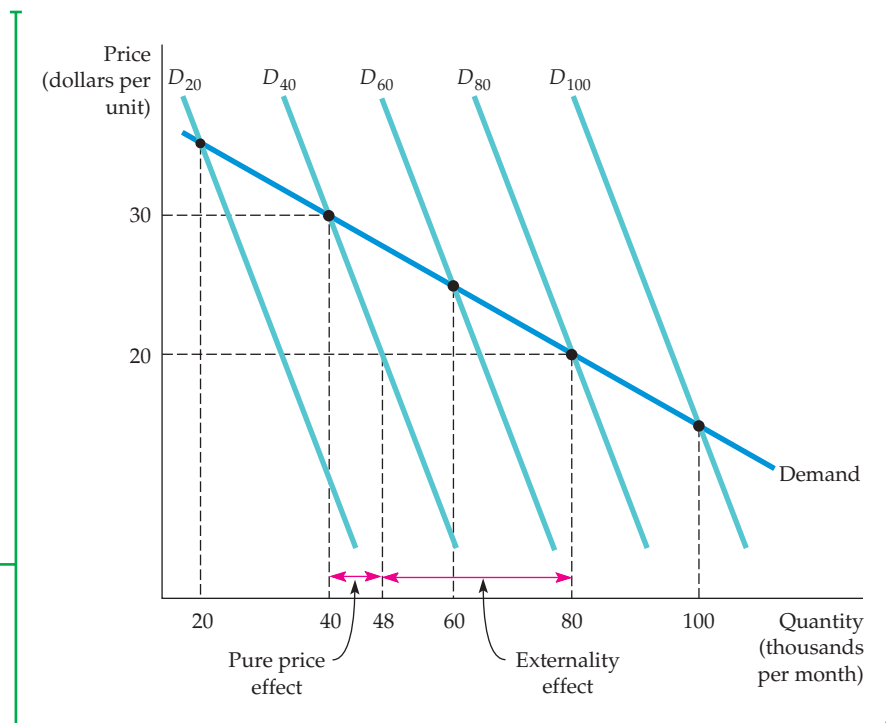
Positive network externalities are illustrated in Figure 4.17, in which the horizontal axis measures the sales of a product in thousands per month. Suppose consumers think that only 20,000 people have purchased a certain product. Because this is a small number relative to the total population, consumers will have little incentive to buy the product. Some consumers may still buy it (depending on price), but only for its intrinsic value. In this case demand is given by the curve D_{20} . (This hypothetical demand curve assumes that there are no externalities.)

Suppose instead that consumers think 40,000 people have bought the product. Now they find it more attractive and want to buy more. The demand curve is D_{40} , which is to the right of D_{20} . Similarly, if consumers think that 60,000 people have bought the product, the demand curve will be D_{60} , and so on. The more people consumers believe to have purchased the product, the farther to the right the demand curve shifts.

Ultimately, consumers will get a good sense of how many people have in fact purchased a product. This number will depend, of course, on its price. In Figure 4.17, for example, we see that if the price were \$30, then 40,000 people would buy the product. Thus the relevant demand curve would be D_{40} . If the price were \$20, 80,000 people would buy the product and the relevant demand curve would be D_{80} . The market demand curve is therefore found by joining the

FIGURE 4.17
POSITIVE NETWORK EXTERNALITY

With a positive network externality, the quantity of a good that an individual demands grows in response to the growth of purchases by other individuals. Here, as the price of the product falls from \$30 to \$20, the positive externality causes the demand for the good to shift to the right, from D_{40} to D_{80} .





points on the curves D_{20} , D_{40} , D_{60} , D_{80} , and D_{100} that correspond to the quantities 20,000, 40,000, 60,000, 80,000 and 100,000.

Compared with the curves D_{20} , etc., the market demand curve is relatively elastic. To see why the positive externality leads to a more elastic demand curve, consider the effect of a drop in price from \$30 to \$20, with a demand curve of D_{40} . If there were no externality, the quantity demanded would increase from 40,000 to only 48,000. But as more people buy the product, the positive network externality increases the quantity demanded further, to 80,000. Thus, the positive network externality increases the response of demand to price changes—i.e., it makes demand more elastic. As we'll see later, this result has important implications for producers' pricing strategies.

Negative Network Externalities

Network externalities are sometimes negative. Congestion offers one example. When skiing, I prefer short lines at ski lifts and fewer skiers on the slopes. As a result, the value of a lift ticket at a ski resort is lower the more people who bought the tickets. Likewise for entry to an amusement park, skating rink, or beach.

Another example of a negative network externality is the **snob effect**—the desire to own an exclusive or unique good. The quantity demanded of a “snob good” is higher the *fewer* people who own it. Rare works of art, specially designed sports cars, and made-to-order clothing are snob goods. The value one gets from a painting or a sports car is partly the prestige, status, and exclusivity resulting from the fact that few other people own one like it.

Figure 4.18 illustrates how a negative network externality works. We will assume that the product in question is a snob good, so people value exclusivity.

• **snob effect** Negative network externality in which a consumer wishes to own an exclusive or unique good.

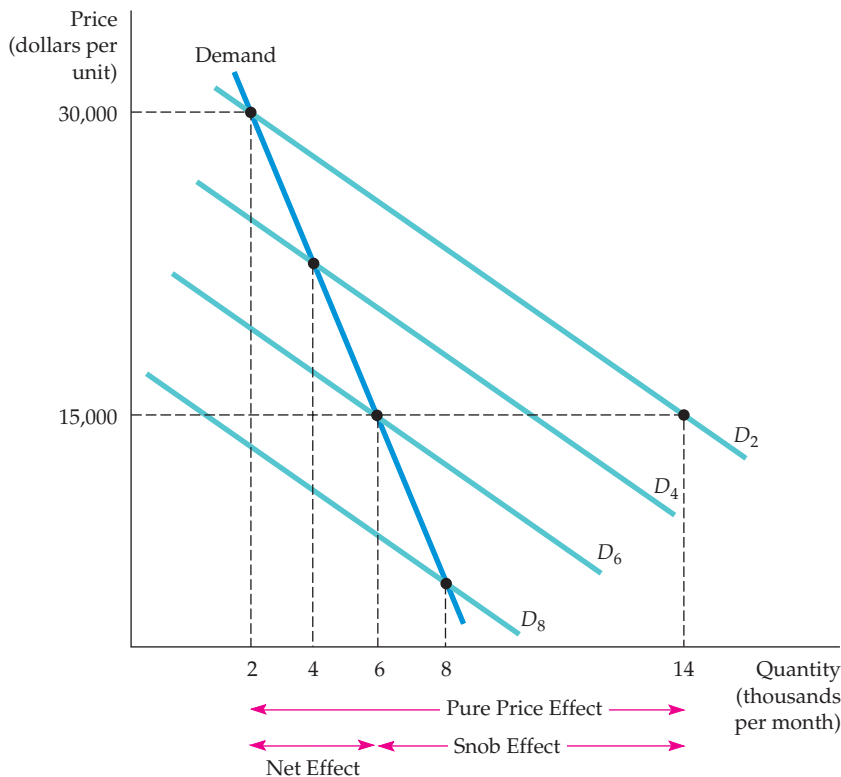


FIGURE 4.18
NEGATIVE NETWORK EXTERNALITY: SNOB EFFECT

The snob effect is a negative network externality in which the quantity of a good that an individual demands falls in response to the growth of purchases by other individuals. Here, as the price falls from \$30,000 to \$15,000 and more people buy the good, the snob effect causes the demand for the good to shift to the left, from D_2 to D_8 .



In the figure, D_2 is the demand curve that would apply if consumer believed that only 2000 people used the good. If they believe that 4000 people use the good, it would be less exclusive, and so its value decreases. The quantity demanded will therefore be lower; curve D_4 applies. Similarly, if consumers believe that 6000 people use the good, demand is even smaller and D_6 applies. Eventually, consumers learn how widely owned the good actually is. Thus, the market demand curve is found by joining the points on curves D_2 , D_4 , D_6 , etc., that actually correspond to the quantities 2000, 4000, 6000, etc.

Note that the negative network externality makes market demand *less* elastic. To see why, suppose the price was initially \$30,000 with 2000 people using the good. What happens when the price is lowered to \$15,000? If there were no externality, the quantity purchased would increase to 14,000 (along curve D_2). But the value of the good is greatly reduced if more people own it. The negative network externality dampens the increase in the quantity demanded, cutting it by 8000 units; the net increase in sales is only to 6000 units.

For a variety of goods, marketing and advertising are geared to creating a snob effect. (Think of Rolex watches.) The goal is a very inelastic demand—which makes it possible for firms to charge very high prices.

Negative network externalities can arise for other reasons. Consider the effect of congestion in queues. Because I prefer short lines and fewer skiers on the slopes, the value I obtain from a lift ticket at a ski resort is lower the more people there are who have bought tickets. Likewise for entry to an amusement park, skating rink, or beach.¹⁰

EXAMPLE 4.7 FACEBOOK

The social networking website, Facebook, began operation in 2004 and had a million users by the end of the year. By early 2011, with over 600 million users, Facebook became the world's second most visited website (after Google). A strong positive network externality was central to Facebook's success.

To understand this, just ask yourself why you would join Facebook rather than some other social networking site. You would join because so many other people have joined. The more friends that also joined, the more useful the site becomes for you as a way to share news and other information with friends. Conversely, if you are the only one of



your social circle who does not use Facebook, you may find yourself out of the loop with respect to news and upcoming events. With more members, there are more people to meet or reconnect with, a bigger audience for your photos and opinions, and generally, a larger variety of content for you to enjoy. In Table 4.5, you can see that as the number of Facebook users has grown, the time the average user spent on the site grew as well.

Network externalities have been crucial drivers for many modern technologies over many years.

Telephones, fax machines, email, Craigslist, Second Life, and Twitter are just a few examples.

¹⁰Tastes, of course, differ. Some people associate a *positive* network externality with skiing or a day on the beach; they enjoy crowds and may even find the slope or beach lonely without them.