

Elasticity and Its Application

Scenario:

You design websites for local businesses.

You charge \$200 per website and currently sell 12 websites per month.

Your costs are rising (including the opportunity cost of your time), so you consider raising the price to \$250.

The law of demand says that you won't sell as many websites if you raise your price.

How many fewer websites? How much will your revenue fall, or might it increase?

These questions can be answered by using the concept of ***elasticity***, which measures how much one variable responds to changes in another variable. In other words, elasticity measure how much buyers and sellers respond to changes in market conditions

I. Price Elasticity of Demand

1. Definitions

- ❖ Price elasticity of demand measures how much Q^D responds to a change in P .
- ❖ Loosely speaking, it measures the price-sensitivity of buyers' demand.

$$\text{Price elasticity of demand} = \frac{\text{Percentage change in } Q^d}{\text{Percentage change in } P}$$

Example:

The price of ice cream rises by 10% and quantity demanded falls by 20%.

$$\text{Price elasticity of demand} = (20\%)/(10\%) = 2$$

- ❖ By its definition, we can write the price elasticity of demand (ϵ_p):

$$\epsilon_p = \left| \frac{\frac{\Delta Q}{Q}}{\frac{\Delta P}{P}} \right| = \left| \frac{\Delta Q}{\Delta P} \frac{P}{Q} \right| = \frac{1}{|\text{slope at } (Q,P)|} \frac{P}{Q}$$

From this formula, you can see that the price elasticity is a property of the point of (Q,P): different points on the demand curve may have different values.

Example:

The price rises from \$4 to \$6 and quantity demanded falls from 120 to 80. (Assume the demand curve is a straight line.)

Original point: $(Q, P) = (120, 4)$

New point: $(Q', P') = (80, 6)$

$$\text{Slope} = \frac{P' - P}{Q' - Q} = \frac{6 - 4}{80 - 120} = -\frac{2}{40}$$

Price elasticity of demand at (120, 4):

$$\epsilon_p = \frac{40}{2} \frac{4}{120} = \frac{2}{3}$$

Price elasticity of demand at (80, 6):

$$\epsilon_p = \frac{40}{2} \frac{6}{80} = \frac{3}{2}$$

2. What Determines Price Elasticity?

- ❖ **Availability of Close Substitutes**

Goods with close substitutes (e.g. breakfast cereal) tend to have more elastic demand because it is easier for consumers to switch.

- ❖ **Necessities versus Luxuries)**

Necessities (e.g. foods) tend to have inelastic demands, whereas luxuries (e.g. sailboat) have elastic demands.

- ❖ **Definition of the Market**

Narrowly defined markets (e.g. blue jean) tend to have more elastic demand than broadly defined markets (e.g. cloth) because it is easier to find close substitutes for narrowly defined goods.

- ❖ **Time Horizon**

Goods tend to have more elastic demand over longer time horizons (e.g. short-run versus long-run effect of increase in gasoline price on demand for gas).

3. Variety of Demand Curves

❖ Rule of thumb:

The flatter the curve, the bigger the elasticity.
The steeper the curve, the smaller the elasticity.

❖ Five different classifications of D curves....

- Perfectly inelastic
- Inelastic
- Unit elastic
- Elastic
- Perfectly elastic

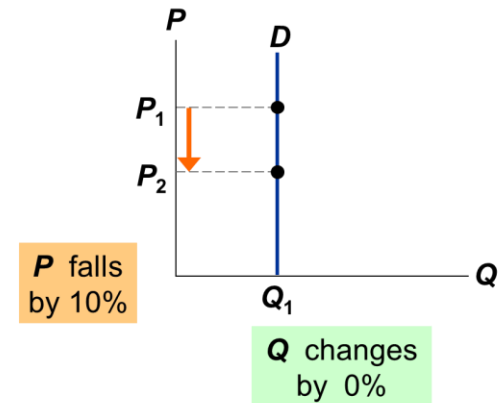
1) **Perfectly inelastic:** regardless of the price, the quantity demanded stays the same (e.g. a life saving drug)

$$\text{Price elasticity of demand} = \frac{\% \text{ change in } Q}{\% \text{ change in } P} = \frac{0\%}{10\%} = 0$$

D curve:
vertical

Consumers' price sensitivity:
none

Elasticity:
0



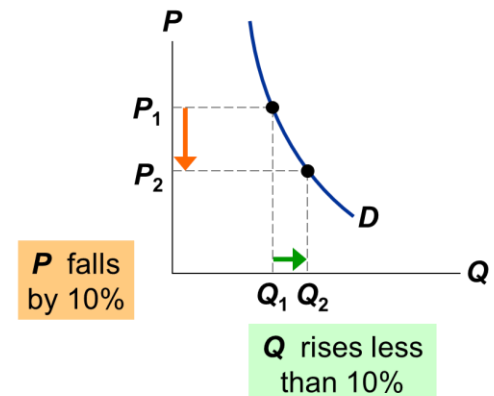
2) **Inelastic:** changes in price cause less proportional changes in quantity demanded

$$\text{Price elasticity of demand} = \frac{\% \text{ change in } Q}{\% \text{ change in } P} = \frac{< 10\%}{10\%} < 1$$

D curve:
relatively steep

Consumers' price sensitivity:
relatively low

Elasticity:
< 1



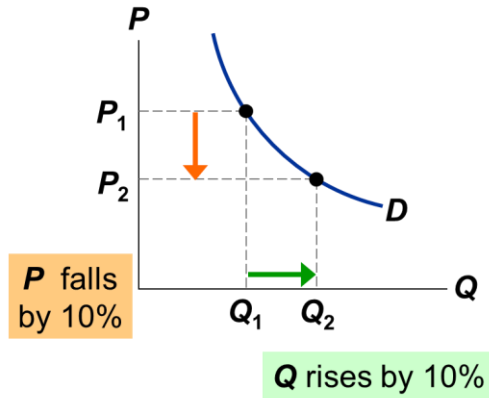
3) **Unit elastic**: changes in price cause equal proportional changes in quantity demanded

$$\text{Price elasticity of demand} = \frac{\% \text{ change in } Q}{\% \text{ change in } P} = \frac{10\%}{10\%} = 1$$

D curve:
intermediate slope

Consumers' price sensitivity:
intermediate

Elasticity:
1



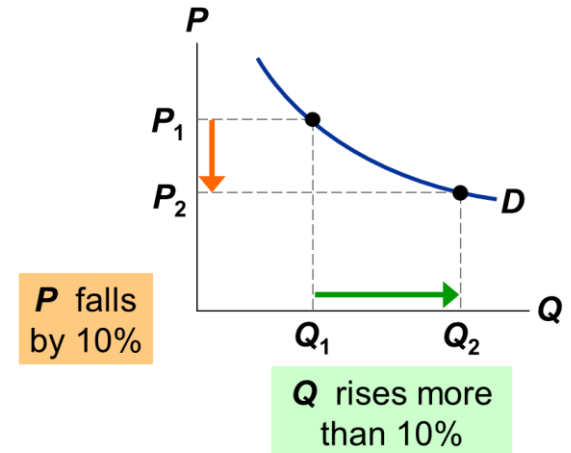
4) **Elastic**: changes in price cause more proportional changes in quantity demanded

$$\text{Price elasticity of demand} = \frac{\% \text{ change in } Q}{\% \text{ change in } P} = \frac{> 10\%}{10\%} > 1$$

D curve:
relatively flat

Consumers' price sensitivity:
relatively high

Elasticity:
> 1



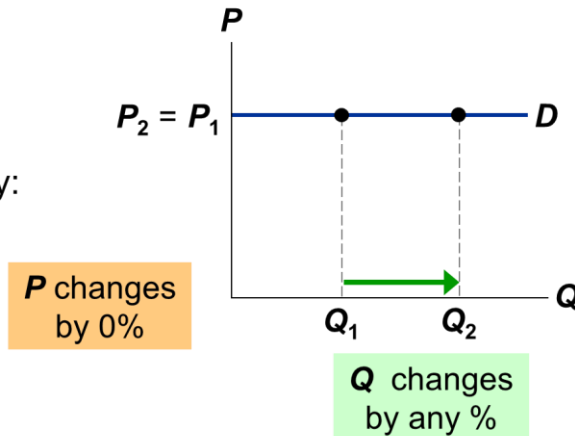
5) **Perfectly elastic:** very small changes in the price lead to huge changes in the quantity demanded (e.g. money)

$$\text{Price elasticity of demand} = \frac{\% \text{ change in } Q}{\% \text{ change in } P} = \frac{\text{any } \%}{0\%} = \text{infinity}$$

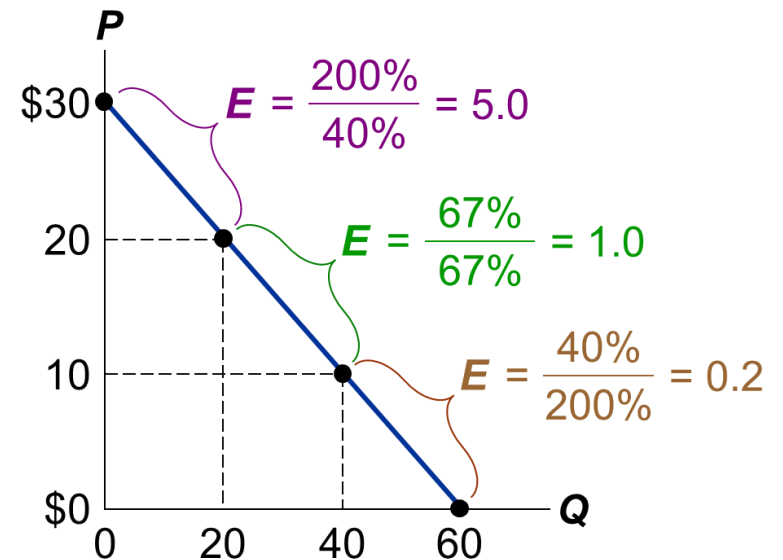
D curve:
horizontal

Consumers' price sensitivity:
extreme

Elasticity:
infinity



6) Elasticity of a Linear Demand Curve



(Note: when calculating the elasticity in the diagram above, I use the middle point as the base.)

- The slope of a linear demand curve is constant, but its elasticity is not.
- Elasticity falls as you move downward along a linear demand curve.

4. Some Statistics

Cigarettes (US)[39]	Rice[46]
-0.3 to -0.6 (General)	-0.47 (Austria)
-0.6 to -0.7 (Youth)	-0.8 (Bangladesh)
Alcoholic beverages (US)[40]	-0.8 (China)
-0.3 or -0.7 to -0.9 as of 1972 (Beer)	-0.25 (Japan)
-1.0 (Wine)	-0.55 (US)
-1.5 (Spirits)	Cinema visits (US)
Airline travel (US)[41]	-0.87 (General)[44]
-0.3 (First Class)	Live Performing Arts (Theater, etc.)
-0.9 (Discount)	-0.4 to -0.9[47]
-1.5 (for Pleasure Travelers)	Transport
Livestock	-0.20 (Bus travel US)[44]
-0.5 to -0.6 (Broiler Chickens) ^[42]	-2.8 (Ford compact automobile)[48]
Oil (World)	Soft drinks
-0.4	-0.8 to -1.0 (general)[49]
Car fuel[43]	-3.8 (Coca-Cola) ^[50]
-0.09 (Short run)	-4.4 (Mountain Dew) ^[50]
-0.31 (Long run)	Steel
Medicine (US)	-0.2 to -0.3[51]
-0.31 (Medical insurance)[44]	Eggs
-0.03 to -0.06 (Pediatric Visits) ^[45]	-0.1 (US: Household only), ^[52] -0.35 (Canada), ^[53] -0.55 (South Africa) ^[54]
Source: Wikipedia, http://en.wikipedia.org/wiki/Price_elasticity_of_demand#cite_note-ayers120-50	

5. Price Elasticity and Total Revenue

- ❖ Continuing our scenario, if you raise your price from \$200 to \$250, would your revenue rise or fall?

$$\text{Revenue} = P \times Q$$

- ❖ A price increase has two effects on revenue:
 - Higher P means more revenue on each unit you sell.
 - But you sell fewer units (lower Q), due to Law of Demand.
- ❖ Which of these two effects is bigger?

It depends on the price elasticity of demand.

- 1) ***If demand is elastic***, then
 price elast. of demand > 1
 $\% \text{ change in } Q > \% \text{ change in } P$

The fall in revenue from lower Q is greater than the increase in revenue from higher P , so revenue falls.

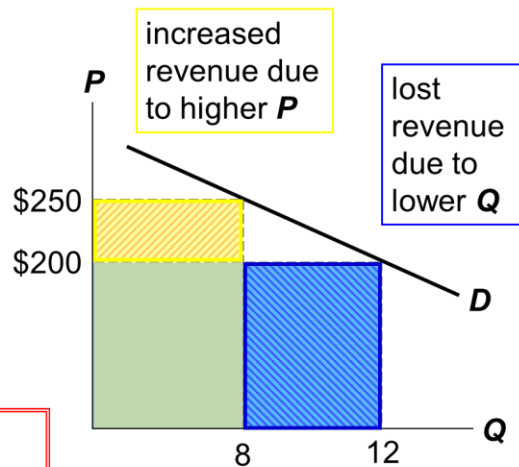
Example:

Elastic demand
 (elasticity = 1.8)

If $P = \$200$,
 $Q = 12$ and
 revenue = \$2400.

If $P = \$250$,
 $Q = 8$ and
 revenue = \$2000.

When D is elastic,
 a price increase
 causes revenue to fall.



- 2) ***If demand is inelastic***, then
 price elast. of demand < 1
 $\% \text{ change in } Q < \% \text{ change in } P$

The fall in revenue from lower Q is smaller than the increase in revenue from higher P , so revenue rises.

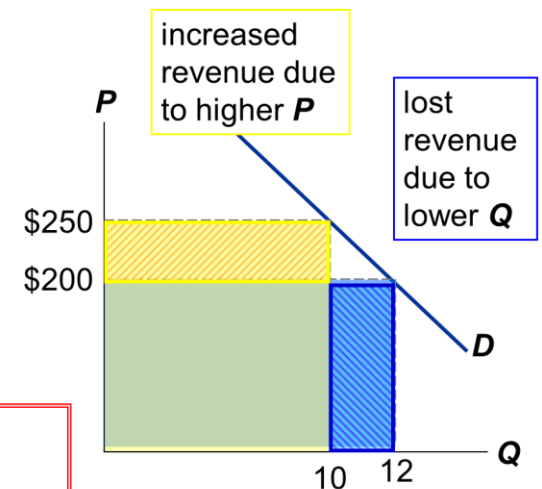
In our example, suppose that Q only falls to 10 (instead of 8) when you raise your price to \$250.

Now, demand is
 inelastic:
 elasticity = 0.82

If $P = \$200$,
 $Q = 12$ and
 revenue = \$2400.

If $P = \$250$,
 $Q = 10$ and
 revenue = \$2500.

When D is inelastic,
 a price increase
 causes revenue to rise.



Example: Elasticity and Total Revenue

- i. Pharmacies raise the price of insulin by 10%. Does total expenditure on insulin rise or fall?

$$\text{Expenditure} = P \times Q$$

Since demand is inelastic, Q will fall less than 10%, so expenditure rises.

- ii. As a result of a fare war, the price of a luxury cruise falls 20%. Does luxury cruise companies' total revenue rise or fall?

The fall in P reduces revenue,
but Q increases, which increases revenue.

Which effect is bigger?

If demand is elastic enough, Q will increase more than 20%, then revenue rises.

II. Price Elasticity of Supply

1. Definitions

$$\text{Price elasticity of supply} = \frac{\text{Percentage change in } Q^s}{\text{Percentage change in } P}$$

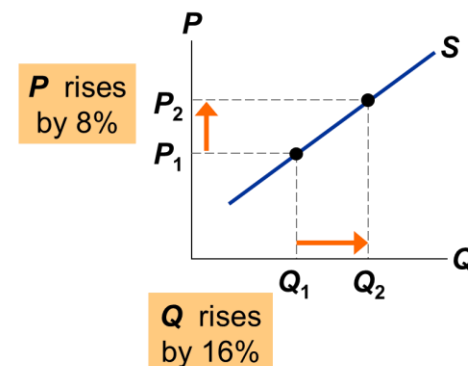
- ❖ Price elasticity of supply measures how much Q_s responds to a change in P .
- ❖ Loosely speaking, it measures sellers' price-sensitivity.
- ❖ By its definition, we can write the price elasticity of demand (e_p):

$$e_p = \left| \frac{\frac{\Delta Q}{Q}}{\frac{\Delta P}{P}} \right| = \left| \frac{\Delta Q}{\Delta P} \frac{P}{Q} \right| = \frac{1}{|\text{slope at } (Q, P)|} \frac{P}{Q}$$

Example:

Price elasticity of supply equals

$$\frac{16\%}{8\%} = 2.0$$



2. Determinants of Supply Elasticity

- ❖ The more easily sellers can change the quantity they produce, the greater the price elasticity of supply.

Example: Supply of beachfront property is harder to vary and thus less elastic than supply of new cars.

- ❖ For many goods, price elasticity of supply is greater in the long run than in the short run because over longer periods:
 - Firms can build new factories or close old ones
 - New firms can enter the market and old firms can shut down.

3. Variety of Supply Curves

- ❖ The slope of the supply curve is closely related to price elasticity of supply.
- ❖ Rule of thumb:
The flatter the curve, the bigger the elasticity.
The steeper the curve, the smaller the elasticity.
- ❖ Five different classifications....
 - Perfectly inelastic supply
 - Inelastic supply
 - Unit elastic supply
 - Elastic supply
 - Perfectly elastic supply

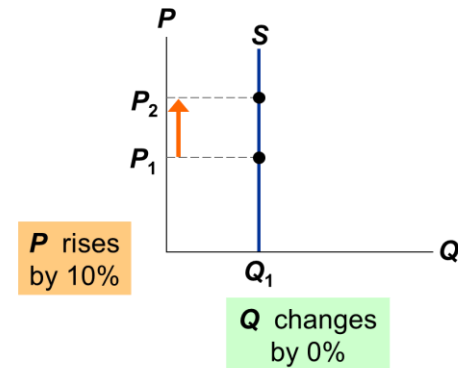
1) Perfectly inelastic supply

$$\text{Price elasticity of supply} = \frac{\% \text{ change in } Q}{\% \text{ change in } P} = \frac{0\%}{10\%} = 0$$

S curve:
vertical

Sellers' price sensitivity:
none

Elasticity:
0



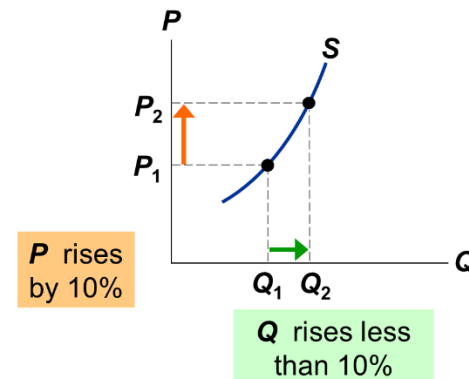
2) Inelastic supply

$$\text{Price elasticity of supply} = \frac{\% \text{ change in } Q}{\% \text{ change in } P} = \frac{< 10\%}{10\%} < 1$$

S curve:
relatively steep

Sellers' price sensitivity:
relatively low

Elasticity:
< 1



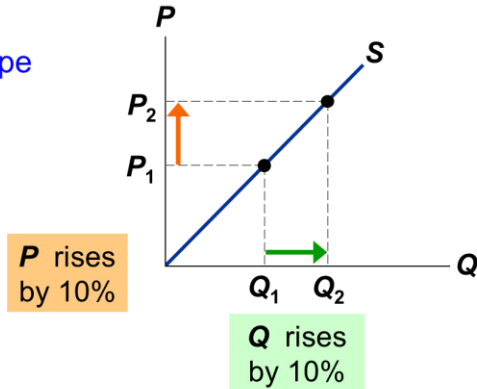
3) Unit elastic supply

$$\text{Price elasticity of supply} = \frac{\% \text{ change in } Q}{\% \text{ change in } P} = \frac{10\%}{10\%} = 1$$

S curve:
intermediate slope

Sellers' price sensitivity:
intermediate

Elasticity:
= 1



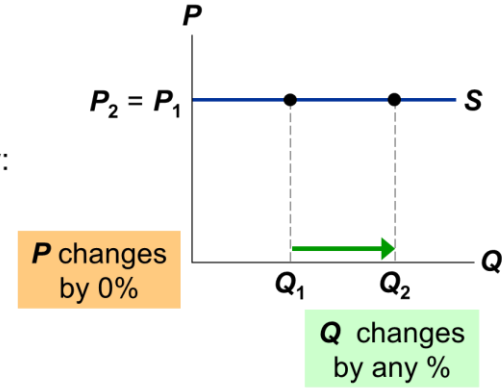
5) Perfectly elastic supply

$$\text{Price elasticity of supply} = \frac{\% \text{ change in } Q}{\% \text{ change in } P} = \frac{\text{any } \%}{0\%} = \text{infinity}$$

S curve:
horizontal

Sellers' price sensitivity:
extreme

Elasticity:
infinity



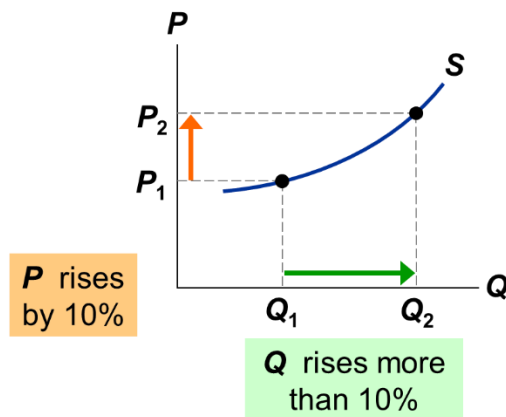
4) Elastic supply

$$\text{Price elasticity of supply} = \frac{\% \text{ change in } Q}{\% \text{ change in } P} = \frac{> 10\%}{10\%} > 1$$

S curve:
relatively flat

Sellers' price sensitivity:
relatively high

Elasticity:
> 1



Example: Elasticity and Change in Equilibrium

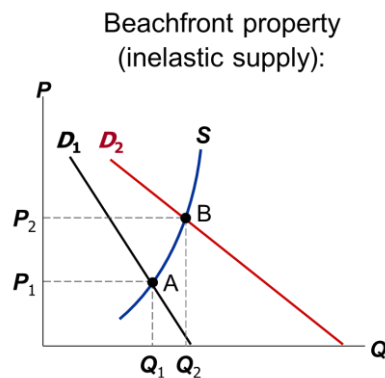
The supply of beachfront property is inelastic.
The supply of new books is elastic.

Suppose population growth causes demand for both goods to double (at each price, Q^D doubles).

For which product will P change the most?
For which product will Q change the most?

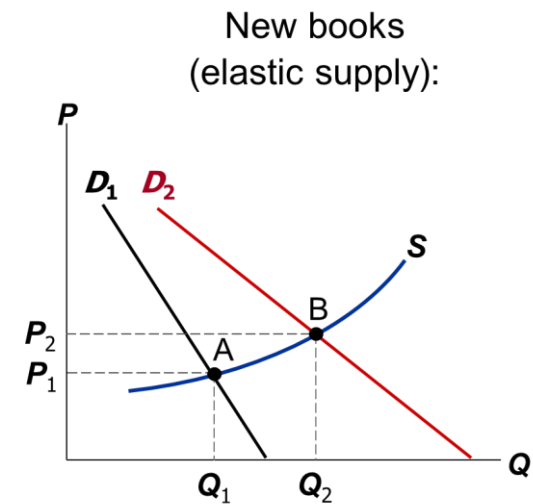
a) Beachfront property

- When supply is inelastic, an increase in demand has a bigger impact on price than on quantity.
- The D curve shifts to the right, but not in a parallel fashion: at each price, quantity demanded is twice as high, so the new D curve will be flatter than the initial one

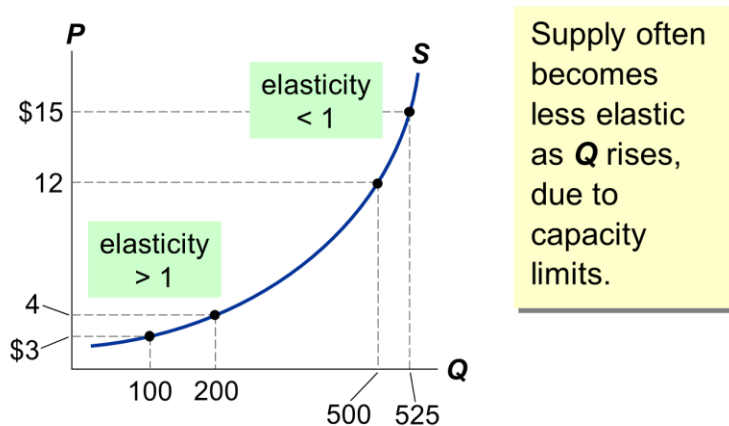


b) New books

When supply is elastic, an increase in demand has a bigger impact on quantity than on price.



4. How the Price Elasticity of Supply Can Vary



- ❖ When the price rises from \$3 to \$4 (a 29% increase, using the midpoint method), quantity rises from 100 to 120 (or 67%). Because 67% > 29%, price elasticity of supply is greater than one. When the price rises from \$12 to \$15 (22%), quantity rises from 500 to 525 (about 5%), so price elasticity of supply is less than one.
- ❖ When output is very low, it is relatively easy for firms to increase output. They may have excess capacity, or they are not requiring full effort from their workers. Increasing output is not difficult, so it doesn't take much of an

increase in price to induce an increase in production.

- ❖ When output is very high, it is relatively expensive for firms to increase output further: there's little or no excess capacity, they are already running their factories and machines at a high level of intensity. To increase output further, they might have to pay their workers overtime, and their machines experience more wear and tear and therefore require more repairs. So, at high levels of output, it takes a much larger price increase to make firms willing to increase output further.
- ❖ Eventually, firms bump up against their capacity constraints, and simply cannot increase output in response to further price increases.
- ❖ Of course, all of this applies to the short run. In the long run, firms can build more factories, and (depending on the market structure) new firms can enter the market.

III. Other Elasticities

- Income Elasticity of Demand:

$$\epsilon_i = \frac{\% \text{ in } Q}{\% \text{ in } I} = \frac{\Delta Q/Q}{\Delta I/I} = \frac{\Delta Q}{\Delta I} \frac{I}{Q}$$

- Cross Price Elasticity of Demand:

$$\epsilon_{p_s} = \frac{\% \text{ in } Q}{\% \text{ in } P_s} = \frac{\Delta Q/Q}{\Delta P_s/P_s} = \frac{\Delta Q}{\Delta P_s} \frac{P_s}{Q}$$

$$\epsilon_{p_c} = \frac{\% \text{ in } Q}{\% \text{ in } P_c} = \frac{\Delta Q/Q}{\Delta P_c/P_c} = \frac{\Delta Q}{\Delta P_c} \frac{P_c}{Q}$$