E L A S T I C I T Y A N D

I T S A P P L I C A T I O N

THE ELASTICITY OF DEMAND

elasticity

*a measure of the responsiveness of quantity demanded or quantity supplied to one of its determinants*

price elasticity of demand *a measure of how much the quantity demanded of a good responds to a change in the price of that good, computed as the percentage change*

*in quantity demanded divided by the*

*percentage change in price*

When we discussed the determinants of demand in Chapter 4, we noted that buy- ers usually demand more of a good when its price is lower, when their incomes are higher, when the prices of substitutes for the good are higher, or when the prices of complements of the good are lower. Our discussion of demand was qualitative, not quantitative. That is, we discussed the direction in which the quantity de- manded moves, but not the size of the change. To measure how much demand re- sponds to changes in its determinants, economists use the concept of **elasticity.**

THE PRICE ELASTICITY OF DEMAND AND ITS DETERMINANTS

The law of demand states that a fall in the price of a good raises the quantity de- manded. The **price elasticity of demand** measures how much the quantity de- manded responds to a change in price. Demand for a good is said to be *elastic* if the quantity demanded responds substantially to changes in the price. Demand is said to be *inelastic* if the quantity demanded responds only slightly to changes in the price.

What determines whether the demand for a good is elastic or inelastic? Be- cause the demand for any good depends on consumer preferences, the price elas- ticity of demand depends on the many economic, social, and psychological forces that shape individual desires. Based on experience, however, we can state some general rules about what determines the price elasticity of demand.

Necessities versus Luxuries Necessities tend to have inelastic de- mands, whereas luxuries have elastic demands. When the price of a visit to the doctor rises, people will not dramatically alter the number of times they go to the doctor, although they might go somewhat less often. By contrast, when the price of sailboats rises, the quantity of sailboats demanded falls substantially. The reason is that most people view doctor visits as a necessity and sailboats as a luxury. Of course, whether a good is a necessity or a luxury depends not on the intrinsic properties of the good but on the preferences of the buyer. For an avid sailor with

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little concern over his health, sailboats might be a necessity with inelastic demand and doctor visits a luxury with elastic demand.

A vailability of Close Substitutes Goods with close substitutes tend to have more elastic demand because it is easier for consumers to switch from that good to others. For example, butter and margarine are easily substitutable. A small increase in the price of butter, assuming the price of margarine is held fixed, causes the quantity of butter sold to fall by a large amount. By contrast, because eggs are a food without a close substitute, the demand for eggs is probably less elastic than the demand for butter.

Definition of the Market The elasticity of demand in any market de- pends on how we draw the boundaries of the market. Narrowly defined markets tend to have more elastic demand than broadly defined markets, because it is easier to find close substitutes for narrowly defined goods. For example, food, a broad category, has a fairly inelastic demand because there are no good substitutes for food. Ice cream, a more narrow category, has a more elastic demand because it is easy to substitute other desserts for ice cream. Vanilla ice cream, a very narrow category, has a very elastic demand because other flavors of ice cream are almost perfect substitutes for vanilla.

T ime Horizon Goods tend to have more elastic demand over longer time horizons. When the price of gasoline rises, the quantity of gasoline demanded falls only slightly in the first few months. Over time, however, people buy more fuel- efficient cars, switch to public transportation, and move closer to where they work. Within several years, the quantity of gasoline demanded falls substantially.

COMPUTING THE PRICE ELASTICITY OF DEMAND

Now that we have discussed the price elasticity of demand in general terms, let’s be more precise about how it is measured. Economists compute the price elasticity of demand as the percentage change in the quantity demanded divided by the per- centage change in the price. That is,

Price elasticity of demand

Percentage change in quantity demanded

Percentage change in price .

For example, suppose that a 10-percent increase in the price of an ice-cream cone causes the amount of ice cream you buy to fall by 20 percent. We calculate your elasticity of demand as

20 percent

Price elasticity of demand 10 percent 2.

In this example, the elasticity is 2, reflecting that the change in the quantity de- manded is proportionately twice as large as the change in the price.

Because the quantity demanded of a good is negatively related to its price, the percentage change in quantity will always have the opposite sign as the

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percentage change in price. In this example, the percentage change in price is a *pos- itive* 10 percent (reflecting an increase), and the percentage change in quantity de- manded is a *negative* 20 percent (reflecting a decrease). For this reason, price elasticities of demand are sometimes reported as negative numbers. In this book we follow the common practice of dropping the minus sign and reporting all price elasticities as positive numbers. (Mathematicians call this the *absolute value.*) With this convention, a larger price elasticity implies a greater responsiveness of quan- tity demanded to price.

THE MIDPOINT METHOD: A BETTER WAY TO CALCULATE PERCENTAGE CHANGES AND ELASTICITIES

If you try calculating the price elasticity of demand between two points on a de- mand curve, you will quickly notice an annoying problem: The elasticity from point A to point B seems different from the elasticity from point B to point A. For example, consider these numbers:

|  |  |  |
| --- | --- | --- |
| Point A: | Price $4 | Quantity 120 |
| Point B: | Price $6 | Quantity 80 |

Going from point A to point B, the price rises by 50 percent, and the quantity falls by 33 percent, indicating that the price elasticity of demand is 33/50, or 0.66. By contrast, going from point B to point A, the price falls by 33 percent, and the quantity rises by 50 percent, indicating that the price elasticity of demand is 50/33, or 1.5.

One way to avoid this problem is to use the *midpoint method* for calculating elasticities. Rather than computing a percentage change using the standard way (by dividing the change by the initial level), the midpoint method computes a percentage change by dividing the change by the midpoint of the initial and final levels. For instance, $5 is the midpoint of $4 and $6. Therefore, according to the midpoint method, a change from $4 to $6 is considered a 40 percent rise, because (6 4)/5 100 40. Similarly, a change from $6 to $4 is considered a 40 per- cent fall.

Because the midpoint method gives the same answer regardless of the direc- tion of change, it is often used when calculating the price elasticity of demand be- tween two points. In our example, the midpoint between point A and point B is:

Midpoint: Price $5 Quantity 100

According to the midpoint method, when going from point A to point B, the price rises by 40 percent, and the quantity falls by 40 percent. Similarly, when going from point B to point A, the price falls by 40 percent, and the quantity rises by

40 percent. In both directions, the price elasticity of demand equals 1.

We can express the midpoint method with the following formula for the price

elasticity of demand between two points, denoted (*Q*1, *P*1) and (*Q*2 , *P*2):

(*Q*2 *Q*1)/[(*Q*2 *Q*1)/2]

1

Price elasticity of demand

(*P*2

*P*1)/[(*P*2

*P* )/2] .

(a) Perfectly Inelastic Demand: Elasticity Equals 0

(b) Inelastic Demand: Elasticity Is Less Than 1

Price Price

|  |  |
| --- | --- |
|  | |
|  |  |
|  |
|  |

|  |  |  |
| --- | --- | --- |
|  | | |
|  |  | |
|  |  | Demand |

Demand

$5 $5

4

1. An increase

in price . . .

4

1. A 22%

increase

in price . . .

0 100

Quantity

0 90

100

Quantity

2. . . . leaves the quantity demanded unchanged.

2. . . . leads to an 11% decrease in quantity demanded.

Price

|  |  |  |
| --- | --- | --- |
|  | | |
|  |  | |
|  |  | Demand |

(c) Unit Elastic Demand: Elasticity Equals 1

$5

4

1. A 22%

increase

in price . . .

0 80

100

Quantity

2. . . . leads to a 22% decrease in quantity demanded.

Price

|  |  |  |
| --- | --- | --- |
|  | | |
|  |  | |
|  |  | Demand |

(d) Elastic Demand: Elasticity Is Greater Than 1

(e) Perfectly Elastic Demand: Elasticity Equals Infinity

Price

$5

4

1. A 22%

increase

1. At any price above $4, quantity demanded is zero.

$4

2. At exactly $4,

Demand

in price . . .

consumers will

buy any quantity.

0 50

100

Quantity

0

3. At a price below $4,

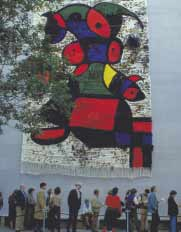
Quantity

2. . . . leads to a 67% decrease in quantity demanded.

quantity demanded is infinite.

THE PRICE ELASTICITY OF DEMAND . The price elasticity of demand determines whether the demand curve is steep or flat. Note that all percentage changes are calculated using the midpoint method.

Figure 5-1



IF THE PRICE OF ADMISSION WERE HIGHER, HOW MUCH SHORTER WOULD THIS LINE BECOME?

income elasticity of demand

*a measure of how much the quantity*

*demanded of a good responds to a*

*change in consumers’ income,*

*computed as the percentage change*

*in quantity demanded divided by the*

*percentage change in income*

CASE STUDY PRICING ADMISSION TO A MUSEUM

You are curator of a major art museum. Your director of finance tells you that the museum is running short of funds and suggests that you consider chang- ing the price of admission to increase total revenue. What do you do? Do you raise the price of admission, or do you lower it?

The answer depends on the elasticity of demand. If the demand for visits to the museum is inelastic, then an increase in the price of admission would in- crease total revenue. But if the demand is elastic, then an increase in price would cause the number of visitors to fall by so much that total revenue would decrease. In this case, you should cut the price. The number of visitors would rise by so much that total revenue would increase.

To estimate the price elasticity of demand, you would need to turn to your statisticians. They might use historical data to study how museum attendance varied from year to year as the admission price changed. Or they might use data on attendance at the various museums around the country to see how the admission price affects attendance. In studying either of these sets of data, the statisticians would need to take account of other factors that affect attendance— weather, population, size of collection, and so forth—to isolate the effect of price. In the end, such data analysis would provide an estimate of the price elas- ticity of demand, which you could use in deciding how to respond to your fi- nancial problem.

OTHER DEMAND ELASTICITIES

In addition to the price elasticity of demand, economists also use other elastici- ties to describe the behavior of buyers in a market.

The Income Elasticity of Demand Economists use the **income elasticity of demand** to measure how the quantity demanded changes as con- sumer income changes. The income elasticity is the percentage change in quan- tity demanded divided by the percentage change in income. That is,

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IN THE NEWS

*On the Road with Elasticity*

HOW SHOULD A FIRM THAT OPERATES A private toll road set a price for its ser- vice? As the following article makes clear, answering this question requires an understanding of the demand curve and its elasticity.

**For Whom the Booth Tolls, Price Really Does Matter**

BY STEVEN PEARLSTEIN

All businesses face a similar question: What price for their product will generate the maximum profit?

The answer is not always obvious: Raising the price of something often has the effect of reducing sales as price- sensitive consumers seek alternatives or simply do without. For every product, the extent of that sensitivity is different. The trick is to find the point for each where the ideal tradeoff between profit margin and sales volume is achieved.

Right now, the developers of a new

private toll road between Leesburg and

Washington-Dulles International Airport are trying to discern the magic point. The group originally projected that it could charge nearly $2 for the 14-mile one-way trip, while attracting 34,000 trips on an average day from overcrowded public roads such as nearby Route 7. But after spending $350 million to build their much heralded “Greenway,” they discovered to their dismay that only about a third that number of commuters were willing to pay that much to shave 20 minutes off their daily commute. . . .

It was only when the company, in desperation, lowered the toll to $1 that it came even close to attracting the ex- pected traffic flows.

Although the Greenway still is los- ing money, it is clearly better off at this new point on the demand curve than it was when it first opened. Average daily revenue today is $22,000, compared with $14,875 when the “special intro- ductory” price was $1.75. And with traf- fic still light even at rush hour, it is possible that the owners may lower tolls even further in search of higher revenue.

After all, when the price was low- ered by 45 percent last spring, it gener- ated a 200 percent increase in volume three months later. If the same ratio ap- plies again, lowering the toll another

25 percent would drive the daily volume up to 38,000 trips, and daily revenue up to nearly $29,000.

The problem, of course, is that the

same ratio usually does not apply at

every price point, which is why this pric- ing business is so tricky. . . .

Clifford Winston of the Brookings Institution and John Calfee of the Ameri- can Enterprise Institute have considered the toll road’s dilemma. . . .

Last year, the economists con- ducted an elaborate market test with

1,170 people across the country who were each presented with a series of op- tions in which they were, in effect, asked to make a personal tradeoff between less commuting time and higher tolls.

In the end, they concluded that the people who placed the highest value on reducing their commuting time already had done so by finding public transporta- tion, living closer to their work, or select- ing jobs that allowed them to commute at off-peak hours.

Conversely, those who commuted significant distances had a higher toler- ance for traffic congestion and were will- ing to pay only 20 percent of their hourly pay to save an hour of their time.

Overall, the Winston/Calfee find- ings help explain why the Greenway’s original toll and volume projections were too high: By their reckoning, only com- muters who earned at least $30 an hour (about $60,000 a year) would be willing to pay $2 to save 20 minutes.

SOURCE: *The Washington Post,* October 24, 1996, p. E1.

Income elasticity of demand

Percentage change in quantity demanded

Percentage change in income .



As we discussed in Chapter 4, most goods are *normal goods:* Higher income raises quantity demanded. Because quantity demanded and income move in the same direction, normal goods have positive income elasticities. A few goods, such as bus

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rides, are *inferior goods:* Higher income lowers the quantity demanded. Because quantity demanded and income move in opposite directions, inferior goods have negative income elasticities.

Even among normal goods, income elasticities vary substantially in size. Ne- cessities, such as food and clothing, tend to have small income elasticities because consumers, regardless of how low their incomes, choose to buy some of these goods. Luxuries, such as caviar and furs, tend to have large income elasticities be- cause consumers feel that they can do without these goods altogether if their in- come is too low.

THE ELASTICITY OF SUPPLY

When we discussed the determinants of supply in Chapter 4, we noted that sellers of a good increase the quantity supplied when the price of the good rises, when their input prices fall, or when their technology improves. To turn from qualita- tive to quantitative statements about supply, we once again use the concept of elasticity.

price elasticity of supply

*a measure of how much the quantity supplied of a good responds to a change in the price of that good, computed as the percentage change in quantity supplied divided by the percentage change in price*

THE PRICE ELASTICITY OF SUPPLY AND ITS DETERMINANTS

The law of supply states that higher prices raise the quantity supplied. The **price elasticity of supply** measures how much the quantity supplied responds to changes in the price. Supply of a good is said to be *elastic* if the quantity supplied

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responds substantially to changes in the price. Supply is said to be *inelastic* if the quantity supplied responds only slightly to changes in the price.

The price elasticity of supply depends on the flexibility of sellers to change the amount of the good they produce. For example, beachfront land has an inelastic supply because it is almost impossible to produce more of it. By contrast, manu- factured goods, such as books, cars, and televisions, have elastic supplies because the firms that produce them can run their factories longer in response to a higher price.

In most markets, a key determinant of the price elasticity of supply is the time period being considered. Supply is usually more elastic in the long run than in the short run. Over short periods of time, firms cannot easily change the size of their factories to make more or less of a good. Thus, in the short run, the quantity sup- plied is not very responsive to the price. By contrast, over longer periods, firms can build new factories or close old ones. In addition, new firms can enter a market, and old firms can shut down. Thus, in the long run, the quantity supplied can re- spond substantially to the price.

COMPUTING THE PRICE ELASTICITY OF SUPPLY

Now that we have some idea about what the price elasticity of supply is, let’s be more precise. Economists compute the price elasticity of supply as the percentage change in the quantity supplied divided by the percentage change in the price. That is,

Price elasticity of supply

Percentage change in quantity supplied

Percentage change in price .

For example, suppose that an increase in the price of milk from $2.85 to $3.15 a gal- lon raises the amount that dairy farmers produce from 9,000 to 11,000 gallons per month. Using the midpoint method, we calculate the percentage change in price as

Percentage change in price (3.15 2.85)/3.00 100 10 percent. Similarly, we calculate the percentage change in quantity supplied as

Percentage change in quantity supplied (11,000 9,000)/10,000 100

20 percent.

In this case, the price elasticity of supply is

20 percent

Price elasticity of supply 10 percent 2.0.

In this example, the elasticity of 2 reflects the fact that the quantity supplied moves proportionately twice as much as the price.

THE VARIETY OF SUPPLY CURVES

Because the price elasticity of supply measures the responsiveness of quantity sup- plied to the price, it is reflected in the appearance of the supply curve. Figure 5-6 shows five cases. In the extreme case of a zero elasticity, supply is *perfectly inelastic,*

(a) Perfectly Inelastic Supply: Elasticity Equals 0

(b) Inelastic Supply: Elasticity Is Less Than 1

Price Price

|  |  |
| --- | --- |
|  | |
|  |  |
|  |
|  |

Supply

Supply

$5 $5

4

1. An increase

in price . . .

4

1. A 22%

increase

in price . . .

0 100

Quantity 0

100 110

Quantity

2. . . . leaves the quantity supplied unchanged.

2. . . . leads to a 10% increase in quantity supplied.

Price

(c) Unit Elastic Supply: Elasticity Equals 1

$5

4

1. A 22%

increase

Supply

in price . . .

0 100 125

Quantity

2. . . . leads to a 22% increase in quantity supplied.

Price

(d) Elastic Supply: Elasticity Is Greater Than 1

Price

(e) Perfectly Elastic Supply: Elasticity Equals Infinity

Supply

$5

4

1. At any price above $4, quantity supplied is infinite.

$4

Supply

increase

in price . . .

2. At exactly $4, producers will

supply any quantity.

0 100 200

Quantity

0

3. At a price below $4,

Quantity

2. . . . leads to a 67% increase in quantity supplied.

quantity supplied is zero.

Figure 5-6 THE PRICE ELASTICITY OF SUPPLY. The price elasticity of supply determines whether the supply curve is steep or flat. Note that all percentage changes are calculated using the

midpoint method.

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Figure 5-7

Price

$15

12

4

3

Elasticity is large

(greater than 1).

Elasticity is small

(less than 1).

HOW THE PRICE ELASTICITY OF SUPPLY CAN VARY. Because firms often have a maximum capacity for production, the elasticity of supply may be very high at low levels of quantity supplied and very low at high levels of quantity supplied. Here, an increase in price from $3 to $4 increases the quantity supplied from 100 to 200. Because the increase in quantity supplied of

67 percent is larger than the increase in price of 29 percent, the supply curve is elastic in this

0 100 200 500

525

Quantity

range. By contrast, when the price rises from $12 to $15, the quantity supplied rises only from

500 to 525. Because the increase in quantity supplied of 5 percent is

and the supply curve is vertical. In this case, the quantity supplied is the same re-

gardless of the price. As the elasticity rises, the supply curve gets flatter, which

shows that the quantity supplied responds more to changes in the price. At the op-

posite extreme, supply is *perfectly elastic.* This occurs as the price elasticity of sup-

ply approaches infinity and the supply curve becomes horizontal, meaning that

very small changes in the price lead to very large changes in the quantity supplied.

In some markets, the elasticity of supply is not constant but varies over the

supply curve. Figure 5-7 shows a typical case for an industry in which firms have

factories with a limited capacity for production. For low levels of quantity sup-

plied, the elasticity of supply is high, indicating that firms respond substantially to

changes in the price. In this region, firms have capacity for production that is not

being used, such as plants and equipment sitting idle for all or part of the day.

Small increases in price make it profitable for firms to begin using this idle capac-

ity. As the quantity supplied rises, firms begin to reach capacity. Once capacity is

fully used, increasing production further requires the construction of new plants.

To induce firms to incur this extra expense, the price must rise substantially, so

supply becomes less elastic.

Figure 5-7 presents a numerical example of this phenomenon. When the price

rises from $3 to $4 (a 29 percent increase, according to the midpoint method), the

quantity supplied rises from 100 to 200 (a 67 percent increase). Because quantity

supplied moves proportionately more than the price, the supply curve has elastic-

ity greater than 1. By contrast, when the price rises from $12 to $15 (a 22 percent in-

crease), the quantity supplied rises from 500 to 525 (a 5 percent increase). In this

case, quantity supplied moves proportionately less than the price, so the elasticity

is less than 1.

smaller than the increase in price of 22 percent, the supply curve is inelastic in this range.

CONCLUSION

According to an old quip, even a parrot can become an economist simply by learn- ing to say “supply and demand.” These last two chapters should have convinced you that there is much truth in this statement. The tools of supply and demand allow you to analyze many of the most important events and policies that shape

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the economy. You are now well on your way to becoming an economist (or, at least, a well-educated parrot).

Summary

◆ The price elasticity of demand measures how much the quantity demanded responds to changes in the price. Demand tends to be more elastic if the good is a luxury rather than a necessity, if close substitutes are available, if the market is narrowly defined, or if buyers have substantial time to react to a price change.

◆ The price elasticity of demand is calculated as the percentage change in quantity demanded divided by the percentage change in price. If the elasticity is less than 1, so that quantity demanded moves

proportionately less than the price, demand is said to be inelastic. If the elasticity is greater than 1, so that quantity demanded moves proportionately more than the price, demand is said to be elastic.

◆ Total revenue, the total amount paid for a good, equals the price of the good times the quantity sold. For inelastic demand curves, total revenue rises as price rises. For elastic demand curves, total revenue falls as price rises.

◆ The income elasticity of demand measures how much the quantity demanded responds to changes in

consumers’ income. The cross-price elasticity of demand measures how much the quantity demanded of one

good responds to the price of another good.

◆ The price elasticity of supply measures how much the quantity supplied responds to changes in the price. This elasticity often depends on the time horizon under consideration. In most markets, supply is more elastic in the long run than in the short run.

◆ The price elasticity of supply is calculated as the percentage change in quantity supplied divided by the percentage change in price. If the elasticity is less than 1, so that quantity supplied moves proportionately less than the price, supply is said to be inelastic. If the elasticity is greater than 1, so that quantity supplied moves proportionately more than the price, supply is said to be elastic.

◆ The tools of supply and demand can be applied in many different kinds of markets. This chapter uses them to analyze the market for wheat, the market for oil, and the market for illegal drugs.