Demand Applications and Elasticity

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Lesson 1: Consumer surplus, Producer surplus, Dead-weight loss

Consumer Surplus

- Do you remember how we link the demand curve with one person's marginal use value?
- If your marginal use value for the first cup of coffee is \$6, you would like to buy the first cup at any price $P \leq \$6$.
- Now, if the market price for the first cup of coffee is \$1, do you feel more happy or more sad?
- **Consumer surplus:** The difference between the maximum amount a person is willing to pay for a good and its current market price.

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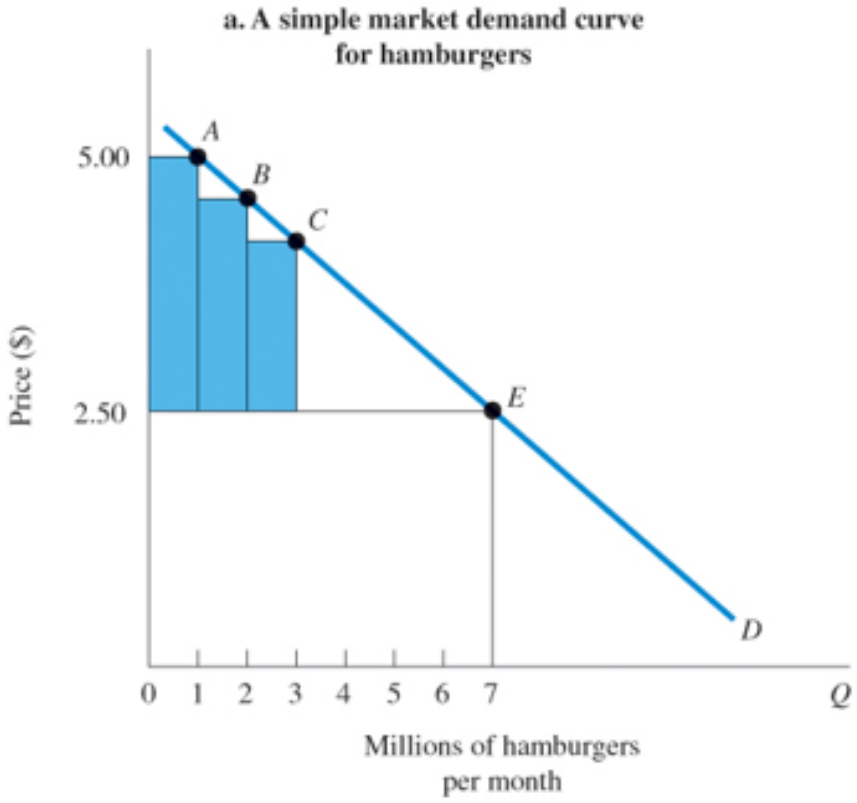
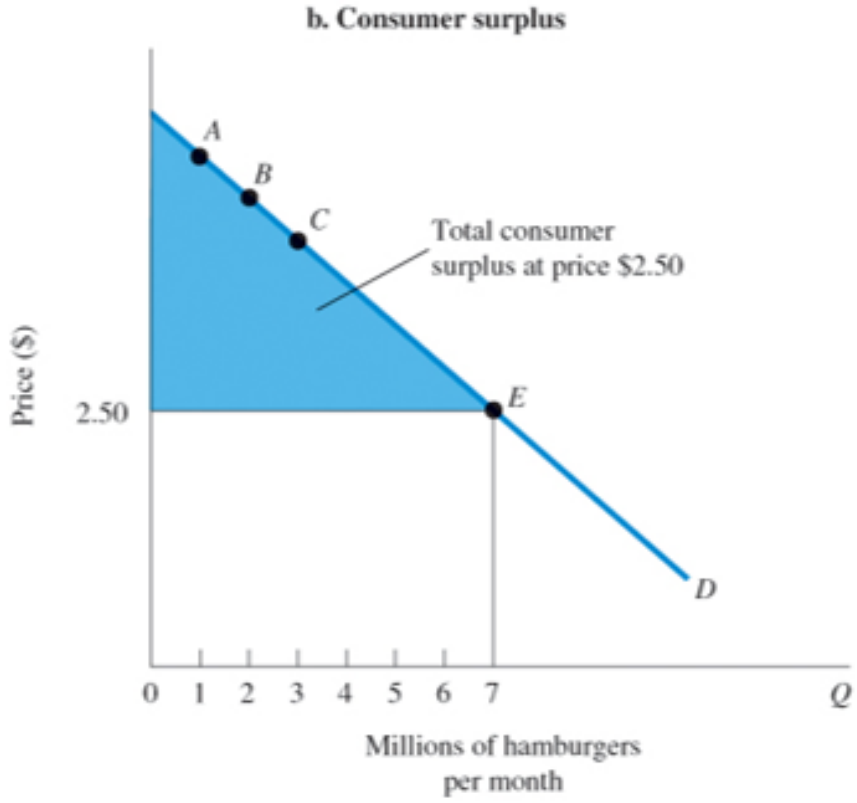
Consumer Surplus





Producer Surplus

- Linking the supply curve with one person's marginal use value of losing one goods
- If you were a owner for a coffee shop, and if your marginal cost to produce the first cup of coffee is \$1, then you would like to sell the first cup at any price $P \geq \$1$.
- Now, if the market price for the first cup of coffee is \$5, do you feel more happy or more sad?
- **Producer surplus**: The difference between the current market price and the cost of production for the firm.

Producer Surplus

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- If you were a owner for a coffee shop, and if your marginal cost to produce the first cup of coffee is \$1, then you would like to sell the first cup at any price $P \geq \$1$.
- Now, if the market price for the first cup of coffee is \$5, do you feel more happy or more sad?
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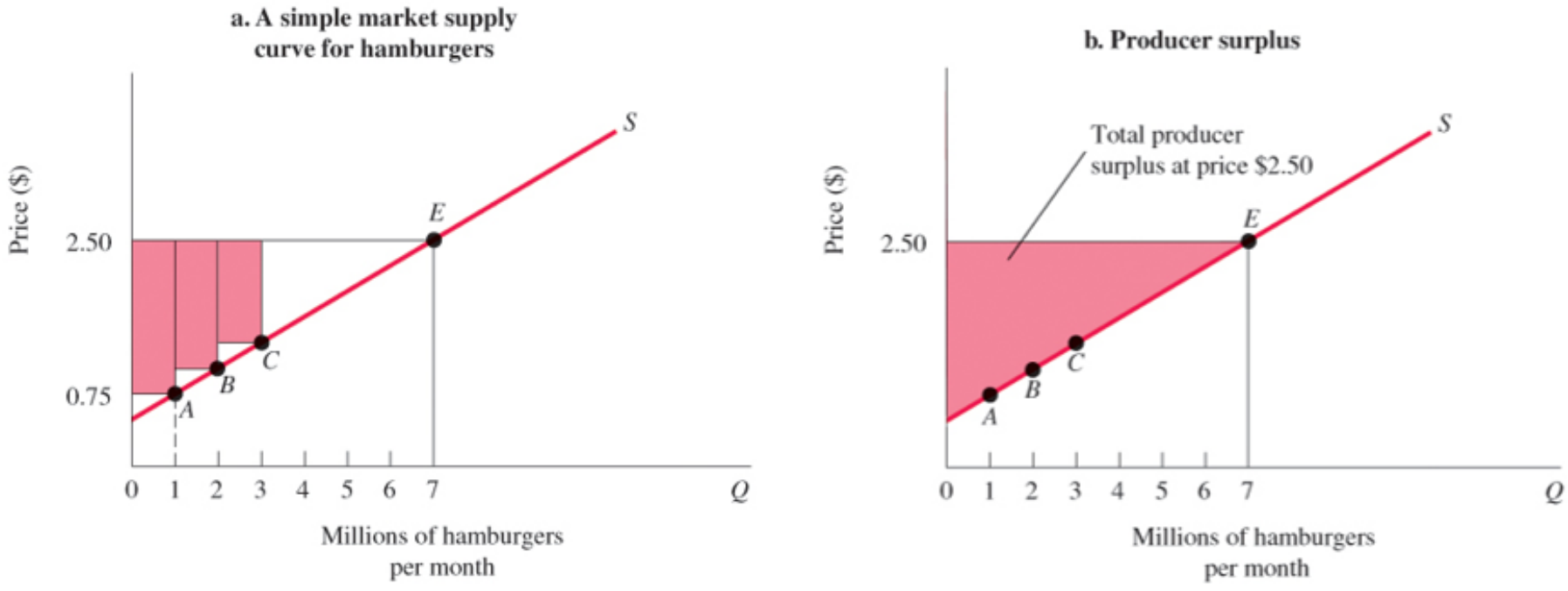
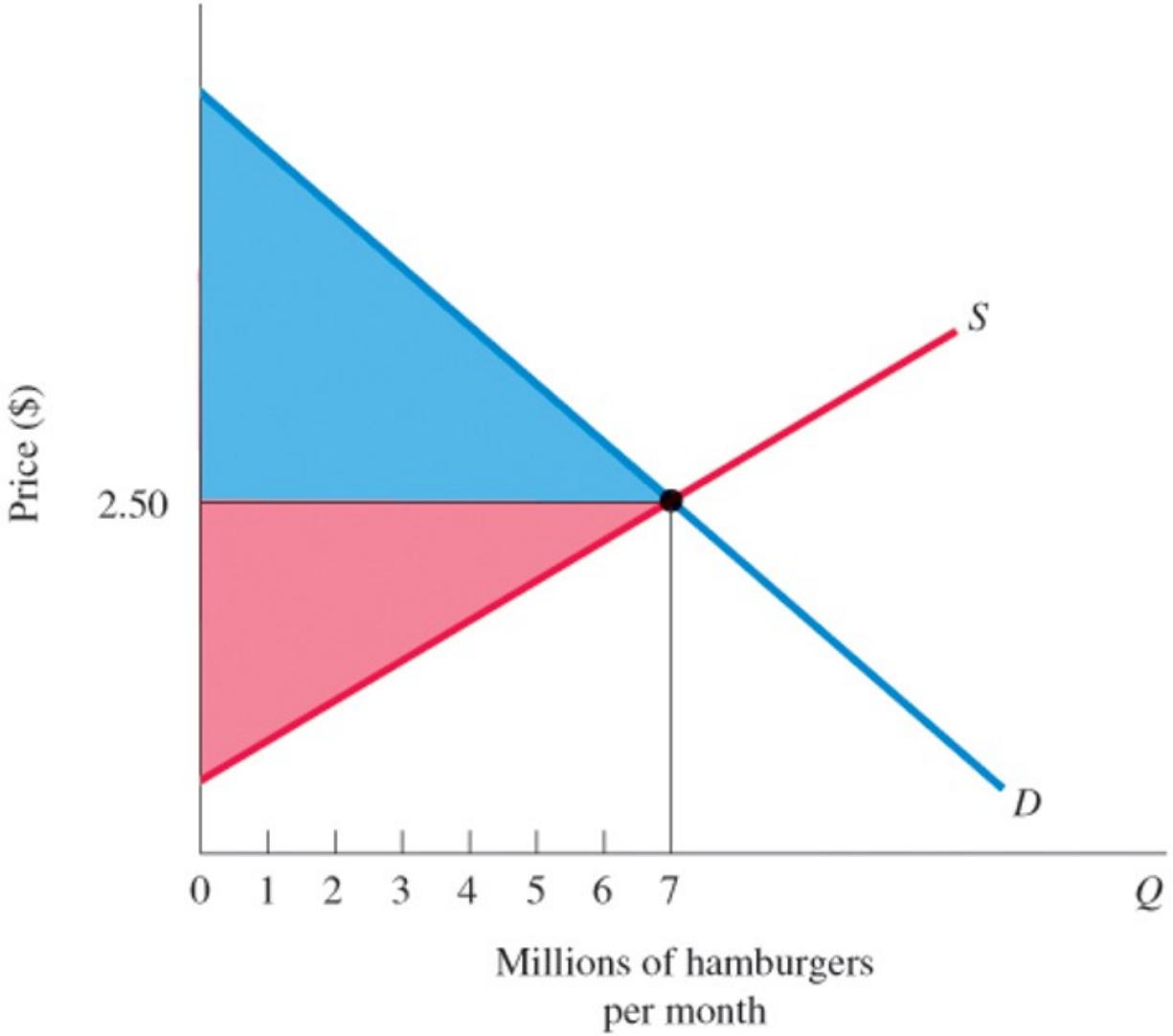
Producer Surplus



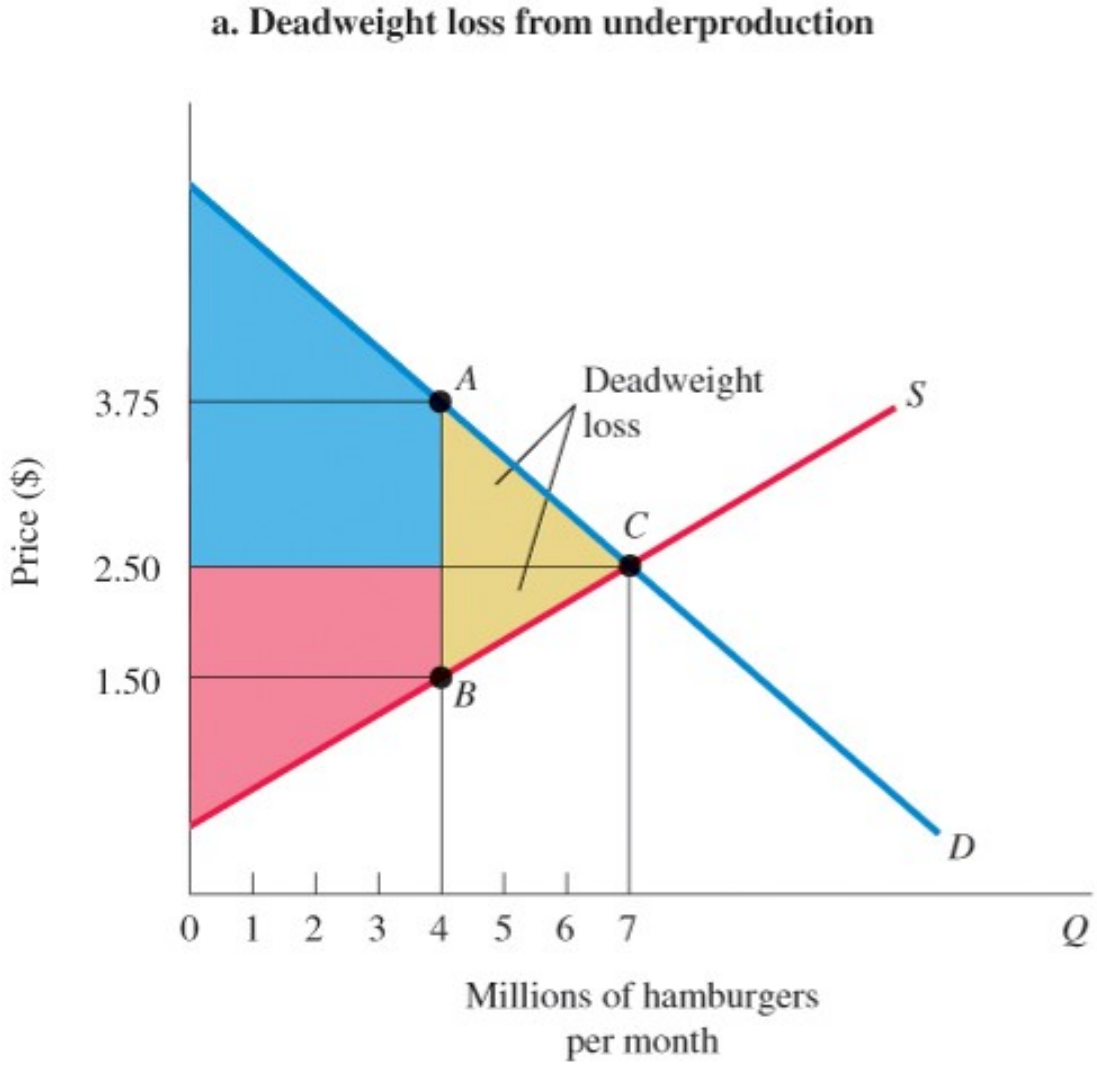
Efficiency

- Total producer and consumer surplus is greatest where supply and demand curves intersect at equilibrium in the competitive market.
- The equilibrium outcome in the perfect competition market achieves **efficiency**.
- **Perfect Competition market or Competitive market**:
  1. All firms and households are price-takers in input and output markets.
  2. Firms and households have perfect information.
  3. All firms maximize profits.
- Competitive markets are efficient because when supply and demand interact freely, markets produce what people want at the least cost.

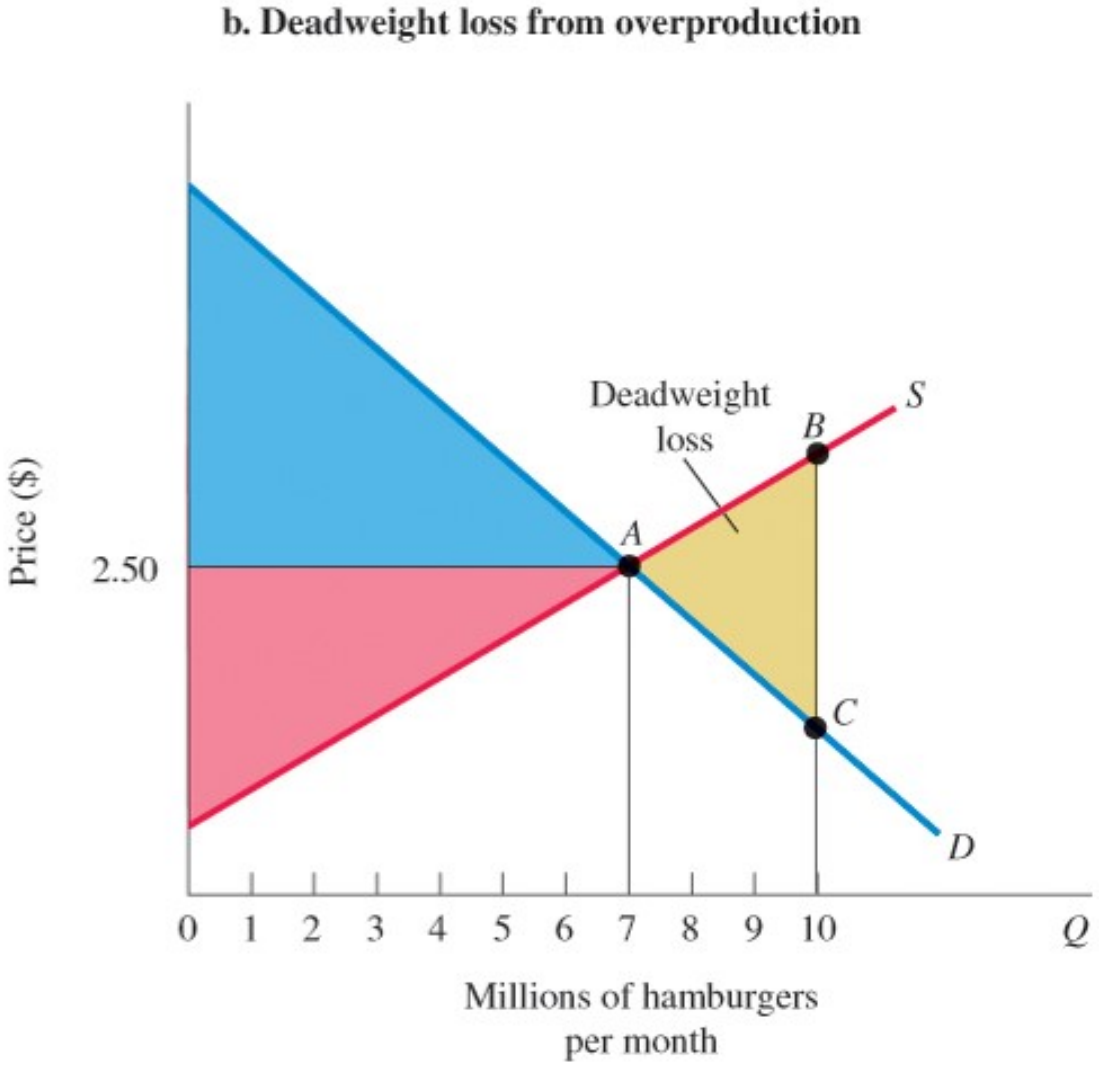
Efficiency



DWL: Underproduction



DWL: Overproduction



Deadweight Loss

- **Deadweight loss (DWL)**: The total loss of producer and consumer surplus from underproduction or overproduction.
- In the competitive market, underproduction and overproduction should not happen unless the government forced firms to do.

Auctions

- Auctions are designed to achieve allocation efficiency.
- Auctions can be conducted either through oral or written bidding methods.
- Types of Auctions
  1. The Ascending-bid auction, (English Auction)
  2. The descending-bid auction, (Dutch Auction)
  3. The first price sealed bid auction
  4. The second price sealed bid auction

Auction: Setup

- **A prize**: a commodity.
- **Players**:
  - 1 Principle: Tries to maximize her total revenues
  - Many bidders: $i = \{1, 2, 3, ...N\}$
    - Bidders are risk-neutral and maximize their payoffs.
    - They try to obtain the prize given their values on the prize and their budgets.
- **Private values**: Each player has a private and independent value for the prize in his/her mind. (v_i)
- **Common knowledge**:
  1. The number of players: N
  2. The range of bids: $[a_i, b_i]$
  3. The distribution of all private values: $(v_1, v_2, ..., v_N) \sim F(v_1, v_2, ..., v_N)$
     - Reserve price: a minimum price for an auction. r
- Symmetry game

Two Types of Auctions

- **First price auction**: All bidders simultaneously submit sealed bids so that no bidder knows the bid of any other participant. The **Highest bidder** pays for **the price that was submitted**, and gets the prize.
    - There is no best choice for the bidder, so the bidder i will bid $\frac{n-1}{n} v_i$
- **Second price auction**: All bidders simultaneously submit sealed bids so that no bidder knows the bid of any other participant. The **Highest bidder** pays for **the price that the second-highest bidder submitted**, and gets the prize.
    - Bidder i will truthfully bids his v_i because it is his best choice.

Practice

- The prize: a package of chocolates
- Players:
  - One seller: Xi
  - Many buyers: N
  - Reserve price: $4

1. Think about your value for the prize, and do not tell others. Write it on the paper.
2. Now, I am planning to have the first-price auction. Please write down your bid on the paper, and do not let others know about it.
3. When everyone finishes, let's see who is the winner.

Practice

- The prize: a package of chocolates
- Players:
  - One seller: Xi
  - Many buyers: N
  - Reserve price: $4

1. Think about your value for the prize, and do not tell others. Write it on the paper.
2. Now, I am planning to have the second-price auction. Please write down your bid on the paper, and do not let others know about it.
3. When everyone finishes, let's see who is the winner and what's his/her value.

Lesson 2: Price Elasticity of Demand

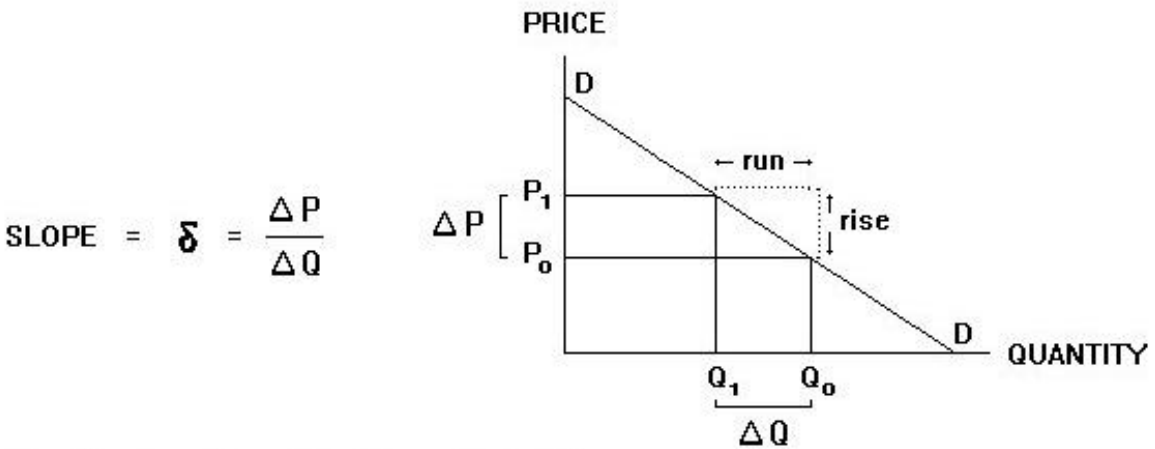
Elasticity

- If the unit price of Big Mac decreases $2, how does it impact the market demand for the Big Mac?
- The law of demand
- The law of demand only tells us that the quantity demanded should increase, but does not tell us: How large the changes are?
- **Elasticity**: used to quantify the response in one variable (price of Big Mac) when another variable (quantity demanded of Big Mac) changes.

Why not using the slope?

- Slope could also reflect how quantity demanded response to the market price, why not using the slope?

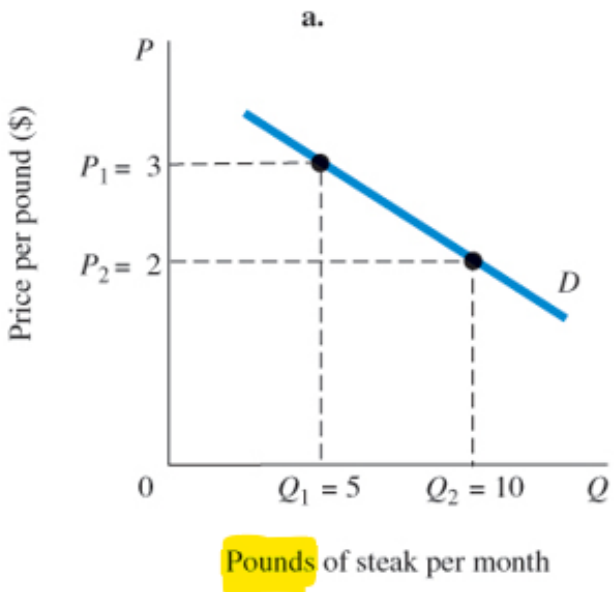
Figure 1

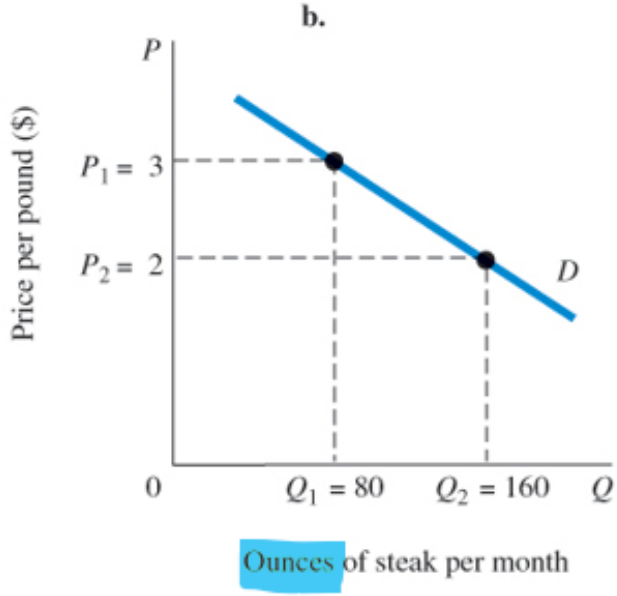


The slope equals the "rise" over the "run".

Slope and Elasticity

- Could we use slope to quantity the market response to the price changes?
- No, because the exact same behavior might be expressed by different slopes (due to different units).





$$\text{Slope: } \frac{\Delta Y}{\Delta X} = \frac{P_2 - P_1}{Q_2 - Q_1} = \frac{2 - 3}{10 - 5} = -\frac{1}{5}$$

$$\text{Slope: } \frac{\Delta Y}{\Delta X} = \frac{P_2 - P_1}{Q_2 - Q_1} = \frac{2 - 3}{160 - 80} = -\frac{1}{80}$$

Slope and Elasticity

- We have to convert the changes in price and quantity to percentages.
- $\Rightarrow$ How much the percent quantity demanded changes for a given percent price change?
- Price elasticity of demand

$$\text{Price elasticity of demand} = \frac{\%\text{ change in quantity demanded}}{\%\text{change in price}}$$

- Elasticity is a ratio of percentage
- By the law of demand, the numerator and denominator should have opposite signs, resulting in a negative ratio.
- There are two ways to calculate the % change
  1. Selecting one of two points as an initial point;
  2. Selecting the midpoint as the initial point $\surd$

Calculating Elasticity: Method 1

Method 1: Selecting one of two points as an initial point

$$\begin{aligned}\%\text{ change in quantity demanded} &= \frac{\text{change in quantity demanded}}{Q_1} \times 100\% \\ &= \frac{Q_2 - Q_1}{Q_1} \times 100\%\end{aligned}$$

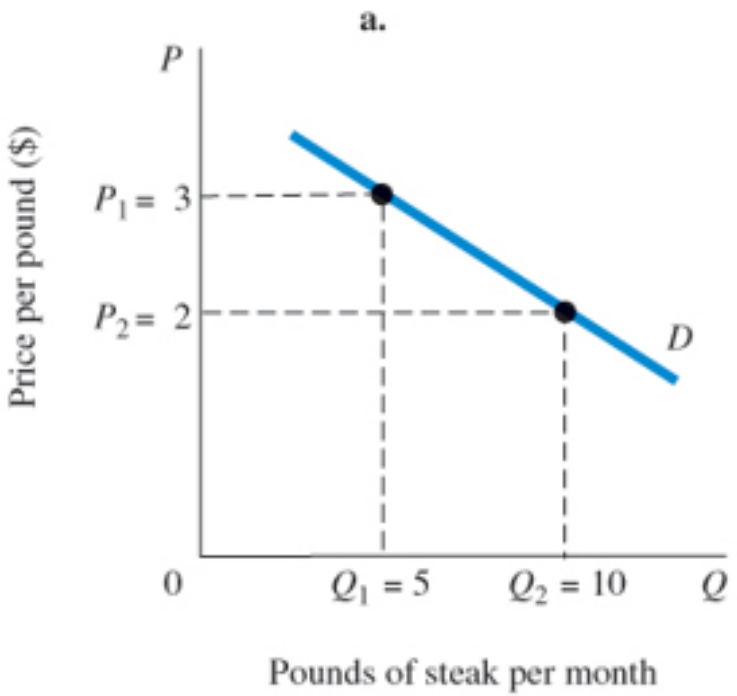
$$\begin{aligned}\%\text{ change in price} &= \frac{\text{change in price}}{P_1} \times 100\% \\ &= \frac{P_2 - P_1}{P_1} \times 100\%\end{aligned}$$

$$\text{Price elasticity of demand} = \frac{\%\text{ change in quantity demanded}}{\%\text{change in price}}$$

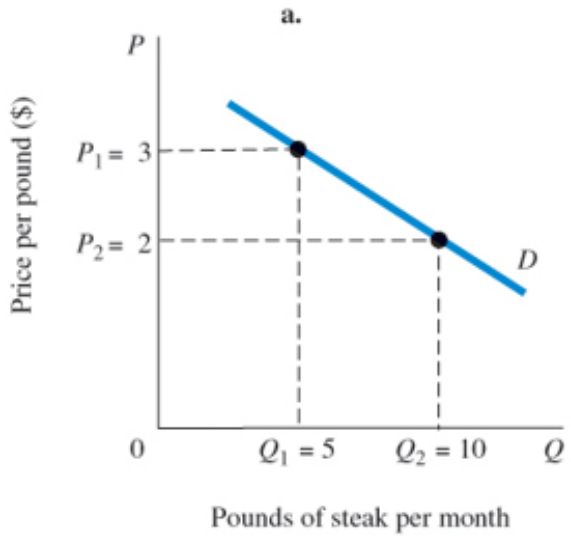
Calculating Elasticity: Method 1

Example: Please calculate the price elasticity of demands by using:

1. Q_1 and P_1 as initial point
2. Q_2 and P_2 as initial point
3. By comparing two results, what do you find?

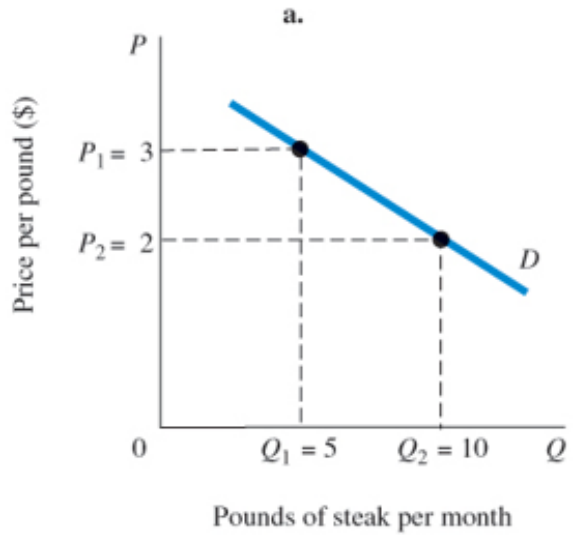


Calculating Elasticity: Method 1



- The answer for the first question:
- % change in quantity demanded $= \frac{Q_2 - Q_1}{Q_1} = \frac{10-5}{5} = 100\%$
- % change in price $= \frac{P_2 - P_1}{P_1} = \frac{2-3}{3} = -33.3\%$
- Elasticity $= \frac{100\%}{-33.3\%} = -3$

Calculating Elasticity: Method 1



- The answer for the second question:
- % change in quantity demanded $= \frac{Q_1 - Q_2}{Q_2} = \frac{5-10}{10} = -50\%$
- % change in price $= \frac{P_1 - P_2}{P_2} = \frac{3-2}{2} = 50\%$
- Elasticity $= \frac{-50\%}{50\%} = -1$

Calculating Elasticity: Method 1

- Finding: We obtain two different price elasticity of demands, although we are calculating elasticity on the same interval on the same demand curve.
- Our expectation: Changing the direction of calculation should not change the elasticity.
- Why do we have this problem?
- We should read the graph from left to right. If we read the graph from the right to the left, then in fact the curve changes.
- To avoid this problem, we might want a better method to calculate elasticity.

Calculating Elasticity: Method 2

Method 2: Selecting the midpoint as an initial point

$$\%\text{ change in quantity demanded} = \frac{\text{change in quantity demanded w.r.t the midpoint}}{\bar{Q}}$$

$$= \frac{Q_2 - \bar{Q}}{\bar{Q}} \times 100\%$$

where $\bar{Q} = \frac{Q_1+Q_2}{2}$

$$\%\text{ change in price} = \frac{\text{change in price w.r.t the midpoint}}{\bar{P}} \times 100\%$$

$$= \frac{P_2 - \bar{P}}{\bar{P}} \times 100\%$$

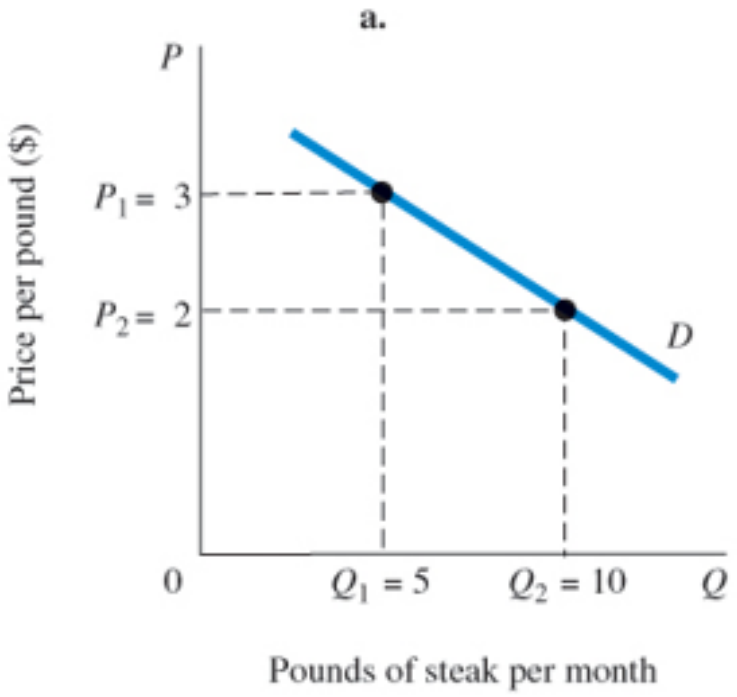
where $\bar{P} = \frac{P_1+P_2}{2}$

$$\text{Price elasticity of demand} = \frac{\%\text{ change in quantity demanded}}{\%\text{change in price}}$$

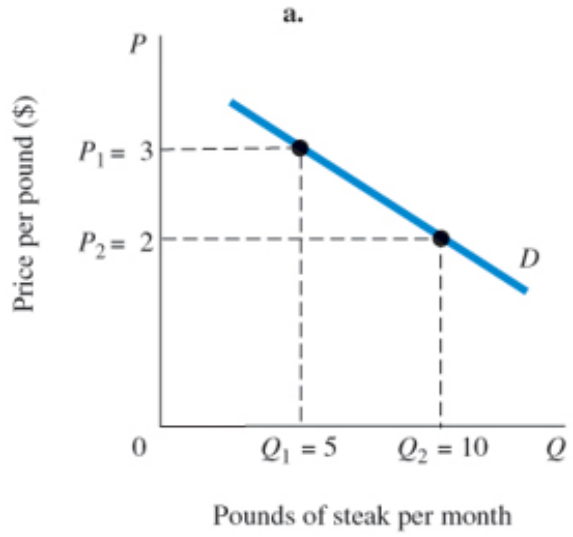
Calculating Elasticity: Method 2

Example: Please calculate the price elasticity of demands by using the midpoint formula and choose

1. Q_1 and P_1 as the after-changing point
2. Q_2 and P_2 as the after-changing point

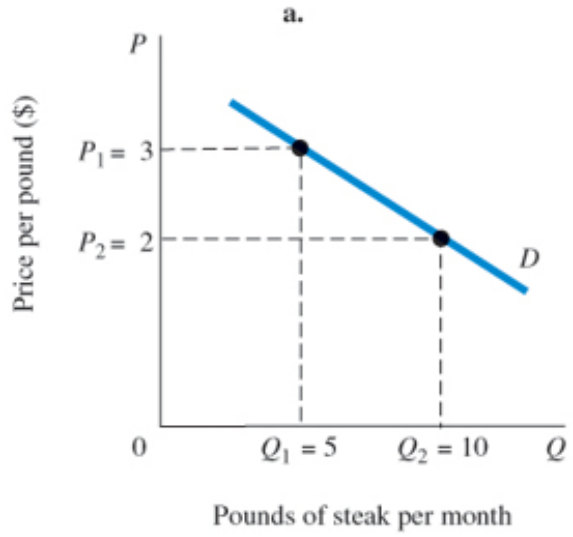


Calculating Elasticity: Method 2



- The answer for the first question:
- % change in quantity demanded w.r.t the midpoint $= \frac{Q_1 - \bar{Q}}{\bar{Q}} = \frac{5-7.5}{7.5} = -33.3\%$
- % change in price w.r.t the midpoint $= \frac{P_1 - \bar{P}}{\bar{P}} = \frac{3-2.5}{2.5} = 20\%$
- Elasticity $= \frac{-33.3\%}{20\%} = -\frac{333}{200}$

Calculating Elasticity: Method 2



- The answer for the second question:
- % change in quantity demanded w.r.t the midpoint $= \frac{Q_2 - \bar{Q}}{\bar{Q}} = \frac{10-7.5}{7.5} = 33.3\%$
- % change in price w.r.t the midpoint $= \frac{P_2 - \bar{P}}{\bar{P}} = \frac{2-2.5}{2.5} = -20\%$
- Elasticity $= \frac{33.3\%}{-20\%} = -\frac{333}{200}$

Calculating Elasticity

- Except method 1 and 2, we have the third method to calculate elasticity: Taking derivative.
- Price elasticity of demands

$$= \frac{\%\text{ change in quantity demanded}}{\%\text{ change in price}} = \frac{\frac{\triangle Q}{Q_1}}{\frac{\triangle P}{P_1}} = \frac{\triangle Q}{\triangle P} \times \frac{P_1}{Q_1} \approx \frac{dQ}{dP} \times \frac{P_1}{Q_1}$$

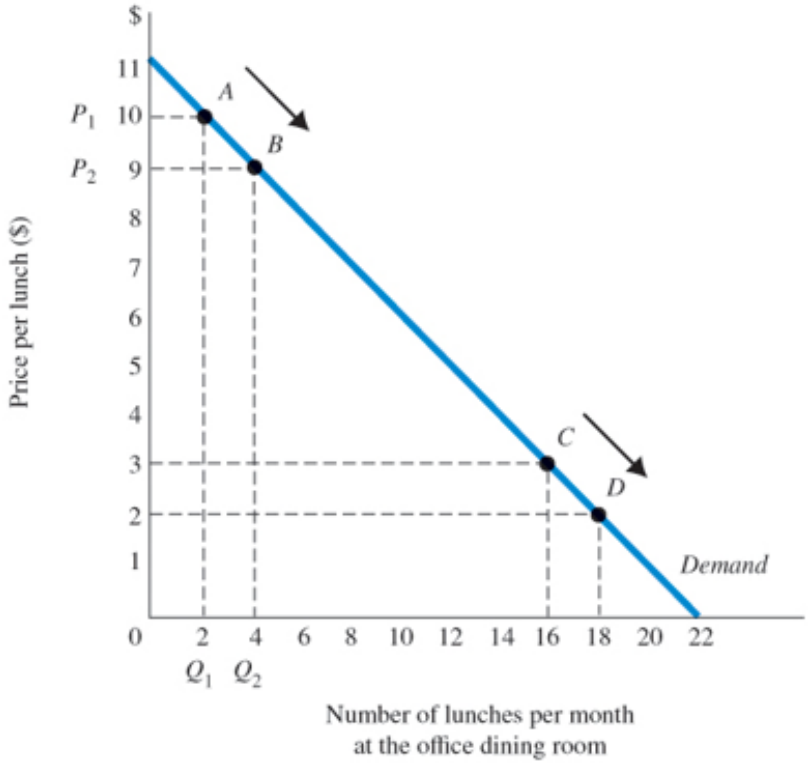
- Example: You have a demand function: $Q = 10 - P$ and you want to calculate the price elasticity of demand at $(Q_1 = 5, P_1 = 5)$
- Answer: Elasticity $= \frac{d(10-P)}{dP} \times \frac{5}{5} = -1$

Types of Elasticity

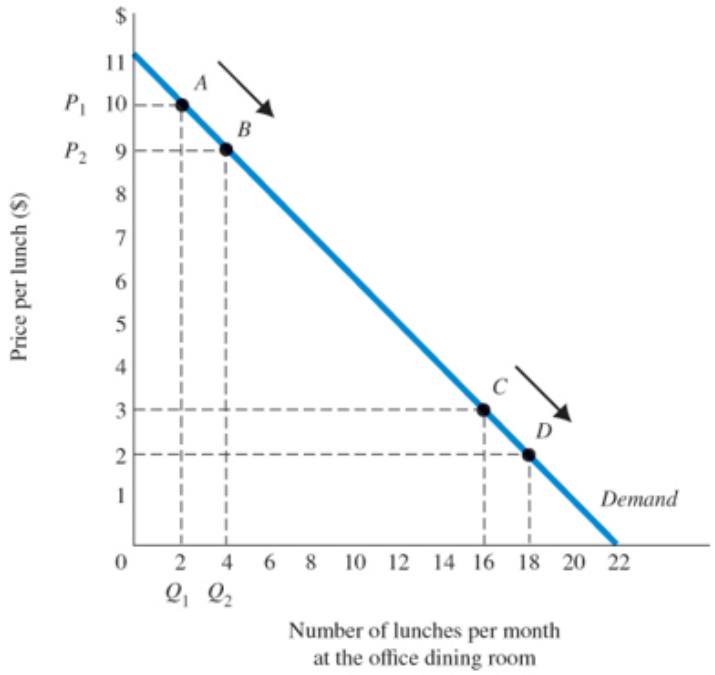
- Elastic: A demand relationship in which the percentage change in quantity demanded is larger than the percentage change in price in absolute value ($|\epsilon_d| > 1$).
- Inelastic: A demand that responds somewhat, but not a great deal, to changes in price. ($0 < |\epsilon_d| < 1$).
- Unitary elastic: A demand relationship in which the percentage change in quantity of a product demanded is the same as the percentage change in price in absolute value. ($|\epsilon_d| = 1$).

Types of Elasticity

- Example: Please calculate the following two price elasticity of demands by using the midpoint formula.
  1. From A to B
  2. From C to D
  3. By comparing two elasticity, what do you find?

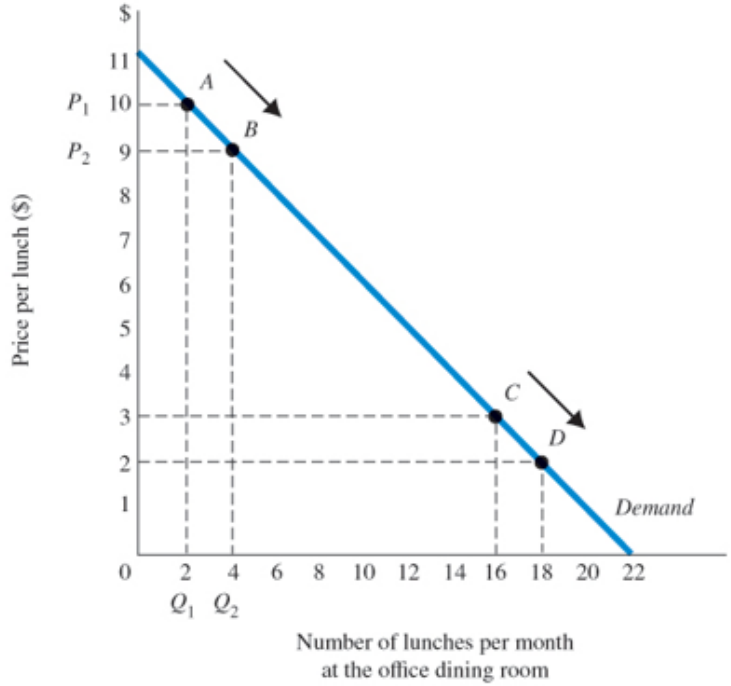


Types of Elasticity



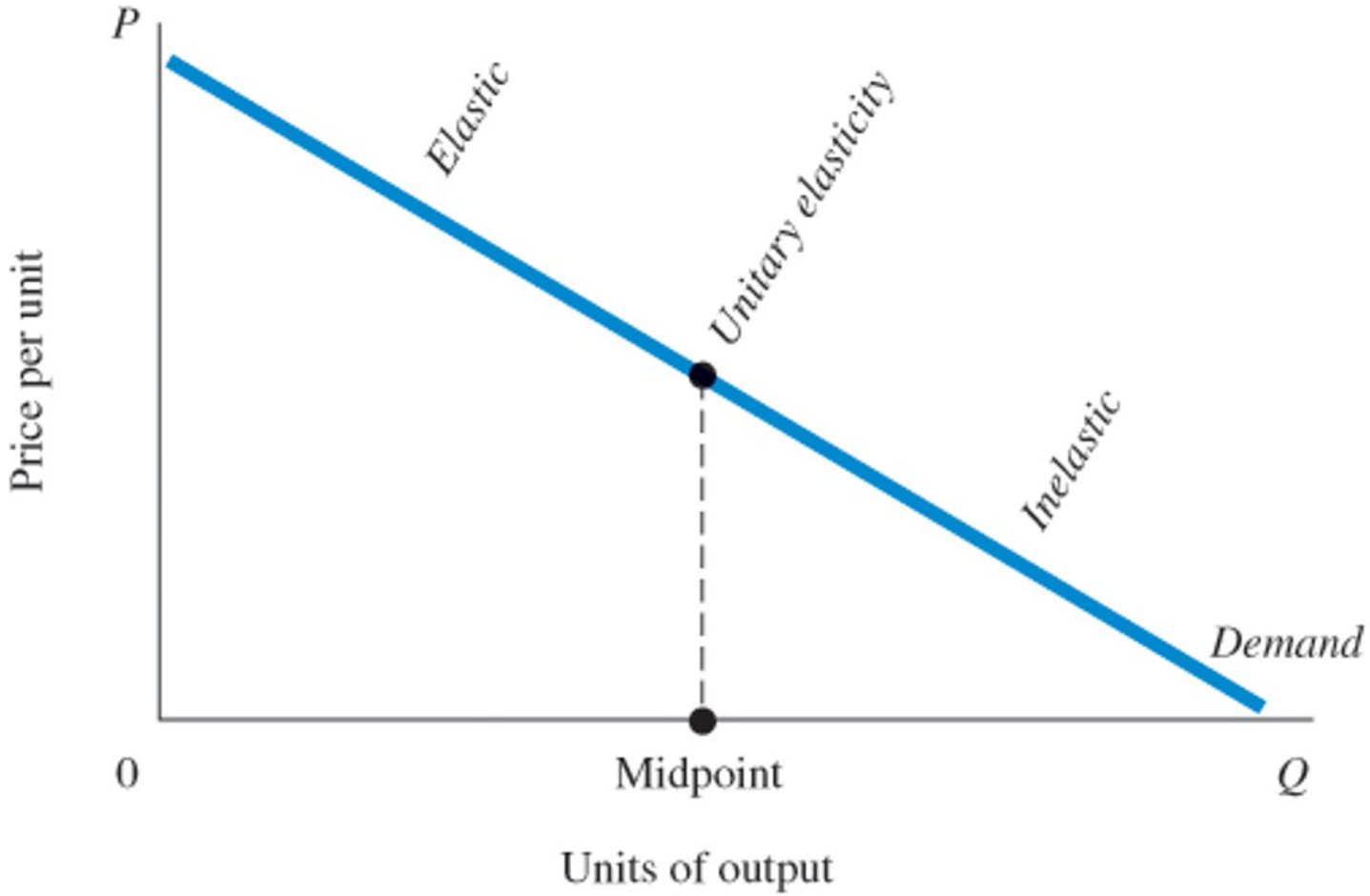
- For the elasticity from A to B
- % change in quantity demanded w.r.t the midpoint = $\frac{Q_B - \bar{Q}}{\bar{Q}} = \frac{4-3}{3} = 33.3\%$
- % change in price w.r.t the midpoint = $\frac{P_B - \bar{P}}{\bar{P}} = \frac{9-9.5}{9.5} = -5.3\%$
- Elasticity = $\frac{33.3\%}{-5.3\%} = -\frac{333}{53} = -6.28$

Types of Elasticity



- For the elasticity from C to D
- % change in quantity demanded w.r.t the midpoint = $\frac{Q_D - \bar{Q}}{\bar{Q}} = \frac{18-17}{17} = 5.9\%$
- % change in price w.r.t the midpoint = $\frac{P_D - \bar{P}}{\bar{P}} = \frac{2-2.5}{2.5} = -20\%$
- Elasticity = $\frac{5.9\%}{-20\%} = -0.295$

Types of Elasticity

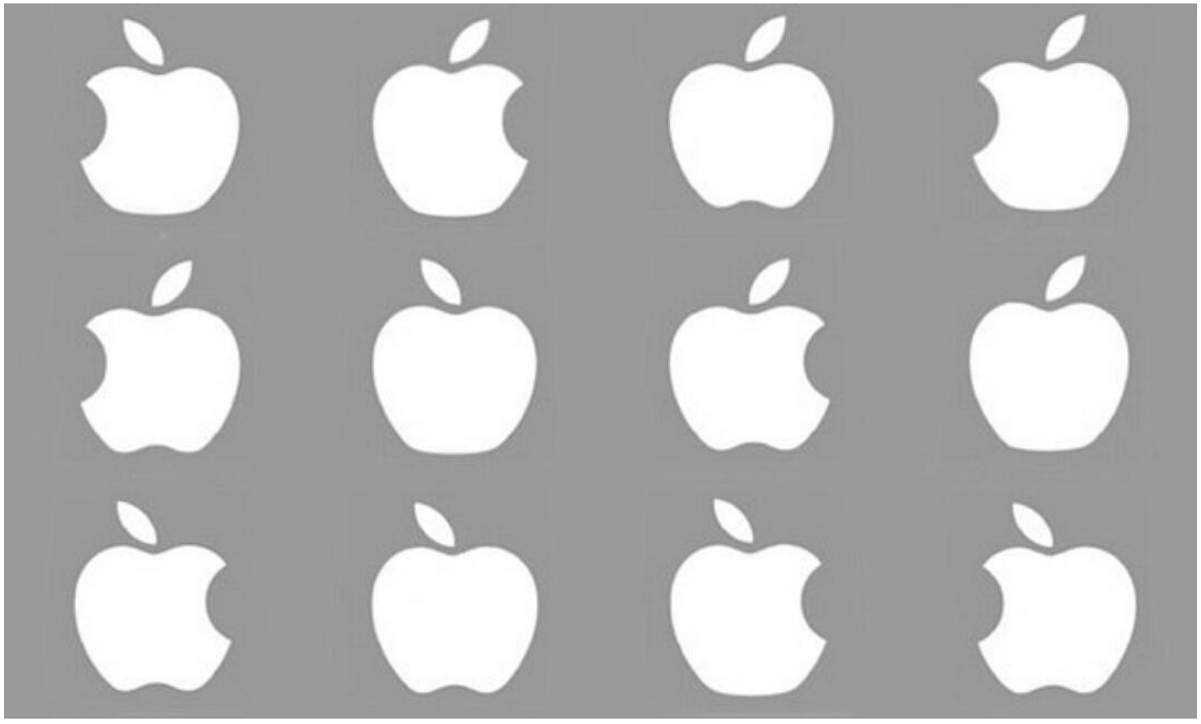


Quiz for Fun

1. Use your electronic devices to search this website: `www.kahoot.it`
2. Pin code
3. Create a nickname for yourself
4. Answer the question

Lesson 3: Elasticity and its Applications

Which one is Apple's Logo?



Review: Elasticity

- Why do we need elasticity? (Quantify market response)
- Why not use the slope to quantify it? (Problem: Different unit cause different answer.)
- How to calculate elasticity?

$$\text{Price elasticity of demand} = \frac{\%\text{ change in quantity demanded}}{\%\text{change in price}}$$

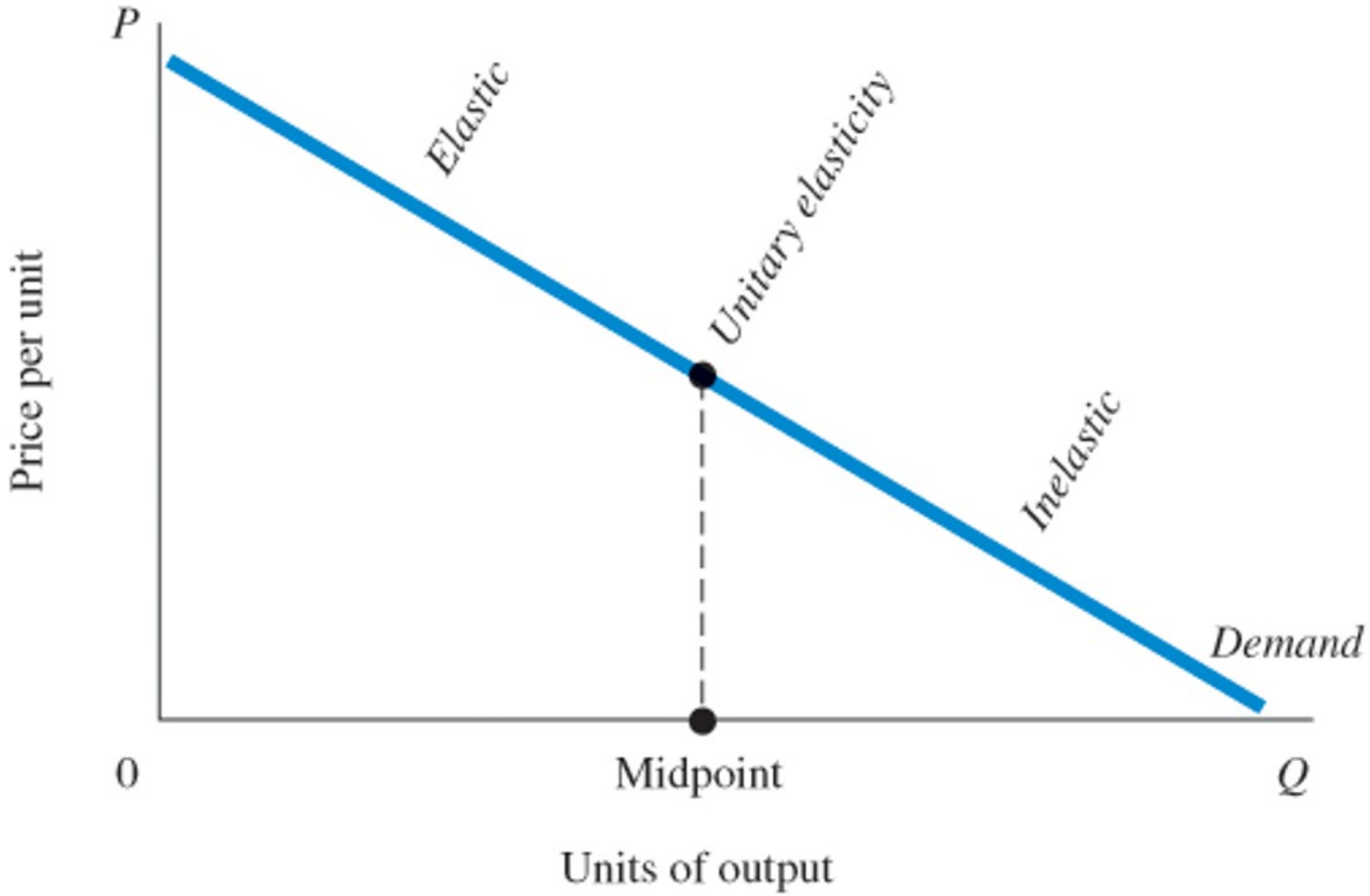
- How to calculate percentage changes?
  - Select one of two points as the initial point (Problem: Give us different answers.)
  - Select the midpoint as the initial point

Example

$$\text{Price elasticity of demand} = \frac{\%\text{ change in quantity demanded}}{\%\text{change in price}}$$

Tom	2022/09/10	2022/09/19	Elasticity
Superbowl's ticket	\$3000	\$5000	
ticket's demand	1	0	
Rice's price	\$5	\$ 6.5	
Rice's demand	2	2	

Types of Elasticity



Finding

- Elasticity is not the slope.
  - The slope of a straight line is constant.
- The demand becomes less elastic as we move down his demand curve.
  - Demand is unit elastic halfway up a linear demand curve.
- *Why the demand is more elastic in the left-upper part?*
  - At high prices and low quantities, it is easy to make a big impact on the level of sales.
  - At low prices and high quantities, increasing quantity demanded is much harder.
  - *Deep reason*: The diminishing of marginal utility.

Elasticity and Total Revenue

Question: If you were the owner of a supermarket, and you realize that most people have **inelastic demands** for the food, what will you do to maximize your company's revenue? Will you raise the price or lower the price?

- Total Revenue = $P \times Q$

Elasticity and Total Revenue

- When demand is inelastic, raising prices will raise revenues. (Why?)
  - The law of demand $\Rightarrow$ If $P \uparrow$, then $Q_d \downarrow$
  - Inelastic demands
  - $\Rightarrow 0 \leq |\epsilon| < 1$
  - $\Rightarrow 0 \leq \frac{Q_d\%}{P\%} < 1$
  - $\Rightarrow |Q_d\%| < |P\%|$
  - TR = $\underbrace{Q_d}_{\downarrow\text{small}} \times \underbrace{P}_{\uparrow\text{large}} \Rightarrow TR \uparrow$
- When demand is elastic, raising prices may decrease total revenues.
  - Elastic demands $\Rightarrow |\epsilon| \geq 1 \Rightarrow |Q_d\%| > |P\%|$
  - TR = $\underbrace{Q_d}_{\downarrow\text{large}} \times \underbrace{P}_{\uparrow\text{small}} \Rightarrow TR \downarrow$

What determines elasticity?

1. Availability of substitutes
   - Example: Consider a number of farms stands lined up along a road. If every firm sells corn of the same quality, then the firm will find it is hard to charge a price much higher than other competitors.(Elastic)
2. The importance of being unimportant
   - When an item represents a small part of our total budget, we tend to pay little attention to its price.
   - Example: If you pick up a pack of mints once in a while you might not notice an increase in price from 25 cents to 35 cents.
3. Luxuries versus necessities
   - Example: Caviar vs the food that we eat everyday
4. The time dimension
   - If UGA decided to increase the price of dormitories, then your short-run's demand is inelastic, but your long-run's demand may be elastic.

1. Income Elasticity of Demand

- **Income Elasticity of Demand**: A measure of the responsiveness of quantity demanded to changes in income.

$$\text{Income Elasticity of Demand} = \frac{\%\text{ change in quantity demanded}}{\%\text{change in income}}$$

- Interpretation: If the income elasticity of demand for housing is 0.8 then a 10 percent increase in income will cause housing demand to increase by 8 percent.
- Income elasticity is positive for normal goods but negative for inferior goods.

2. Cross Price Elasticity of Demand

- **Cross Price Elasticity of Demand**: A measure of the response of the quantity of one good demanded to a change in the price of another good.

$$\text{Cross Price Elasticity of Demand} = \frac{\%\text{ change in quantity of Y demanded}}{\%\text{change in price of X}}$$

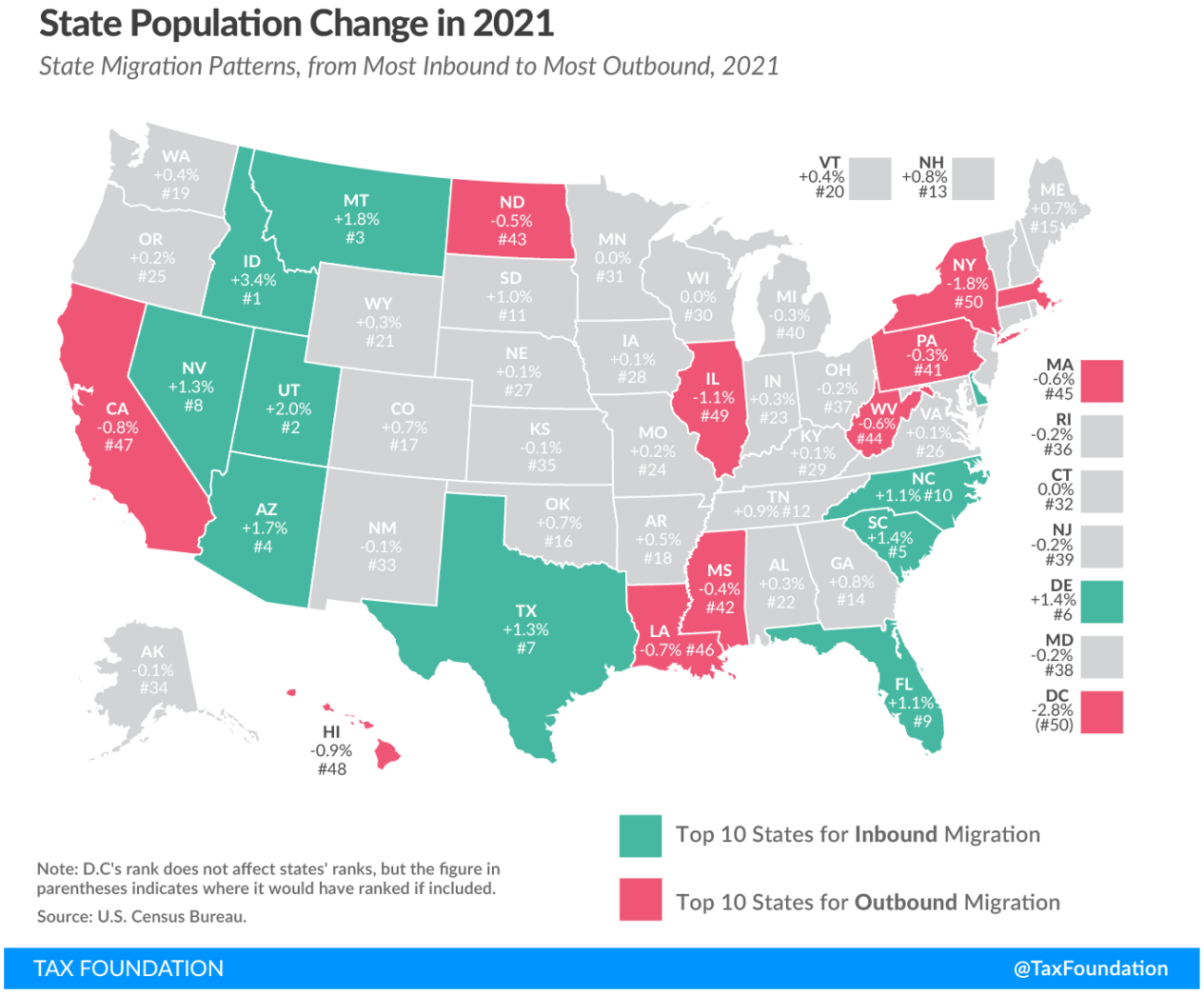
- Substitutes: have positive cross-price elasticity
- Complements: have negative cross-price elasticity

3. Elasticity of Supply

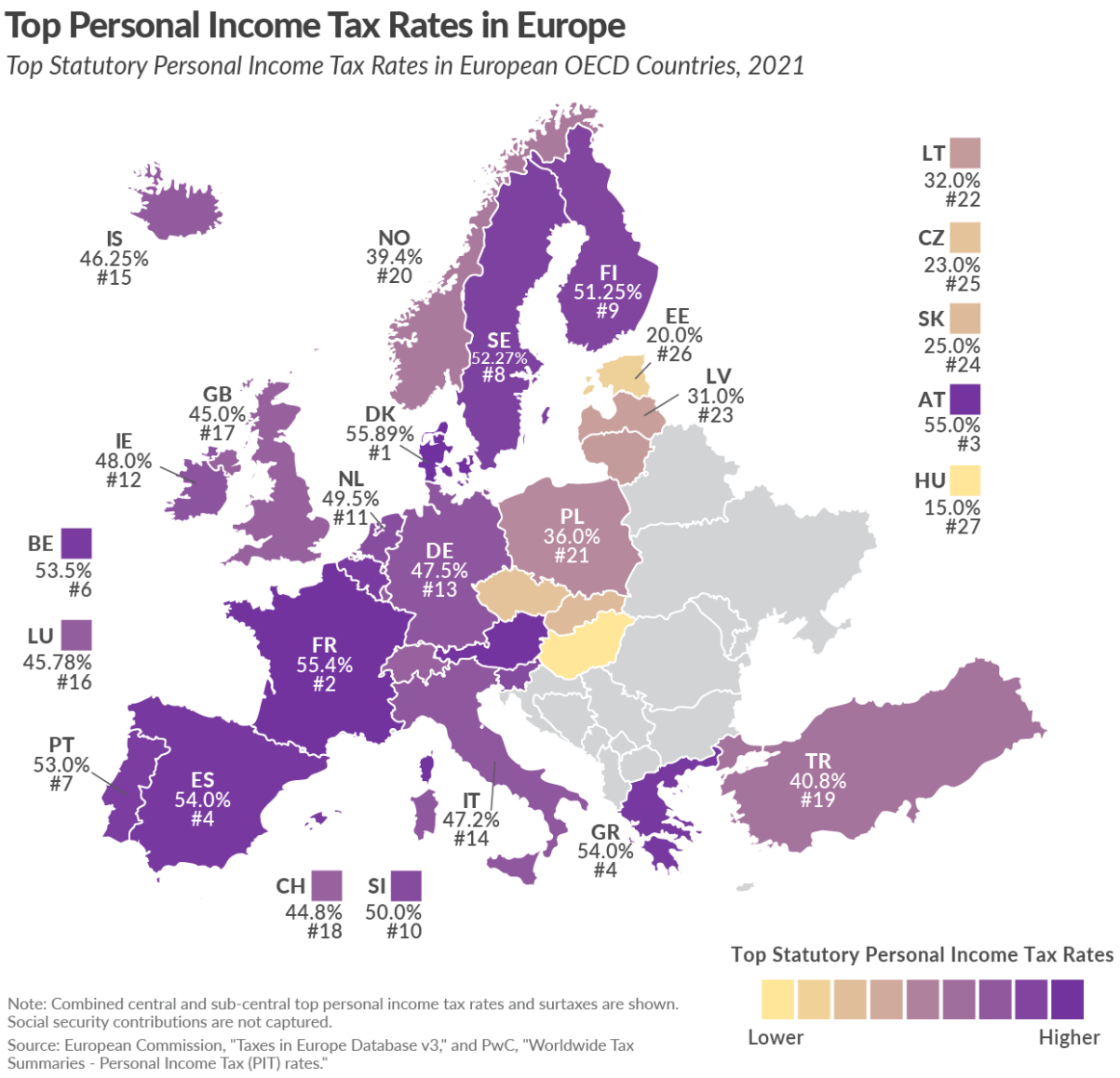
- **Elasticity of Supply**: A measure of the response of quantity of a good supplied to a change in price of that good.

$$\text{Elasticity of Supply} = \frac{\%\text{ change in quantity supplied}}{\%\text{change in price}}$$

Application: Tax Rates and Migration in Europe



Tax Rates and Migration in Europe



Tax Rates and Migration in Europe

- Countries that are members of the European Union agree to labor mobility. However, income tax rates vary among the different countries. What is the labor supply elasticity with respect to tax rates for highly skilled workers?
- Denmark's tax rate on incomes over €100,000 was 55 percent.
- In an attempt to attract highly skilled workers, Denmark offered them a flat 30 percent tax rate for 3 years.

$$\text{The elasticity of migration} = \frac{\%\text{Changes in Inbound Migration}}{\%\text{Changes in Income Tax Rates}}$$

- A 10 percent reduction in the tax rate induced a 20 percent increase in migration.

Excise Taxes and Smuggling Activities in the Cigarette Market

- **Excise tax**: A per-unit tax on a specific good.
- In 1999, CA voters passed a a measure increasing cigarette taxes by \$0.5 per pack. CA also banned smoking in restaurants and bars.
- However, the tax did not raise the expected revenue for the CA government. What could happen here?
- One reason is revenue loss from tax evasion. Can you list some potential sources of evasion?
- Three main reasons:
  1. Smuggling from neighbor states that impose lower taxes (Nevada)
  2. Purchases from Native American casinos located in California
  3. Outright fraud by retailers who purchase cigarettes without the state tax stamp

Excise Taxes and Smuggling Activities in the Cigarette Market

- Former New York City mayor Michael Bloomberg pushed through a tax increase on cigarettes in 2010.
- The tax in the city is now \$5.85 per pack, bringing the retail price to \$12.85.
- Outside New York City, the tax is lower and the retail price is \$11.90.
- Researcher found: In 2015 about 57 percent of the cigarettes consumed in New York City were smuggled, the most of any state.

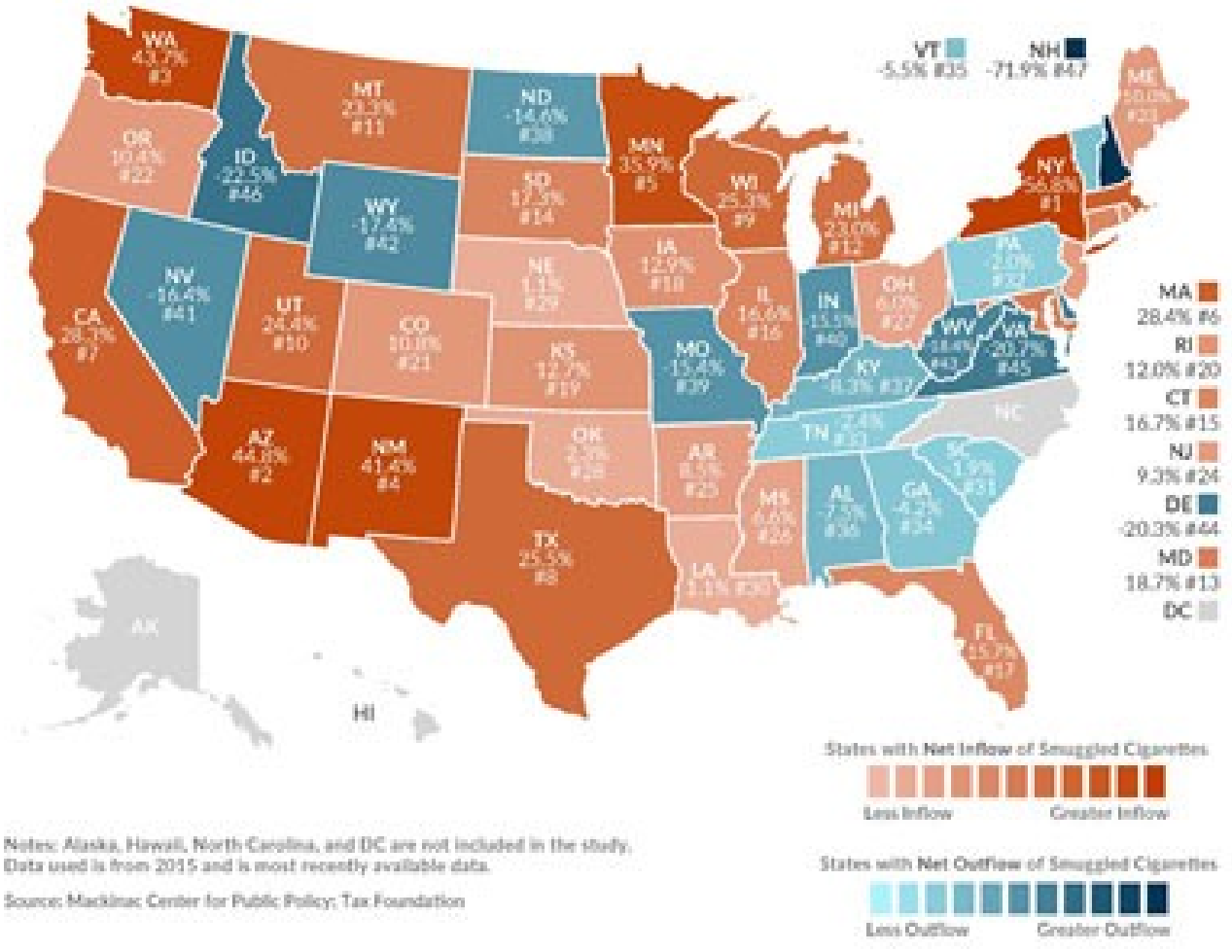
$$Elasticity = \frac{\%\text{Changes in Smuggling}}{\%\text{Changes in Cigarette tax}}$$

Excise Taxes and Smuggling Activities

FIGURE 2.

Cigarette Smuggling by State

Smuggled Cigarettes Consumed as a Percentage of Total Cigarettes Consumed, 2015



Notes: Alaska, Hawaii, North Carolina, and DC are not included in the study. Data used is from 2015 and is most recently available data.

Source: Mackinac Center for Public Policy; Tax Foundation

Quiz for Fun

1. Use your electronic devices to search this website: `www.kahoot.it`
2. Pin code
3. Create a nickname for yourself
4. Answer the question