Elasticity

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AUTUMN 2020
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How Shapes of Supply and Demand Curves Matter

The shape of the demand curve (and supply curve) is determined by how much a shock affects the equilibrium price and quantity.

If own price changes or the CP is violated how much quantity demanded or demand changes is given by the concept of elasticity.

Concept of Elasticity

Elasticity Percentage change in one variable resulting from a 1-percent change in another. Quantifies exact magnitude of changes.

Three types of elasticity of demand:

Own price elasticity

Cross-price elasticity

Income elasticity

Price Elasticity of Demand

(Own) Price elasticity of demand : Percentage change in quantity demanded of a good resulting due to 1-percent change in its price. It quantifies change in quantity demanded.

Measurement of elasticity: e_p= (Percentage change in quantity demanded of a good)/(Percentage change in price of the particular good)

Ranges of e_p

1. Law of dd:

$$-\infty < e_p < 0$$

i. Elastic dd: $-\infty < e_p < -1$ (Luxury good)

ii. Inelastic dd: $-1 < e_p < 0$ (Necessary good)

iii. Unit Elastic dd: $e_p = -1$

2. Violation of Law of dd : $0 < e_p < \infty$

Measurement of elasticity:
Arc elasticity

Measures finite changes:

$$e_p = \frac{\frac{\Delta x}{x} \times 100}{\frac{\Delta p}{p} \times 100} = \frac{\frac{x_1 - x_0}{\frac{1}{2}(x_1 + x_0)}}{\frac{p_1 - p_0}{\frac{1}{2}(p_1 + p_0)}} = \frac{(x_1 - x_0)(p_1 + p_0)}{(p_1 - p_0)(x_1 + x_0)}$$

Example :

Let $p_0 = 10$ & $x_d^0 = 100$
$p_1 = 5$ & $x_d^1 = 125$

Arc Elasticity $= \frac{15}{225} * \frac{25}{5}$

$= 0.33$

Point elasticity:

Measures infinitesimally small changes

$$e_p = \frac{\frac{dx}{x} \times 100}{\frac{dp}{p} \times 100} = \frac{dx}{dp} \times \frac{p}{x} = \frac{\hat{x}}{\hat{p}}$$

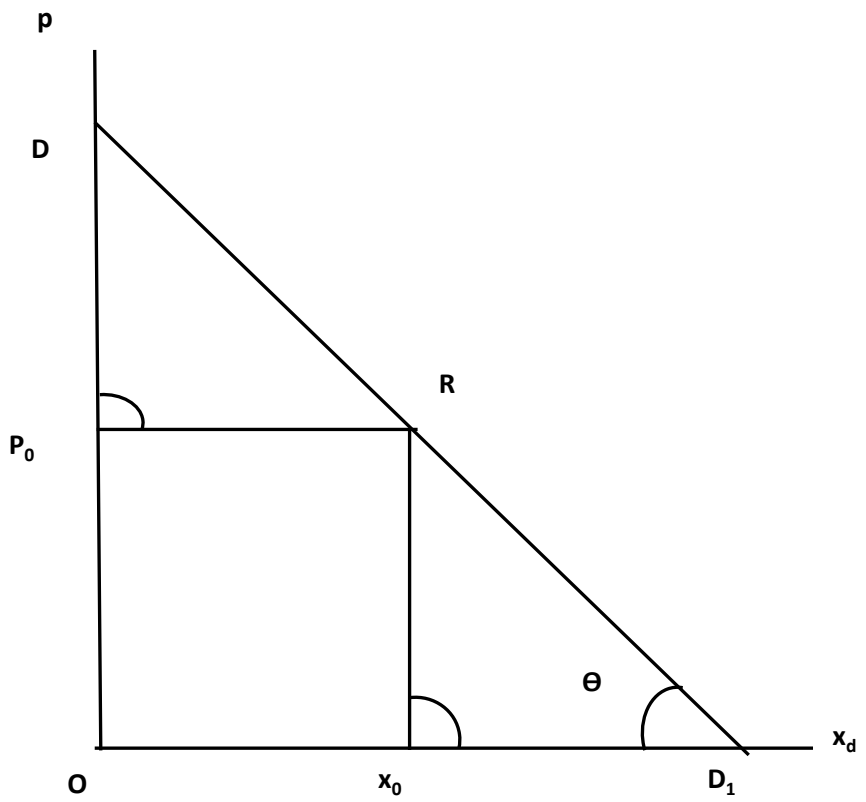
Examples

1. $x_d = \frac{b}{p}$ $e_{p=-1}$

2. $x_d = a - bp$ $e_{p=-bp/(a-bp)}$

3. $x = \frac{MP_y}{P_x}$ $e_{p=-1}$

Geometric measurement of Ep



$$E_p \text{ at } R = \frac{1}{ab.slope}.\frac{p}{x}$$

Slope of dd curve DD_1 = $\tan\theta = \frac{Rx_0}{x_0D_1}$

$$\&, e_p = \frac{x_0D_1}{Rx_0}.\frac{Rx_0}{x_0O} = \frac{x_0D_1}{x_0O} \text{ -----(1)}$$

ΔDP_0R , ΔRx_0D are similar triangles
Therefore , ΔDP_0R , ΔRx_0D_1 are similar triangles
So $\frac{x_0D_1}{Rx_0} = \frac{P_0R}{DP_0}$

$$\Rightarrow \frac{x_0D_1}{OP_0} = \frac{Ox_0}{DP_0} \Rightarrow \frac{x_0D_1}{Ox_0} = \frac{OP_0}{DP_0} \text{ -----(2)}$$

Third expression: $e_p\big|_R = \frac{x_0D_1}{Ox_0} = \frac{RD_1}{RD}$ **= Length of lower segment at R/ Length of upper segment at R**

Relationship between slope and elasticity of demand:

- Elasticity varies inversely with Slope???
- Answer. Not necessarily.

- The price elasticity of demand depends not only on the slope of the demand curve but also on the price and quantity (p/x term).

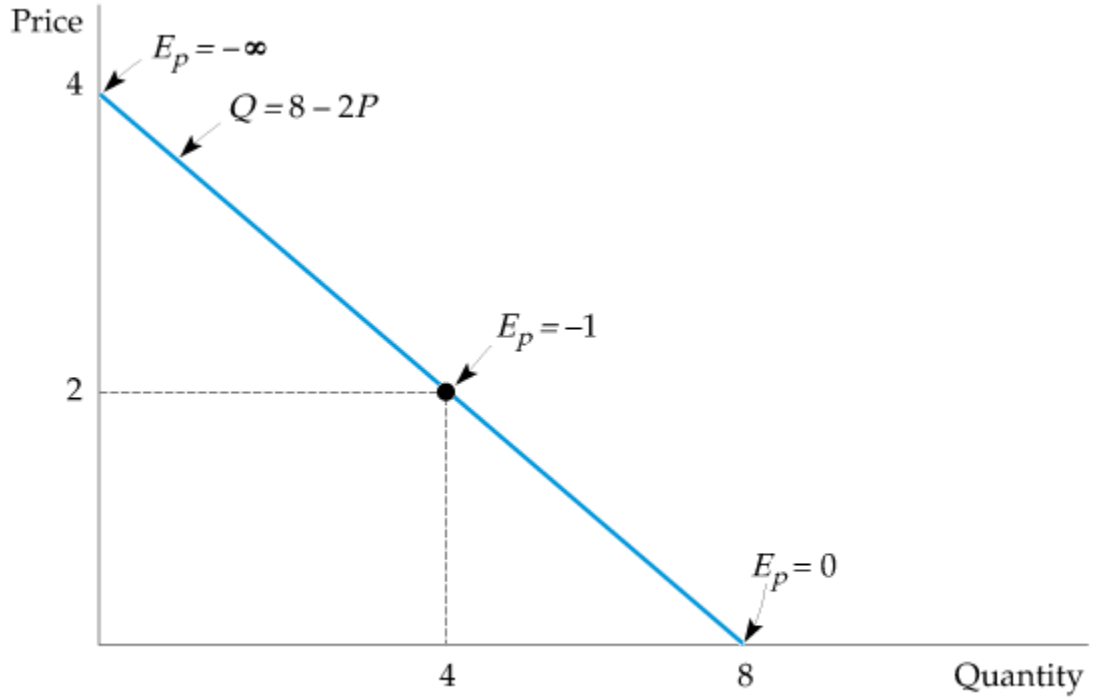
- Only in two cases, when the demand curve is vertical or horizontal, slope and elasticities are related in one-to-one manner. Otherwise there is no relationship between the two.

Example 1

Linear Demand Curve $Q=a-bP$

Figure 2

The elasticity here varies along the curve as price and quantity change. Slope is constant for this linear demand curve but elasticity starts from infinity at the vertical intercept to becomes zero at the horizontal intercept.



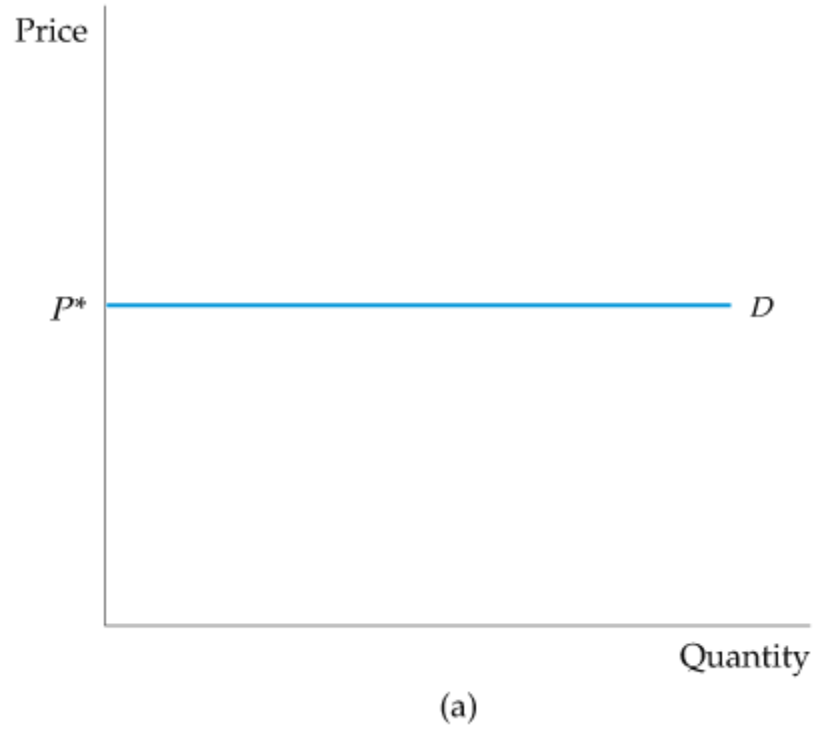
Example 2

(a) Infinitely Elastic Demand

For a horizontal demand curve, $\Delta Q/\Delta P$ is infinite. Because a tiny change in price leads to an enormous change in demand, the elasticity of demand is infinite.

Here slope zero, elasticity is infinity.

Figure 3



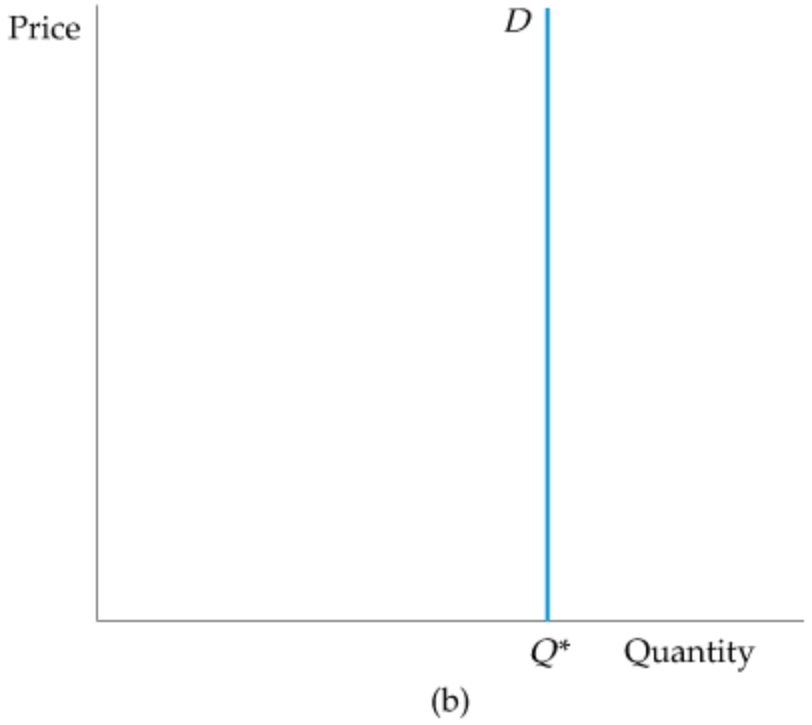
Example 3

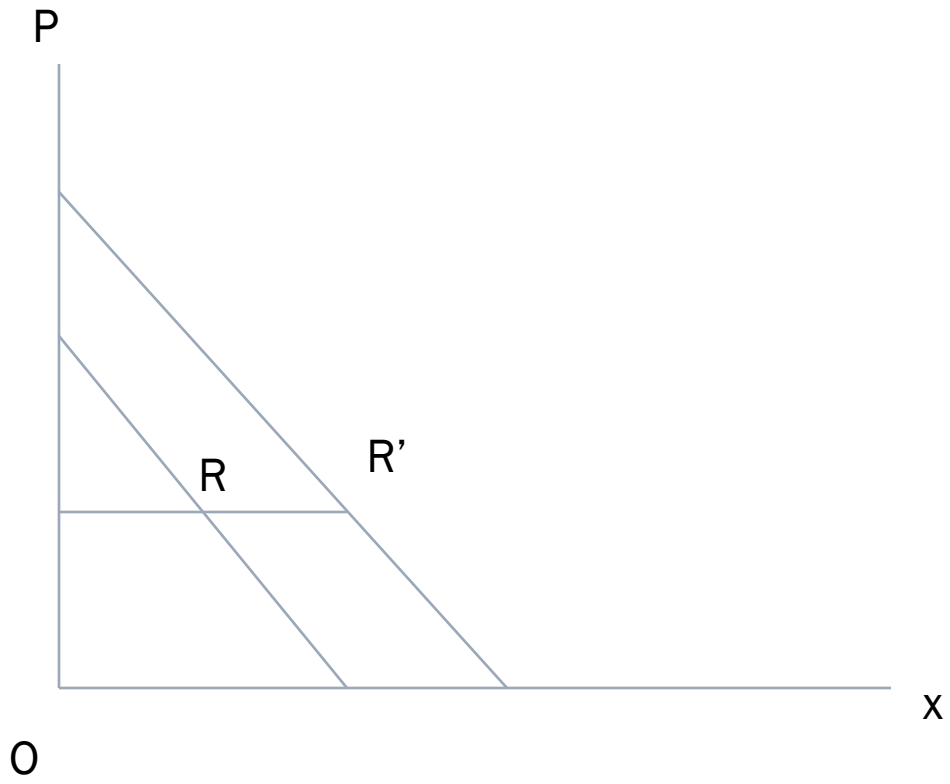
(b) Completely Inelastic Demand

For a vertical demand curve, $\Delta Q/\Delta P$ is zero. Because the quantity demanded is the same no matter what the price, the elasticity of demand is zero.

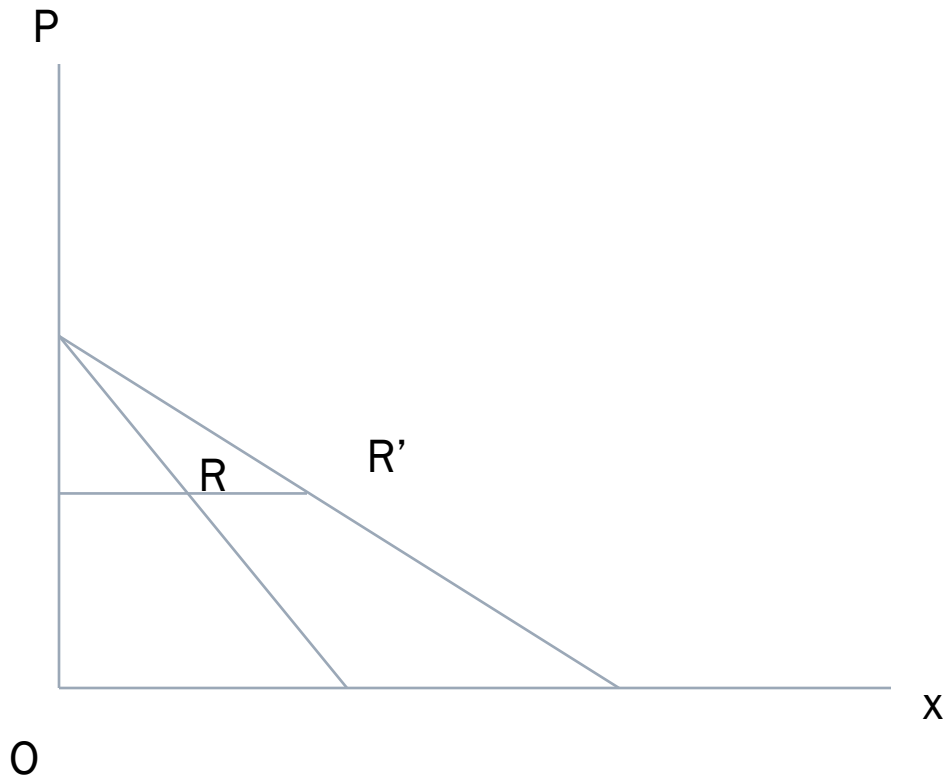
Here slope is infinity, elasticity is zero.

Figure 4





Two demand curves can have same slope but different elasticities



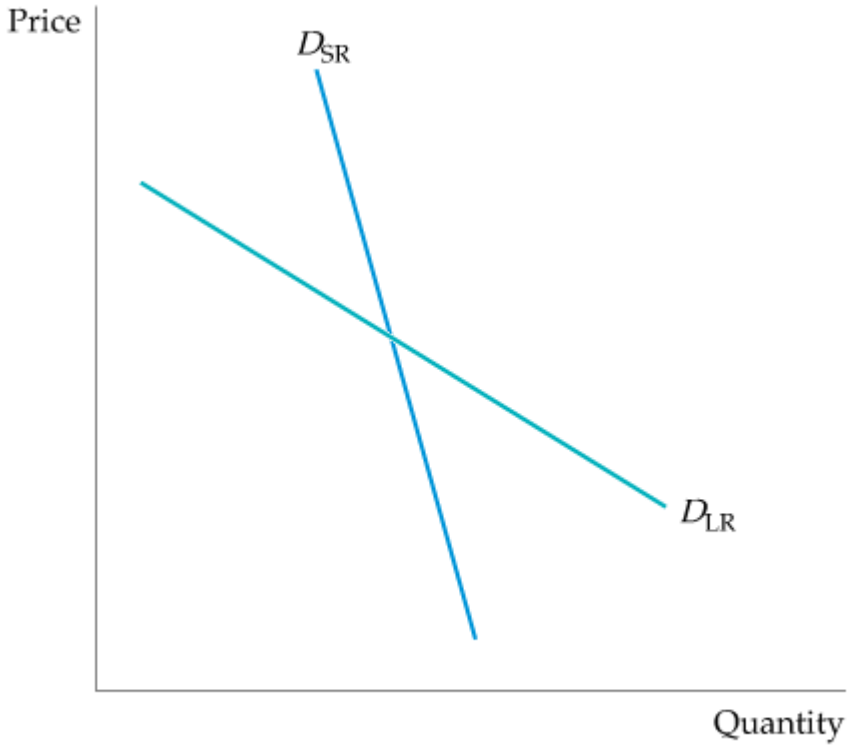
Two demand curves can have same elasticity but different slopes.

SHORT-RUN VERSUS LONG-RUN ELASTICITIES

(a) Gasoline: Short-Run and Long-Run Demand Curves

(a) In the short run, an increase in price has lesser effect on the quantity of gasoline demanded. Motorists may drive less, but they will not change the kinds of cars they are driving overnight.

In the longer run they will shift to smaller and more fuel-efficient cars, the effect of the price increase will be larger. Demand is more elastic in the long run than in the short run.

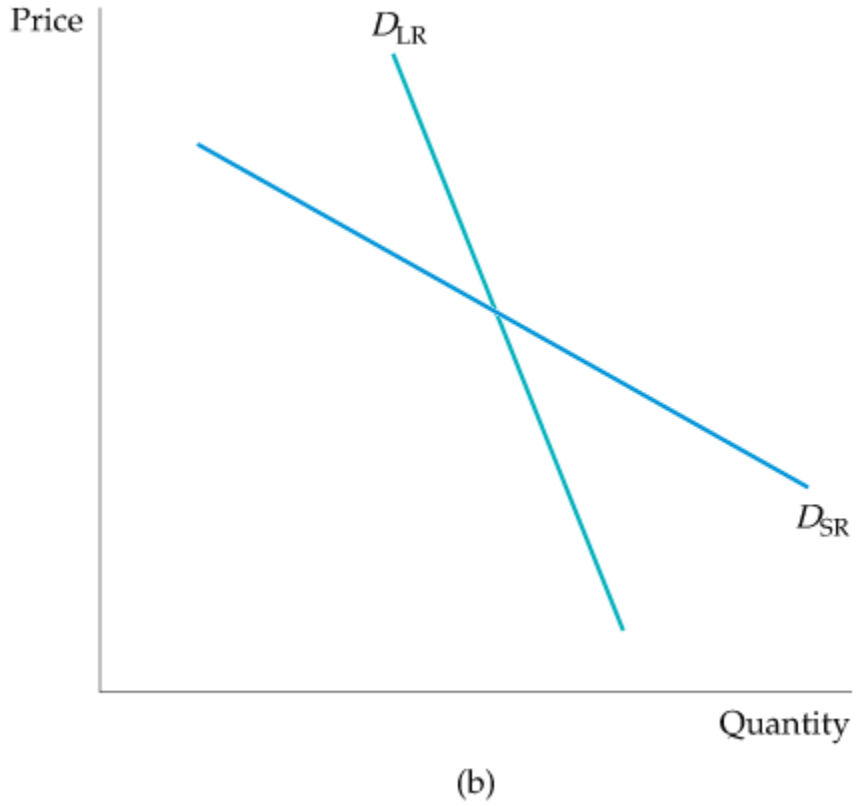


(a)

SHORT-RUN VERSUS LONG-RUN ELASTICITIES

Demand and Durability

(b) Automobiles: Short-Run and Long-Run Demand Curves



(b) The opposite is true for automobile demand. If price increases, consumers initially defer buying new cars; thus annual quantity demanded falls sharply.

In the long run old cars wear out and are replaced; thus annual quantity demanded picks up. Demand, therefore, is less elastic in the long run than in the short run.

SHORT-RUN VERSUS LONG-RUN ELASTICITIES

Example of Pindyck & Rubinfeld

TABLE Demand for Gasoline

	Number of Years Allowed to Pass Following a Price or Income Change				
Elasticity	**1**	**2**	**3**	**5**	**10**
Price	−0.2	−0.3	−0.4	−0.5	−0.8
Income	0.2	0.4	0.5	0.6	1.0

TABLE Demand for Automobiles

	Number of Years Allowed to Pass Following a Price or Income Change				
Elasticity	**1**	**2**	**3**	**5**	**10**
Price	−1.2	−0.9	−0.8	−0.6	−0.4
Income	3.0	2.3	1.9	1.4	1.0

To summarize the elasticity of dd in SR & LR:

In general, $e_{pLR} > e_{pSR}$

For durable goods: $e_{pLR} < e_{pSR}$

Income elasticity of demand

Percentage change in the quantity demanded resulting from a 1-percent increase in income. It captures shift of the demand curve when income changes.

$$e_M = \frac{\hat{x}}{\hat{M}}$$

$e_M > 0$ => normal good

$0 < e_M < 1$ => necessary good

$e_M > 1$ => luxury good

$e_M < 0$ => inferior good

Cross-price elasticity of demand

Percentage change in the quantity demanded of one good resulting from a 1-percent increase in the price of another.

$$e_{ij} = \frac{\hat{x}_i}{\hat{p}_j}$$

$e_{ij} > 0$ => good i & j are substitutes

$e_{ij} < 0$ => good i & j are complements

Is there any relationship between own price & cross price elasticity of demand?

- The two elasticities may be positively related.
- Higher cross price elasticity (positive values) indicate greater availability of substitutes. Hence if price of a particular product increases, say for example, consumers will switch to other related substitutes.
- That is why own price elasticity of a particular brand within product class (like LG AC, Colgate toothpaste) is high compared to the elasticity value of the product class itself (AC versus ceiling fan- imperfect substitutes).

Price elasticity of supply

Percentage change in quantity supplied resulting from a 1-percent increase in price

$$e_s = \frac{\hat{x}_s}{\hat{p}} = \frac{dx_s}{dp} \times \frac{p}{x_s}$$

= Slope of Average/ Slope of Marginal

SHORT-RUN VERSUS LONG-RUN ELASTICITIES

Supply and Durability

Copper: Short-Run and Long-Run Supply Curves

Like that of most goods, the supply of primary copper is more elastic in the long run.

If price increases, firms would like to produce more but are limited by capacity constraints in the short run.

In the longer run, they can add to capacity and produce more.

(a)

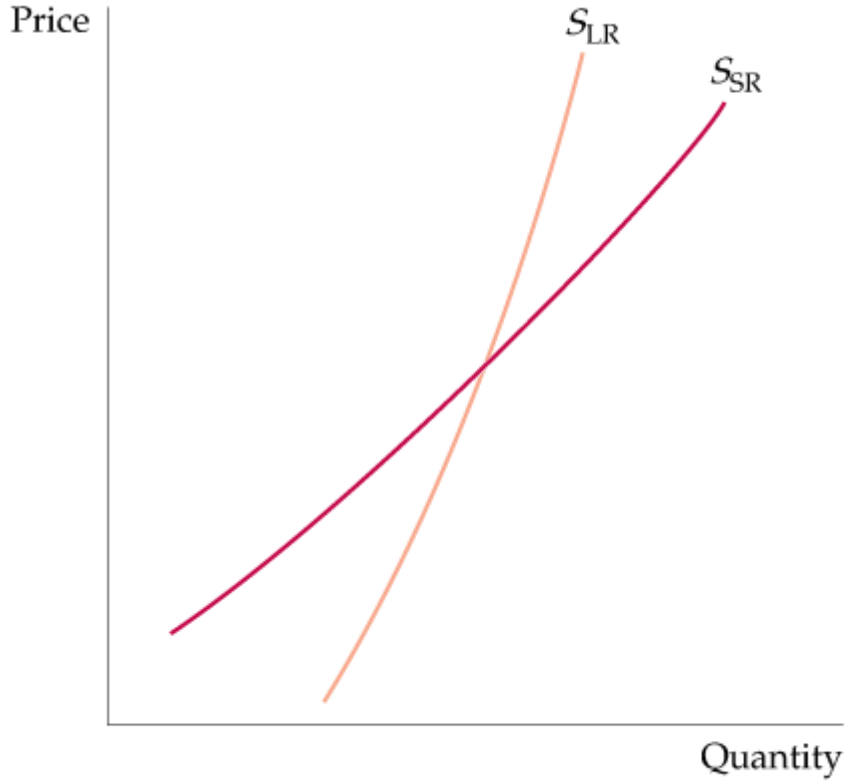
SHORT-RUN VERSUS LONG-RUN ELASTICITIES

Supply and Durability

Copper: Short-Run and Long-Run Supply Curves

If price increases, there is a greater incentive to convert scrap copper into new supply. Initially, therefore, secondary supply (i.e., supply from scrap) increases sharply.
But later, as the stock of scrap falls, secondary supply contracts.

Secondary supply is therefore less elastic in the long run than in the short run.



(b)

Table Supply of Copper

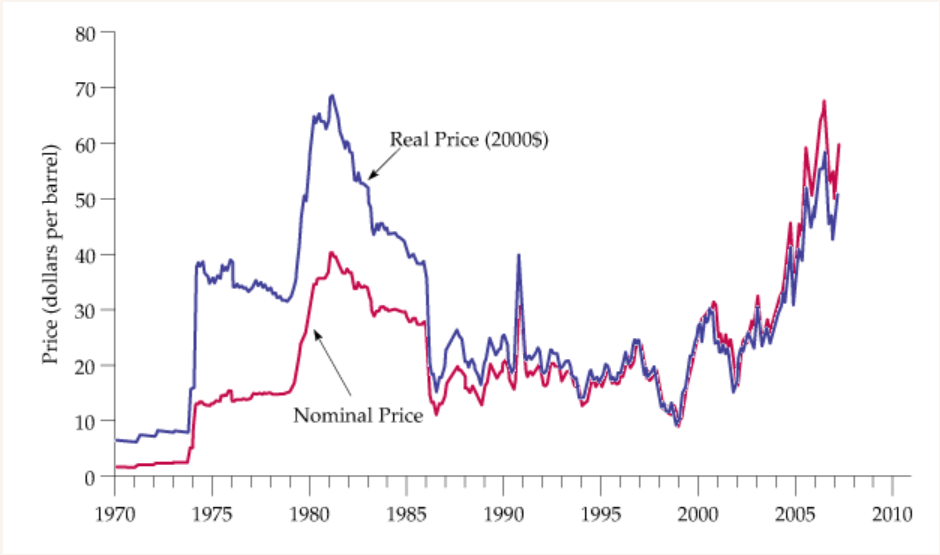
Price Elasticity of:	Short-Run	Long-Run
Primary supply	0.20	1.60
Secondary supply	0.43	0.31
Total supply	0.25	1.50

EXAMPLE of Pindyck & Rubinfeld. UNDERSTANDING AND PREDICTING THE EFFECTS OF CHANGING MARKET CONDITIONS (1/3)

Since the early 1970s, the world oil market has been buffeted by the OPEC cartel and by political turmoil in the Persian Gulf.

Price of Crude Oil

The OPEC cartel and political events caused the price of oil to rise sharply at times. It later fell as supply and demand adjusted.



EXAMPLE. (2/3)

Because this example is set in 2005–2007, all prices are measured in 2005 dollars. Here are some rough figures:

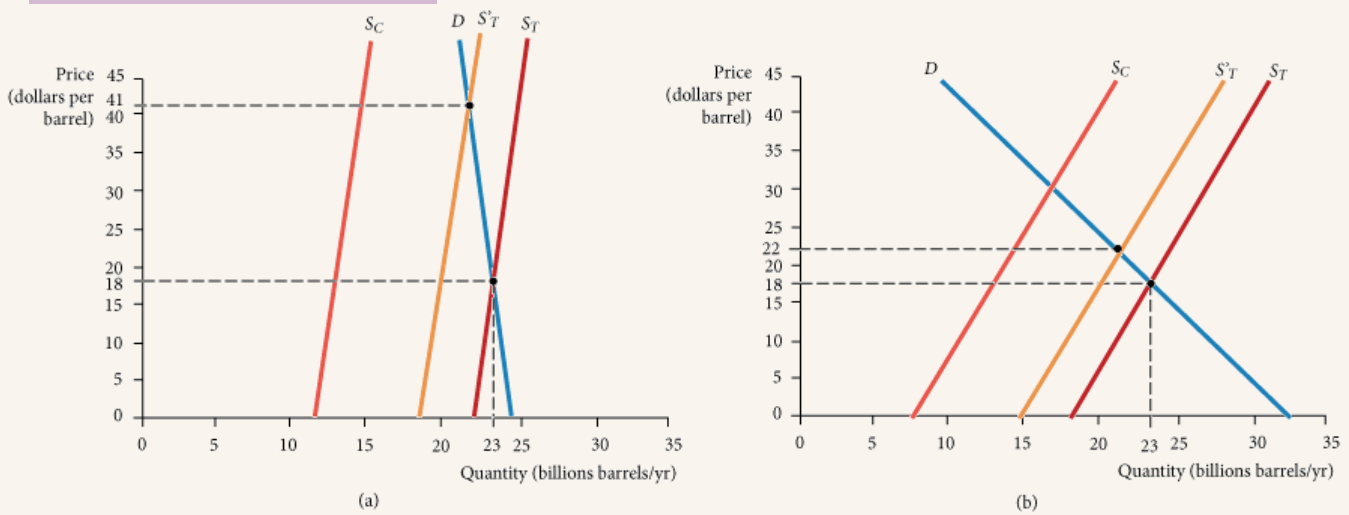
•2005–7 world price = $50 per barrel
•World demand and total supply = 34 billion barrels per year (bb/yr)
•OPEC supply = 14 bb/yr
•Competitive (non-OPEC) supply = 20 bb/yr

The following table gives price elasticity estimates for oil supply and demand:

	Short Run	Long Run
World demand:	-0.05	-0.40
Competitive supply:	0.10	0.40

EXAMPLE.(3/3)

Impact of Saudi Production Cut



The total supply (S_T) is the sum of competitive (non-OPEC) supply (S_C) and the 14 bb/yr of OPEC supply. Part (a) shows the short-run supply and demand curves.
If Saudi Arabia stops producing, the supply curve will shift to the left by 3 bb/yr. In the short-run, price will increase sharply.

Part (b) shows long-run curves.
In the long run, because demand and competitive supply are much more elastic, the impact on price will be much smaller.

References:

- Maddala & Miller
- Pindyck & Rubinfeld