SUPPLEMENTAL CLASS NTOES

Unit 2. Elasticities, Cross-Elasticities, and Diversion Ratios

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Substitutes/Complements

- Substitutes
  - *Definition*: Two products or services are *substitutes* if, when consumer demand increases for one product, it will decrease for the other product
    - Symbolically:

$$\frac{\Delta q_2}{\Delta q_1} < 0$$

Because Δq_1 and Δq_2 move in opposite directions, they will have different signs (i.e., one will be positive and the other will be negative)

  - Examples
    - Coke and Pepsi
    - iPhone and Galaxy S series mobile phones
    - Nike and Adidas shoes
    - Hertz and Avis rental cars
  - *Horizontal mergers* involve combinations of firms that offer substitute products

Substitutes/Complements

- Substitutes
  - Substitutes and prices
    - If products 1 and 2 are substitutes, then as the price of 1 increases, the demand for 2 increases
    - Proof:

$$\overset{(-)}{\frac{\Delta q_2}{\Delta q_1}}\;\overset{(-)}{\frac{\Delta q_1}{\Delta p_1}} = \overset{(+)}{\frac{\Delta q_2}{\Delta p_1}} > 0$$

  - $\frac{\Delta q_2}{\Delta q_1}$ is a negative number (by definition of a substitute)
  - $\frac{\Delta q_1}{\Delta p_1}$ is a negative number (it is the slope of the demand curve for product 1)
  - A negative number times a negative number is positive, so $\frac{\Delta q_2}{\Delta p_1}$ is positive
  - If Δp_1 is positive (i.e., the price of product 1 goes up), then Δq_2 must be positive (i.e., demand for product 2 goes up)

Substitutes/Complements

- Complements
  - *Definition*: Two products are *complements* if, when consumer demand increases for one product, consumer demand also will increase for the other product
  - Symbolically:

$$\frac{\Delta q_2}{\Delta q_1} > 0$$

  - Examples
    - *Vertical mergers* involve complements
      - Television LCD screens and TV sets
      - Car engines and cars
      - Cable TV programming and cable TV distribution (AT&T/Time Warner)
      - Drug manufacture and drug distribution
    - But many conglomerate mergers can also involve complements
      - Printers and ink cartridges
      - Razors and razor blades
      - Computers and computer software

Substitutes/Complements

- Complements
  - Complements and prices
    - If products 1 and 2 are complements, then as the price of 1 increases, the demand for 2 decreases
    - Proof:

$$\overset{(+)}{\frac{\Delta q_2}{\Delta q_1}}\,\overset{(-)}{\frac{\Delta q_1}{\Delta p_1}} = \overset{(-)}{\frac{\Delta q_2}{\Delta p_1}} < 0$$

      - $\frac{\Delta q_2}{\Delta q_1}$ is a positive number (by definition of a complement)
      - $\frac{\Delta q_1}{\Delta p_1}$ is a negative number (it is the slope of the demand curve for product 1)
      - A negative number times a positive number is negative, so $\frac{\Delta q_2}{\Delta p_1}$ is negative
      - If Δp_1 is positive (i.e., the price of product 1 goes up), then Δq_2 must be negative (i.e., demand for product 2 goes down)

Elasticities

- Own-elasticity of demand
  - *Definition*: The percentage change in the quantity demanded divided by the percentage change in the price of that *same* product

The Greek letter epsilon (ε) is the usual symbol in economics for elasticity

$$\varepsilon = \frac{\%\Delta q_i}{\%\Delta p_i}$$

Percentage change q_i in the quantity of product *i* demanded

Percentage change p_i in the price of product *i*

- These are sometimes called *elasticity of demand* or *price elasticity of demand*
  - Examples:
    - If price increases by 5% and demand decreases by 10%, then the own-elasticity is -2 (= -10%/5%)
    - If price increases by 3% and demand decreases by 1%, then the own-elasticity is -1/3 (= -1%/3%)

Technically, these are called *arc elasticities* because they give percentage changes for discrete changes in prices and quantities

Elasticities

- Own-elasticity of demand
  - Conventions
    - Own-elasticities are often simply called *elasticities* or *price elasticities*
    - Technically, own-elasticities are always negative numbers (given downward-sloping demand)
      - But economists often drop the negative sign and use the absolute value
      - The idea is that everyone knows that own-elasticities are negative, so why bother saying it? Using absolute values are also more intuitive (substitutability increases as the absolute value increases)

Elasticities

For intuition only
(NOT technically correct,
but it is usually the
intuition that is important)

- Some important definitions
  - *Inelastic demand*: Not very price sensitive

$$|\varepsilon| = \left|\frac{\text{\%change in quantity}}{\text{\%change in price}}\right| < 1$$

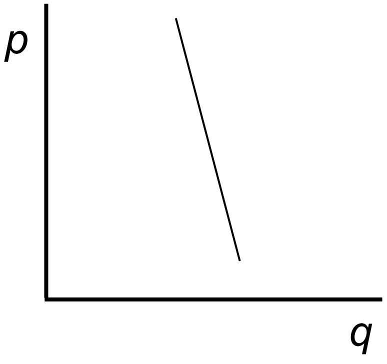
  - *Unit elasticity*:

$$|\varepsilon| = \left|\frac{\text{\%change in quantity}}{\text{\%change in price}}\right| = 1$$

  - *Elastic demand*: Price sensitive

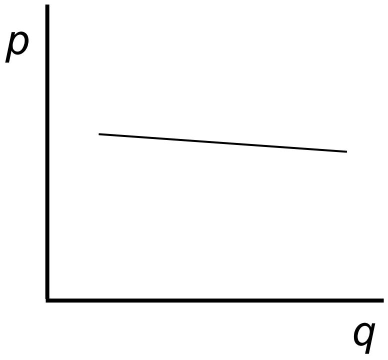
$$|\varepsilon| = \left|\frac{\text{\%change in quantity}}{\text{\%change in price}}\right| > 1$$

Inelastic demand



Little sensitivity
to changes in
price

Elastic demand

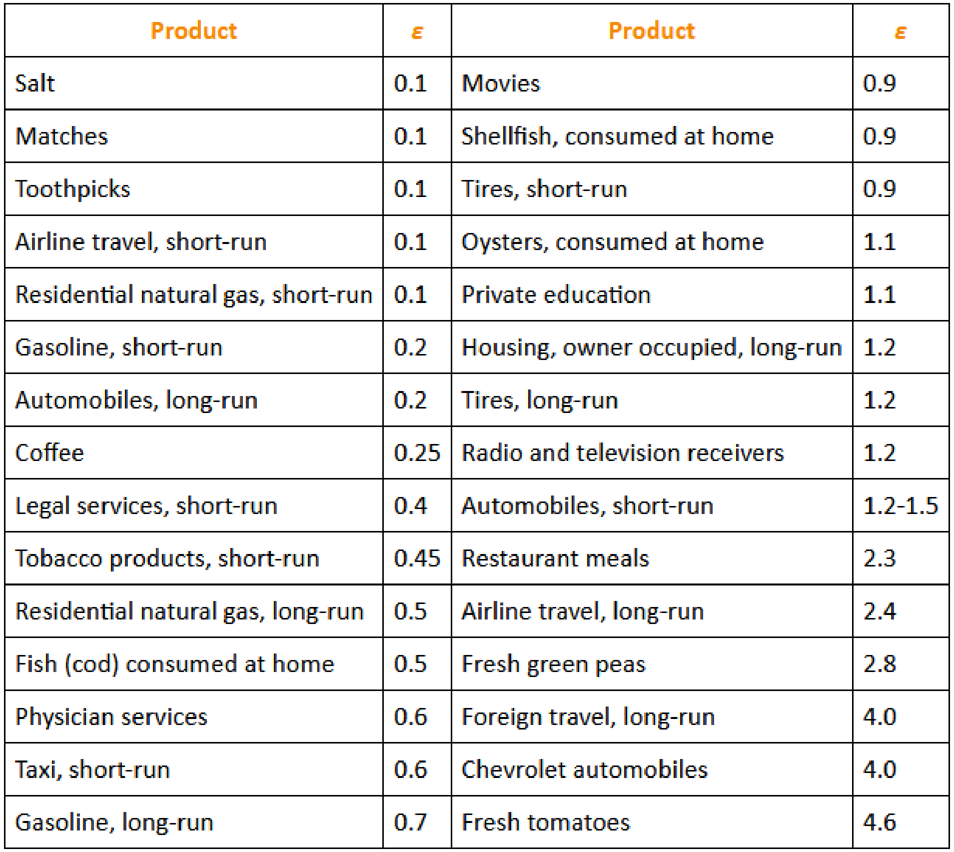


More sensitivity
to changes in
price

Note: |*x*| is the *absolute value* of *x*, which is the magnitude of *x* without the sign. So |3| = |-3| = 3.

Elasticities

- Own-elasticity of demand: Some numerical estimates



Product	*ε*	Product	*ε*
Salt	0.1	Movies	0.9
Matches	0.1	Shellfish, consumed at home	0.9
Toothpicks	0.1	Tires, short-run	0.9
Airline travel, short-run	0.1	Oysters, consumed at home	1.1
Residential natural gas, short-run	0.1	Private education	1.1
Gasoline, short-run	0.2	Housing, owner occupied, long-run	1.2
Automobiles, long-run	0.2	Tires, long-run	1.2
Coffee	0.25	Radio and television receivers	1.2
Legal services, short-run	0.4	Automobiles, short-run	1.2-1.5
Tobacco products, short-run	0.45	Restaurant meals	2.3
Residential natural gas, long-run	0.5	Airline travel, long-run	2.4
Fish (cod) consumed at home	0.5	Fresh green peas	2.8
Physician services	0.6	Foreign travel, long-run	4.0
Taxi, short-run	0.6	Chevrolet automobiles	4.0
Gasoline, long-run	0.7	Fresh tomatoes	4.6

Source: Preston McAfee & Tracy R. Lewis, Introduction to Economic Analysis ch. 3.1 (2009)

Elasticities

- Own-elasticity of demand: Some estimates with explanations
  - Food and beverages
    - Milk: -0.65
      - Milk tends to be relatively inelastic, as it is considered a staple food item for many households. A 10% increase in the price of milk would lead to only a 6.5% decrease in quantity demanded
    - Coffee: -0.25
      - Coffee is quite inelastic, likely due to its addictive nature. A 10% price increase would only reduce demand by about 3%
    - Soft drinks: -1.2
      - Soft drinks are more elastic than staple foods. A 10% price increase would lead to a 12% decrease in quantity demanded

Elasticities

- Own-elasticity of demand: Some estimates with explanations (con’t)
  - Consumer goods
    - Clothing: -0.9 to -1.1
      - Clothing elasticity varies but tends to be close to unitary elastic. A 10% price increase might lead to a 9-11% decrease in demand.
    - Automobiles (short-run): -1.2 to -1.5
      - Cars are generally elastic in the short-run. A 10% increase in car prices could reduce demand by 12−15%. Automobiles are durable goods. Consumers can delay purchases if they already have a car, which increase short-run elasticity.
    - Automobiles (long-run): -0.2
      - Cars are generally inelastic in the long-run. A 10% increase in car prices could reduce demand only by 2%. In the long-run, cars wear out or get into accidents and need to be replaced. If you need a new car, you need a new car.
    - Gasoline (short-run): -0.2 to -0.4
      - Gasoline is generally inelastic in the short-run. A 10% increase in gasoline prices could reduce demand only by 2%. You own a car with a particular gas consumption, and most of your car trips are necessary, not discretionary.
    - Gasoline (long-run): -0.7
      - Gasoline, while still inelastic, is less inelastic in the long-run than in the short-run. Consumers can shift their new car purchases to more gasoline-efficient cars.

Elasticities

- Own-elasticity of demand: Some estimates with explanations
  - Services
    - Airline tickets (short-run): -0.1
      - Air travel is very inelastic in the short-run (at least historically). A 10% increase in fares might reduce demand by 1%. Marginal airline travel in the short-run is dominated by business travel, which is largely insensitive to small changes in airline ticket prices.
    - Airline tickets (long-run): -2.4
      - Air travel tends to be elastic. A 10% increase in fares might reduce demand by 24%. Marginal airline travel in the long-run is dominated by leisure travelers, who tend to be very price sensitive.
    - Movie tickets: -0.9
      - Cinema attendance is slightly inelastic. A 10% increase in ticket prices would lead to about a 9% decrease in attendance.

Elasticities

- Own-elasticity of demand: Some estimates with explanations
  - Necessities
    - Electricity: -0.3 to -0.5
      - Electricity demand is quite inelastic. A 10% price increase would only reduce consumption by 3-5% in the short term.
    - Residential natural gas (short-run): -0.1
      - Residential natural gas is inelastic in the short-run. A 10% price increase would only reduce consumption by 1% in the short term. A house equipped for residential gas, say for heating and cooking, cannot switch to electricity without considerable expense.
    - Residential natural gas (long-run): -0.5
      - Residential natural gas is inelastic, but less inelastic in the long-run than in the short-run. A 10% price increase would only reduce consumption by 5% in the long term. New houses and houses undergoing major renovations can be built with appliances that do not require natural gas.

Elasticities

- Own-elasticity of demand
  - Relationship to the slope of the residual demand curve:

$$\varepsilon_i \equiv \frac{\%\Delta q_i}{\%\Delta p_i} \equiv \frac{\dfrac{\Delta q_i}{q_i}}{\dfrac{\Delta p_i}{p_i}} = \frac{\Delta q_i}{\Delta p_i}\frac{p_i}{q_i},$$

Slope of the demand curve

that is, the own-elasticity at a point on the firm's residual demand curve is equal to the slope of the residual demand curve at that point times the ratio of price to quantity at that point

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- Mathematical note *(optional)*
  - In calculus terms*:*

$$\varepsilon_i \equiv \frac{dq_i}{dp_i}\frac{p_i}{q_i}$$

This deals with the continuous case

Elasticities

Remember $\varepsilon = \frac{\Delta q_i}{\Delta p_i}\frac{p_i}{q_i}$

- Elasticity of demand and the slope of the demand curve
  - Even when the demand curve is linear (so that the slope is constant), elasticity varies along the demand curve because the ratio of p_i to q_i changes along the curve

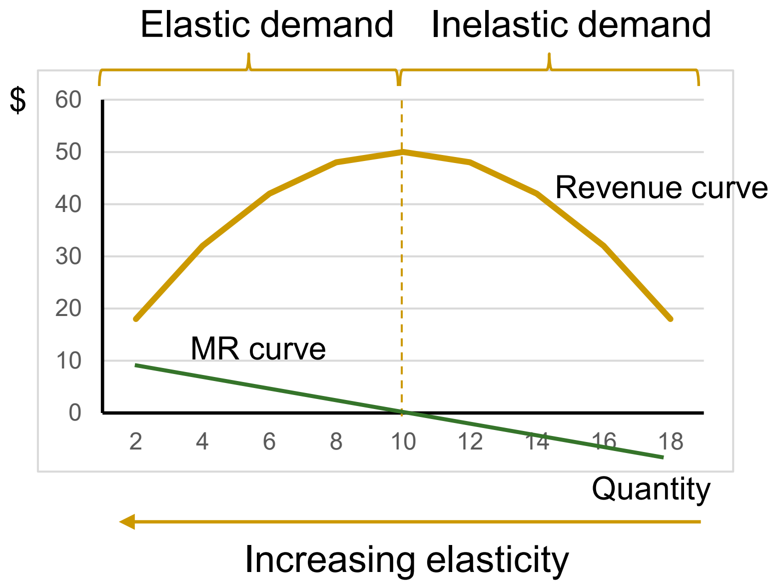
Inverse demand curve:
p = 20 – 2*q*

p	*q*	Slope	*p*/*q*	ε	Total revenue
1	18	-2	0.0556	-0.1111	18
2	16	-2	0.1250	-0.2500	32
3	14	-2	0.2143	-0.4286	42
4	12	-2	0.3333	-0.6667	48
5	10	-2	0.5000	-1.0000	50
6	8	-2	0.7500	-1.5000	48
7	6	-2	1.1667	-2.3333	42
8	4	-2	2.0000	-4.0000	32
9	2	-2	4.5000	-9.0000	18

Inelastic demand $|\varepsilon| < 1$

Unit elasticity $|\varepsilon| = 1$

Elastic demand $|\varepsilon| > 1$



General rules:
Elasticity decreases as quantity increases and prices decreases → lower *p*/*q* ratios
Elasticity increases as quantity decrease and prices increase → higher *p*/*q* ratios

Elasticities

- *Proposition*
  - When a firm maximizes its revenues, the elasticity of its residual demand function is -1 (*ε* = -1)
    - We see this on the graph on the previous slide

- *Proof with linear demand* (optional)

Step 1. Solve for *q* and *p* at the revenue maximum

$$r(q) = p(q)q$$

Definition of revenue

$$= (a + bq)q$$

$$= aq + bq^2$$

Substituting the inverse demand function for *p*

$$mr(q) = a + 2bq = 0$$

FOC for a revenue maximum

$$q = \frac{-a}{2b}$$

$$p = \frac{a}{2}$$

Solving for *q* and *p*

Step 2. Substitute for the slope, *q* and *p* in the elasticity formula and simplify

$$\varepsilon = \frac{\Delta q}{\Delta p}\frac{p}{q}$$

Definition of elasticity

$$= \frac{1}{b}\frac{p}{q}$$

Substituting for the slope

$$= \frac{1}{\cancel{b}}\frac{\left(\frac{\cancel{a}}{\cancel{2}}\right)}{\left(\frac{-\cancel{a}}{\cancel{2}\cancel{b}}\right)}$$

Substituting for *p* and *q*

$$= -1$$

Simplifying

Q.E.D.

Elasticities

- *Proposition*
  - When a firm maximizes its revenues are maximized, the elasticity of its residual demand function is -1 (ε = -1)
    - We see this on the graph on the previous slide

- *Proof in the general case* (optional)

$$r(q) = p(q)q$$ Definition of revenues

$$\frac{dr}{dq} = p + q\frac{dp}{dq} = 0$$ First-order condition (FOC) for a revenue maximum

$$p = -q\frac{dp}{dq}$$ Rearranging FOC

$$\varepsilon = \frac{dq}{dp}\frac{p}{q}$$ Definition of elasticity

$$= \frac{\cancel{dq}}{\cancel{dp}}\frac{-\cancel{q}\frac{\cancel{dp}}{\cancel{dq}}}{\cancel{q}} = -1$$ Substituting for *p* and simplifying

Q.E.D.

Note: $$\frac{dy}{dx} = \frac{1}{\frac{dx}{dy}}$$ That is, the derivative of a function $y = f(x)$ is equal to the reciprocal of the derivative of the inverse function $x = g(y)$

Elasticities

- The *Lerner condition* for profit-maximizing firms
  - *Proposition*: When a firm maximizes its profits, at the profit-maximum levels of price and output the firm's own elasticity *ε* is equal to 1/*m*:

$$\left|\varepsilon\right| = \frac{1}{m},$$

where *m* is the *gross margin*:

$$m = \frac{p-c}{p}$$

Important: If you know the firm's margin, you can calculate the firm's own-elasticity of residual demand.

Proof (optional):

The firm's first order condition for a profit-maximum:

Marginal revenue = Marginal cost

Mathematically $$p + \frac{dp}{dq}q = c$$

Rearranging and dividing by *p*: $$\frac{p-c}{p} = -\frac{dp}{dq}\frac{q}{p}$$

$$m = \frac{1}{\left|\varepsilon\right|}, \text{ so } \left|\varepsilon\right| = \frac{1}{m}$$ Q.E.D.

Elasticities

- Optimal pricing rule for a profit-maximizing firm:

$$p = \frac{|\varepsilon|}{|\varepsilon| - 1}$$

Proof:

Start with the Lerner condition (solving for *m*):

$$m = \frac{p - c}{p} = \frac{1}{|\varepsilon|}$$

So:

$$\frac{p - c}{p} = \frac{1}{|\varepsilon|}$$

$$p|\varepsilon| - c|\varepsilon| = p$$

$$p(|\varepsilon| - 1) = c|\varepsilon|$$

Solving for *p*:

$$p = c\frac{|\varepsilon|}{|\varepsilon| - 1}$$

Q.E.D.

Elasticities

- Predicting quantity changes for a given price increase
  - An approximation
    - We can approximate a percentage quantity change %Δ*q* for a given percentage price change %Δp by multiplying the own-elasticity ε by the percentage price change:

$$\varepsilon = \frac{\%\Delta q}{\%\Delta p} \Rightarrow \%\Delta q \approx \varepsilon \%\Delta p$$

      - The relationship is not exact since the elasticity can change over the discrete range of the price change (as it does on a linear demand function)
  - An exact relationship exists for the unit quantity change Δ*p* for linear demand curves:

$$\varepsilon = \frac{\frac{\Delta q}{q}}{\frac{\Delta p}{p}} = \frac{\Delta q}{\Delta p}\frac{p}{q} \Rightarrow \Delta q = \varepsilon \frac{q}{p} \Delta p$$

    - Or, if you know the slope *b* of the demand curve

$$b = \frac{\Delta q}{\Delta p} \Rightarrow \Delta q = b \Delta p$$

These relationships can be important when determining a quantity change associated with a price increase in the hypothetical monopolist test for market definition

Cross-elasticities

- Cross-elasticity of demand
  - *Definition*: The percentage change in the quantity demanded for product *j* divided by the percentage change in the price of product *i*.

$$\varepsilon_{ij} = \frac{\%\Delta q_j}{\%\Delta p_i}$$

Percentage change q_j in the quantity of product *j* demanded

Percentage change p_i in the price of product *i*

- With a little algebra (as before):

$$\varepsilon_{ij} = \frac{\Delta q_j}{\Delta p_i}\frac{p_i}{q_j}$$

Positive for substitutes
Negative for complements

- Cross-elasticities are positive for substitutes and negative for complements

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- Mathematical note (optional)
  - In calculus terms:

$$\varepsilon_{ij} = \frac{dq_j}{dp_i}\frac{p_i}{q_{ji}}$$

Cross-elasticities

- Cross-elasticities—More definitions
  - *High cross-elasticity of demand*:
    - A small change in the price of product *i* will cause a large change of demand to product *j*
    - As a result, product *j* brings a lot of competitive pressure on product *i*

Make sure you understand why!

    - *Think of it this way:*
      - In a two-firm market, a high cross-elasticity means a large number of *marginal customers* who will abandon product *i* when its price increases and will divert to product *j*
      - It also means a correspondingly smaller number of *inframarginal customers* who will stay with product *i* in the wake of a price increase)
  - *Low cross-elasticity of demand*:
    - A large change in the price of product *i* will cause only a small change of demand to product *j*
    - As a result, product *j* brings little competitive pressure on product *i*

Make sure you understand why!

This is why antitrust lawyers talk so much about cross-elasticities!

An important relationship

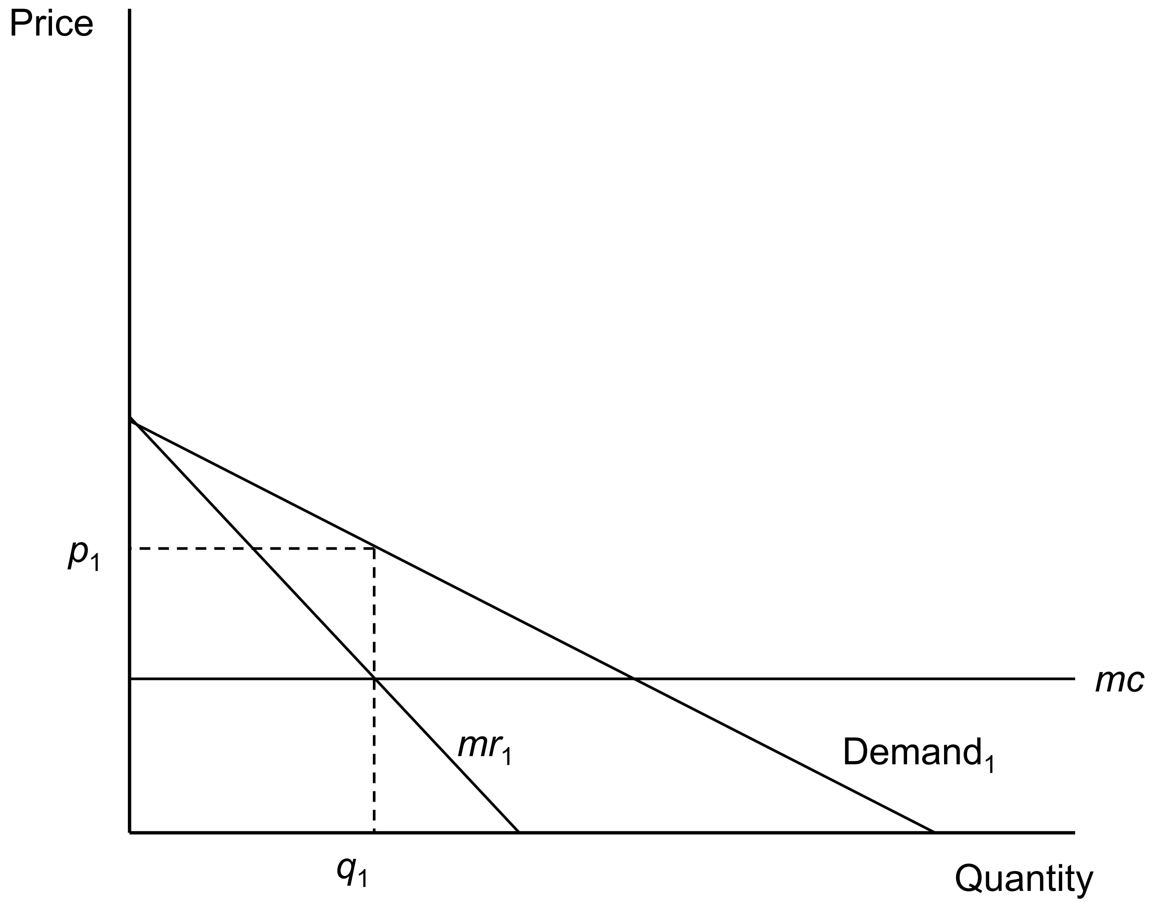
- Relationship of own-elasticities to cross-elasticities
  - Intuitively, the higher the cross-elasticities with the other products, the more elastic is the own-elasticity
  - Consequently, if a merger has the effect of decreasing the cross-elasticities of one or more substitute products, then the own-elasticity also decreases
  - *Key result*: All other things being equal, decreasing the cross-elasticity of demand of substitute products shifts the intersection of the marginal revenue curve and the marginal cost curve to the left, leading the firm to decrease output and increase prices

Let's look at the next two graphs to see why

An important relationship

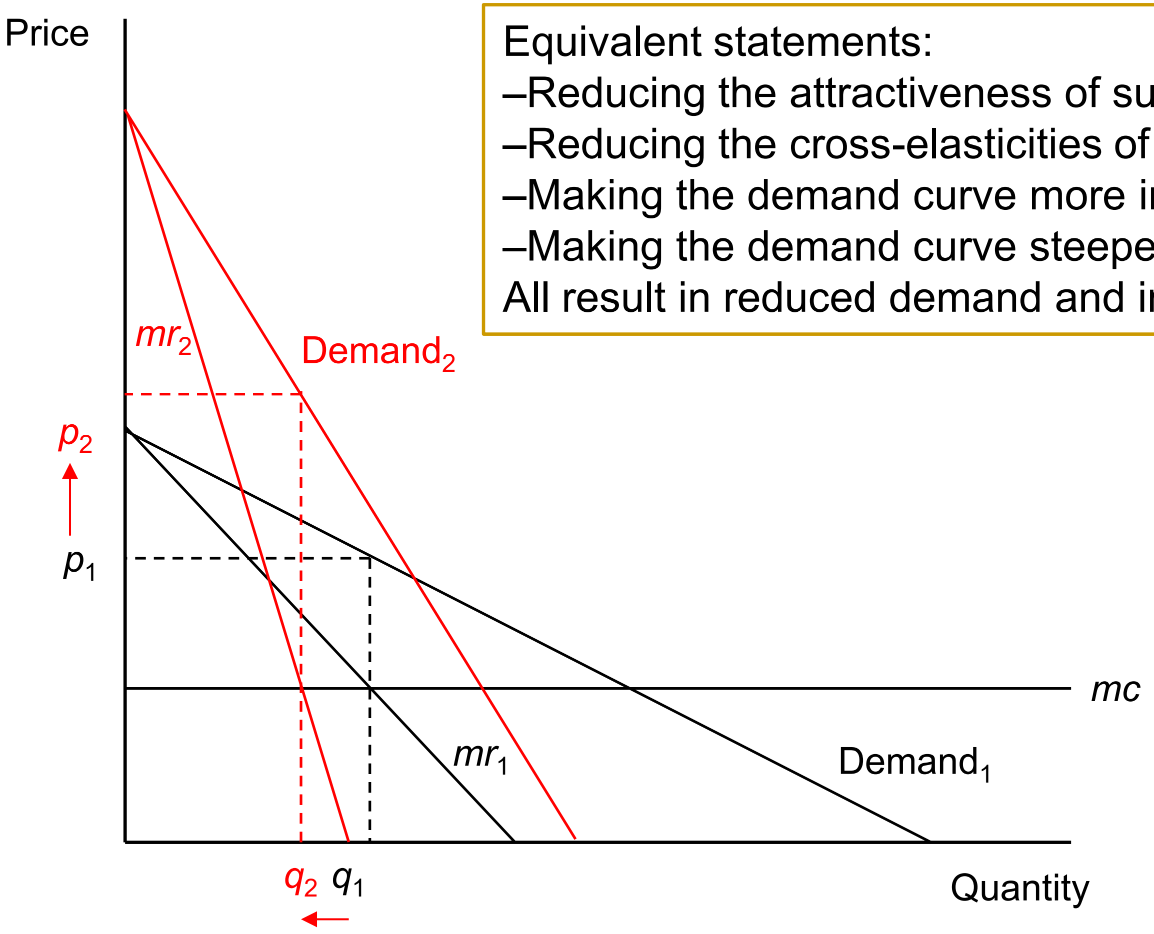
- Relationship of own-elasticities to cross-elasticities

Suppose that this graph describes the initial equilibrium, with price p_1 and quantity q_1



An important relationship

- Relationship of own-elasticities to cross-elasticities



This graph describes the second equilibrium, with price p_2 and quantity q_2 after demand for the firm's product has become more inelastic

Equivalent statements:
–Reducing the attractiveness of substitutes
–Reducing the cross-elasticities of demand
–Making the demand curve more inelastic
–Making the demand curve steeper
All result in reduced demand and increased prices

An important relationship

- Relationship of own-elasticities to cross-elasticities
  - Technically:

$$|\varepsilon_{11}| = 1 + \frac{1}{s_1}\sum_{i=2}^{n} \varepsilon_{1i} s_i$$

$\varepsilon_{i1} > 0$ if the other products are substitutes for product 1

where ε_{11} is the own-elasticity of product 1, ε_{1i} is the cross-elasticity of substitute product *i* with respect to the price of product 1 (evaluated at current prices and quantities), and s_i is the market share of firm *i*.

  - Two important takeaways
    1. As the cross-elasticities on the right-hand side decrease, the demand for product 1 becomes more inelastic (i.e., $|\varepsilon|$ becomes smaller)
       - This allows Firm 1 to exercise market power and charge higher prices
    2. Competitors with larger market shares have more influence in constraining the price of Firm 1 for any given cross-elasticity (i.e., the cross-elasticities in the formula are weighted by market share)

You do not have to know the formula, but you should know the takeaways

Diversion ratios

- *Definition*: Diversion ratio (*D*)

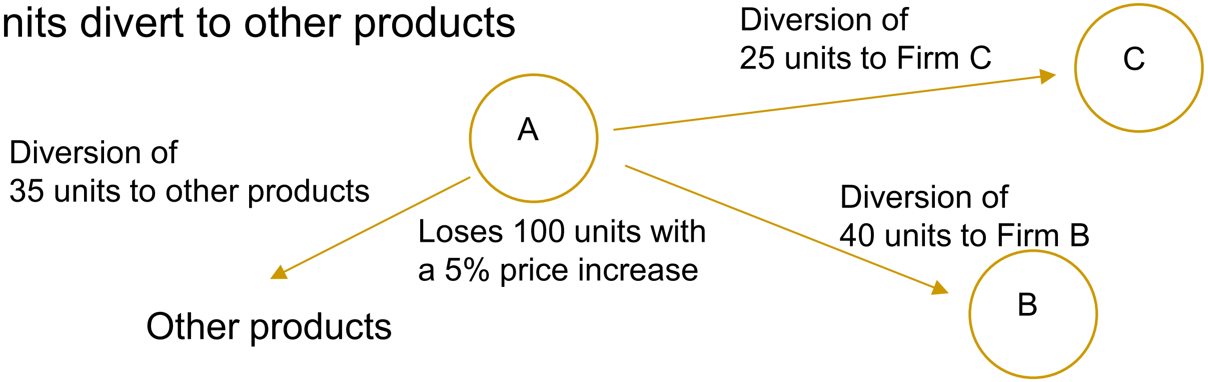
$$D_{12} = \frac{\text{Units captured by Firm 2 as a result of Firm 1's price increase}}{\text{Total units lost by Firm 1 as a result of Firm 1's price increase}} = \left|\frac{\Delta q_2}{\Delta q_1}\right|$$

    - NB: By convention, diversion ratios are *positive*. Since $\Delta q_1/\Delta p_1$ is negative (since the demand curve is downward sloping), we need to look at the absolute value of the fraction

- Thinking about diversion ratios
    - Think of D_{12} as $D_{1\rightarrow 2}$, that is, the percentage of units lost by Firm 1 that are "diverted" to Firm 2 (which produces a substitute product) resulting from Firm 1's price increase when Firm 2's price stays constant
        - This heuristic assumes that there is a one-to-one switch between Firm 1's and Firm 2's products

Diversion ratios

- Example
  - When Firm A raises its price by 5% and loses 100 units (all other firms hold their price constant)—
    - 40 units divert to Firm B
    - 25 units divert to Firm C
    - 35 units divert to other products



Diversion of
25 units to Firm C

C

A

Diversion of
35 units to other products

Loses 100 units with
a 5% price increase

Diversion of
40 units to Firm B

B

Other products

  - Then:

$$D_{A \to B} = \frac{40}{100} = 0.40 \text{ or } 40\%$$

$$D_{A \to C} = \frac{25}{100} = 0.25 \text{ or } 25\%$$

Since $D_{A \to B} > D_{A \to C}$, B is generally regarded as a closer substitute to A than C

Diversion ratios and cross-elasticities

- Although related, cross-elasticities and diversion ratios are different
  - Cross-elasticity measures the amount of diversion from product A to product B in response to a price increase in A as a percentage of B*’s original total output*
  - A diversion ratio measures the amount of diversion from product A to product B in response to a price increase in A as a percentage of *A’s lost marginal sales*

  - Technically (optional):

$$D_{12} = \left| \frac{dq_B / dp_A}{dq_A / dp_A} \right| = -\left(\frac{dq_B / dp_A}{dq_A / dp_A} \right) \overbrace{\left(\frac{p_A / q_B}{p_A / q_A} \; \frac{q_B / 1}{q_A / 1} \right)}^{= 1} = -\overbrace{\left(\frac{dq_B / dp_A \;\; p_A / q_B}{dq_A / dp_A \;\; p_A / q_A} \right)}^{\text{Rearranging terms}} \left(\frac{q_B}{q_A} \right) = -\overbrace{\frac{e_{AB}}{e_{AA}} \frac{q_B}{q_A}}^{\text{Simplifying}}$$

Cross-elasticities and diversion ratios

- Modern antitrust economics still speaks in terms of cross-elasticities when it often means diversion ratios
    - For example, products with high diversion ratios are said to have high cross-elasticity, BUT:

High diversion ratios do *not* imply high cross-elasticities

- Example:
    - Firm A faces a very inelastic demand of -0.2
        - Loses 1 out of 100 customers for a 5% SSNIP
    - But of the sales A loses, 90% go to B → A has a very high diversion ratio to B
    - The cross-elasticity from A to B can be high, low, or anything in between depending on B's original output:

$$\varepsilon_{AB} = \frac{\%\Delta q_B}{\%\Delta p_A} = \frac{\dfrac{\Delta q_B}{q_B}}{\dfrac{\Delta p_A}{p_A}}$$

All other things being equal (including the magnitude of Δq_B):

- High cross-elasticity if Δq_B is large compared to q_B
- Low cross-elasticity if Δq_B is small compared to q_B

Diversion ratios

- How are diversion ratios estimated? Six common methods—
  1. Indications in the company documents
  2. Consumer surveys
     - But very sensitive to survey design and customer ability to accurately predict product choice in the presence of a price increase
  3. Switching shares as proxies
     - Where switching behavior is not limited to reactions to changes in relative price
     - *Example*: H&R Block/TaxACT (where the court accepted a diversion analysis based on IRS switching data only as corroborating other evidence)
  4. Demand system estimation/econometrics
     - Econometric estimation of all own- and cross-elasticities of all interacting firms
     - Very demanding data requirements—Usually possible only in retail deals where point-of-purchase scanner data is available

Diversion ratios

- How are diversion ratios estimated?

5. Data collected during the regular course of business (including win-loss data)—Very common
    - *Example*: Using win-loss data
        - Over time, Firm A bids for one-year supply contracts in a nationwide market against nationwide competitors
        - On contracts that Firm A had won, collect data over some period of time on what happens when the contracts come up from renewal. There are two possibilities—
            - Firm A wins the bid for renewal
            - Firm A loses the bid to a competitor
        - Then the estimated diversion ratio D_{AB} to a competitor B is:

$$D_{AB} = \frac{\text{Number of times Firm B wins the bid}}{\text{Number of times Firm A loses the bid}}$$

- *Example*: Over a three-year period, Firm A won 50 bids. On the rebid—
    - Firm A won 40 times → Firm A lost 10 times
    - Firm B won 6 times
    - Firm C won 4 times

Then, for this time period: $D_{AB} = \frac{6}{10} = 60\%$ $D_{AC} = \frac{4}{10} = 40\%$

Diversion ratios

- How are diversion ratios estimated?
  6. Market shares as proxies: Relative market share method
     - Very popular method
     - Assumes that customers divert in proportion to the market shares of the competitor firms (after adjusting for any out-of-market diversion)
       - ❑ So that the largest competitors (by market share) get the highest diversions
     - When all diversion is to products within the candidate market:

$$D_{A \to B} = \frac{s_B}{1 - s_A},$$

where s_A and s_B are the market shares of firms A and B, respectively

- Example: Candidate market—
  - ❑ Firm A 40%
  - ❑ Firm B 30%
  - ❑ Firm C 24%
  - ❑ Firm D 6%

  60% points to be allocated to three firms pro rata by their market shares

  - ❑ No diversion outside the candidate market

Then:

$$D_{A \to B} = \frac{0.30}{1 - 0.40} = 50.0\%$$

$$D_{A \to C} = \frac{0.24}{1 - 0.40} = 40.0\%$$

$$D_{A \to D} = \frac{0.06}{1 - 0.40} = 10.0\%$$

Adds to 100%, to account for 100% of the diverted sales

Diversion ratios

- How are diversion ratios estimated?
  6. Market shares as proxies: Relative market share method (con't)
     - When there is some diversion to products outside the candidate market:

$$D_{A\to B}=\left(1-\frac{\Delta q_{outside}}{\Delta q_A}\right)\frac{s_B}{1-s_A},$$

where $\frac{\Delta q_{outside}}{\Delta q_A}$ is the percentage of Firm A's lost sales that are diverted to firms outside of the market

- Example: Candidate market—
  - Firm A 50%
  - Firm B 25%
  - Firm C 15%
  - Firm D 10%

  Shares in the candidate market (= 100%)
  - Outside diversion: 15%

  → 85% points to be allocated to the firms in the candidate market

Then:

$$D_{A\to B}=(1-0.15)\frac{0.25}{1-0.50}=42.5\%$$

$$D_{A\to c}=(1-0.15)\frac{0.15}{1-0.50}=25.5\%$$

$$D_{A\to D}=(1-0.15)\frac{0.10}{1-0.50}=17.0\%$$

$$D_{A\to O}=15\%$$

Total 85%
With outside diversion: 100%