EconS 305 - Elasticity - Part 1

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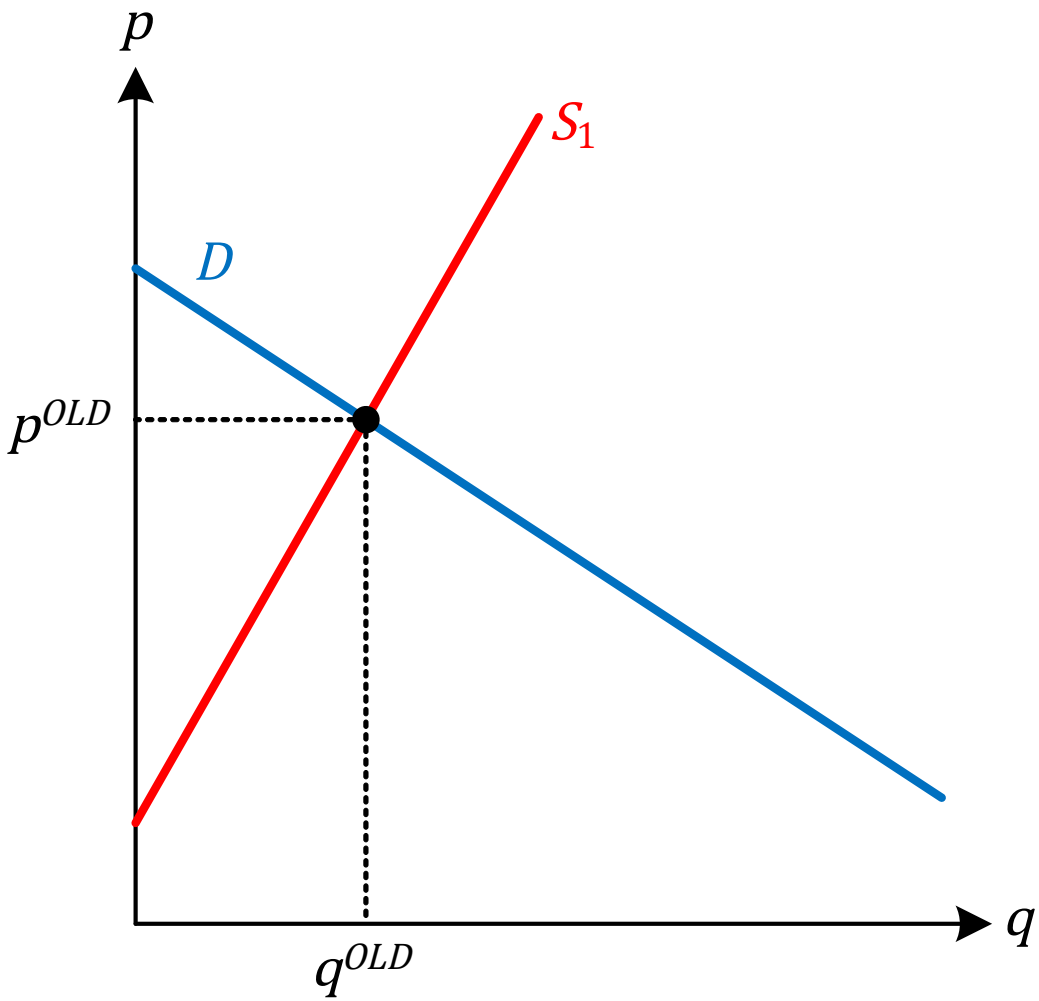
Introduction

- Today, we're talking about elasticity, a measurement of how sensitive quantity is to several different factors.
  - We will cover the price elasticity of demand and income elasticity of demand today.
  - On Monday, we'll look at the cross price elasticity and the elasticity of supply.

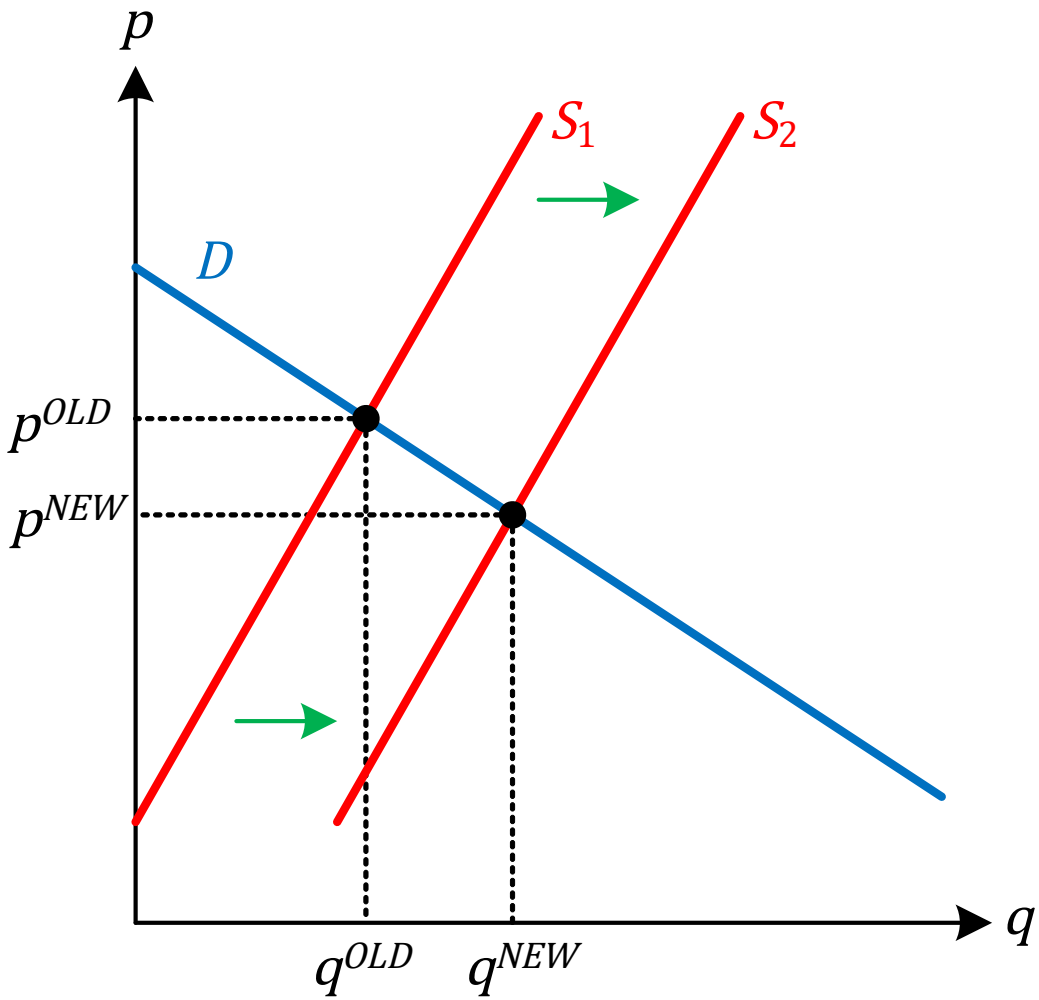
Elasticity

- We looked at the equilibrium of supply and demand models, and we also looked at which direction they change when shocked.
- Now, we're going to look at what determines the size of the change in equilibrium, Elasticity.
    - This has a lot to do with the shape of the supply and demand curves.

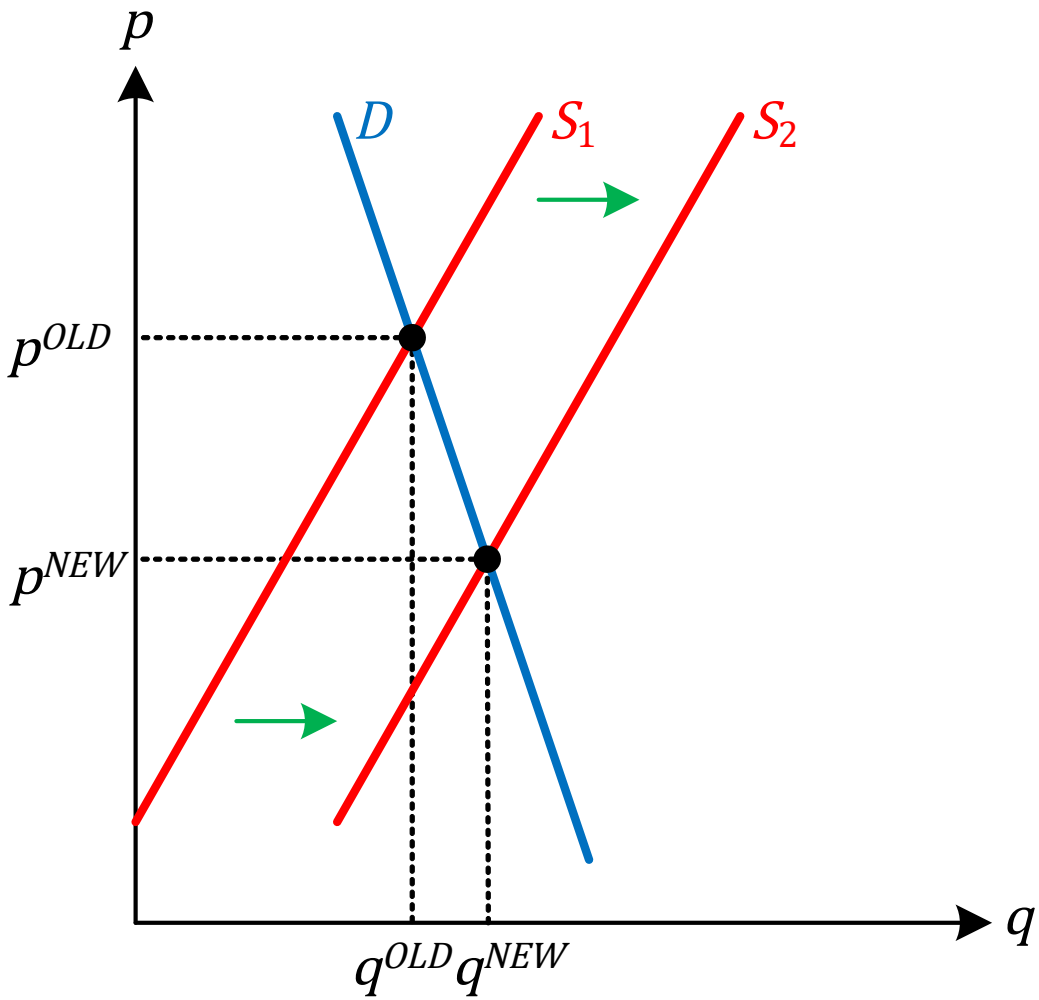
Elasticity



Elasticity



Elasticity



Elasticity

- As the demand curve gets flatter, it becomes more and more sensitive to price changes. A small price change on a flatter demand curve could cause a large reduction in quantity demanded, while a small price change on a relatively steep demand curve could have little impact.
- We call the the percentage change in a variable in response to a given percentange change in another variable the **elasticity**.
  - That's the textbook definition.
- Basically, elasticity measures how sensitive things are to small changes. Let's start with price and demand.

Price Elasticity of Demand

- The **Price Elasticity of Demand** measures the percentage change in quantity demanded for a given percentage change in price.
  - i.e., If the price lowers by 3%, by what percent will the quantity demanded increase?
- We can measure the price elasticity of demand with the following formula,

$$\varepsilon = \frac{\text{Percentage change in quantity demanded}}{\text{Percentage change in price}} = \frac{\frac{\Delta q}{q}}{\frac{\Delta p}{p}}$$

where $\Delta q = q^{NEW} - q^{OLD}$ is the change in quantity.

Price Elasticity of Demand

- A quick (and very easy) example.
- A firm lowers its price by 1%. In return, it sees a 4% increase in the quantity it sells. What is the firm's price elasticity of demand?

Price Elasticity of Demand

- We can apply the formula to get our answer. Note that the price *decreased*, meaning that the change was negative.

$$\varepsilon = \frac{\text{Percentage change in quantity demanded}}{\text{Percentage change in price}} = \frac{4}{-1} = -4$$

- One of the nice things about elasticities in general is that there are no units involved. This gives us a really useful unit of measure that can be used in numerous contexts.
  - Researchers use elasticities all the time to communicate ideas.

Price Elasticity of Demand

$$\varepsilon = -4$$

- Why is the price elasticity of demand negative?
  - This is a consequence of the Law of Demand from last week. Remember that price and quantity move in opposite directions, so if price increases, quantity will decrease and vice-versa. Thus, the price elasticity of demand will always be negative as long as the Law of Demand holds (i.e., we don't have a Giffen good).
- What about the 4? What does that mean?
  - Disregarding the sign (i.e., just looking at the absolute value of the price elasticity of demand), the higher the number, the more responsive quantity is to small price changes. We say that any $|\varepsilon| > 1$ is elastic, while any $|\varepsilon| < 1$ is inelastic (with $|\varepsilon| = 1$ being knows as unit-elastic)

Price Elasticity of Demand

- Elastic vs. Inelastic
  - When we say that demand is elastic, it means that quantity is more sensitive than price when price changes. This usually means that there are gains for a firm to lowering their price to attract more customers.
  - When we say that demand is inelastic, it means that quantity is less sensitive than price when price changes. This usually means that there are gains for a firm to raising their price, with the increase in price offsetting the loss of customers.
  - Where the firm actually prices though will depend more on supply and demand.
- We'll come back to this in a little bit.

Price Elasticity of Demand

- The price elasticity of demand is influenced by several factors:
  - **Availability of substitutes** - If the consumer can substitute one good for another easily, the demand will be more elastic as they won't put up with price increases as much.
  - **Percentage of income** - The higher the percentage of income that the good represents, the more likely the consumer is to shop around and find a good deal. For example, housing is quite elastic.

Price Elasticity of Demand

- The price elasticity of demand is influenced by several factors:
  - **Necessity** - The more necessary the good is (like water), the less elastic the consumer will be.
  - **Duration** - When a price changes, at first, consumers may not be able to find good substitutes, but as time goes on, consumers will become more elastic as new substitutes are discovered.
  - **Brand Loyalty** - Companies with loyal customers will face much more inelastic demand for their products.
  - etc.

Price Elasticity of Demand

- We can rearrange the price elasticity of demand formula to obtain

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

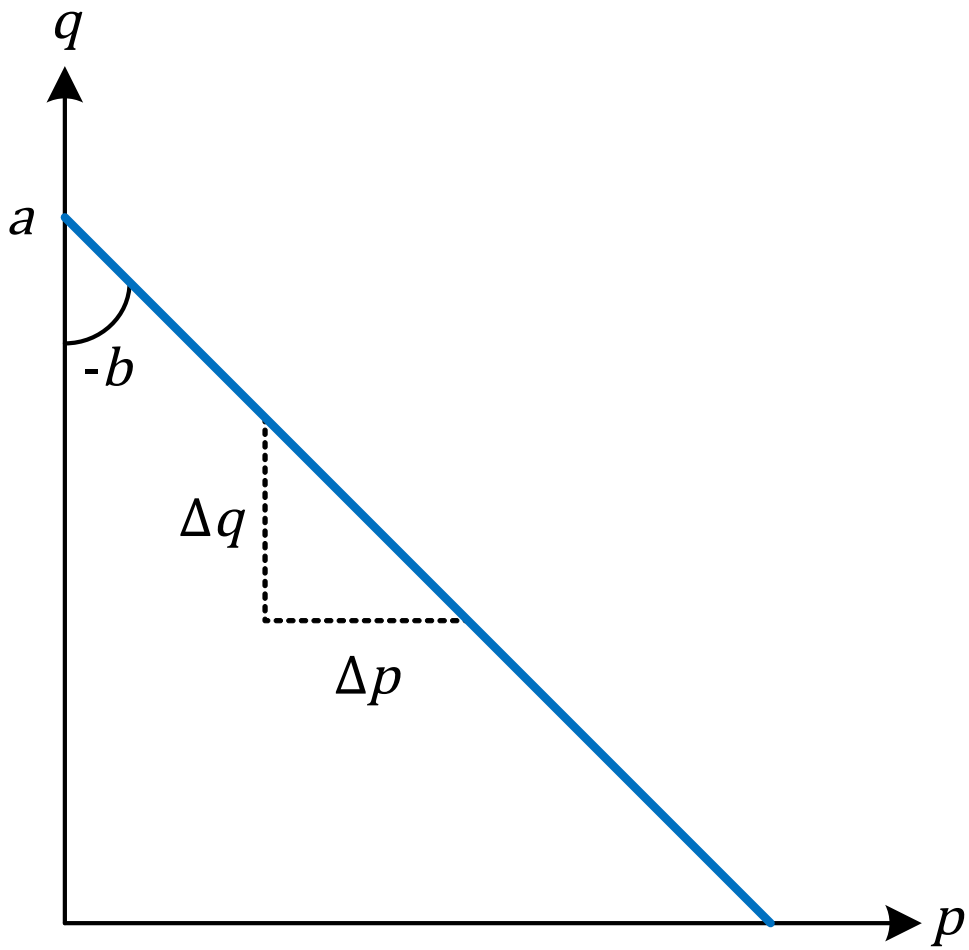
- This is a very useful transformation because of the $\frac{\Delta q}{\Delta p}$ term. Let's look at an example.
- Consider a linear demand function

$$q_D = a - bp$$

where a and b are positive numbers.

- Recall from algebra that $\frac{\Delta q}{\Delta p}$ is the same thing as the slope of the line, $-b$ in this case.

Price Elasticity of Demand



Price Elasticity of Demand

- Thus, when we have a *linear* demand function, we can just substitute $-b$ for $\frac{\Delta q}{\Delta p}$, making our elasticity formula

$$\varepsilon = -b\frac{p}{q}$$

  which is much easier to manage.
- What about non-linear demand functions?
  - The problem with those is that $\frac{\Delta q}{\Delta p}$ isn't constant across the whole function. We would need to use calculus to figure out the slope of the line at that particular point.
    - All of our demand functions in this class will be linear, though.
- Let's look at an example.

Example

- Consider the following demand function

$$q_D = 12 - 3p$$

- What is the price elasticity of demand when $p = 1$?

Example

$$q_D = 12 - 3p$$

- Recall the formula for price elasticity of demand

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

The first thing we want to do is substitute for the $\frac{\Delta q}{\Delta p}$ term. This is equal to the slope coefficient in our demand function (note that I rewrote the demand function a little bit),

$$q_D = 12 + \underbrace{-3}_{=\frac{\Delta q}{\Delta p}} p$$

- We can substitute this expression into our elasticity formula to obtain

$$\varepsilon = -3\frac{p}{q}$$

Example

$$\varepsilon = -3\frac{p}{q}$$

- Next, we want to evaluate the elasticity where $p = 1$, but we also need to know the quantity that corresponds with that price. To get the quantity, we just plug $p = 1$ into the demand function,

$$q_D = 12 - 3p = 12 - 3(1) = 9$$

- Then, just substitute the values into our elasticity formula to obtain our solution,

$$\varepsilon = -3\frac{p}{q} = -3\frac{1}{9} = -\frac{1}{3}$$

- Since $|\varepsilon| = \frac{1}{3} < 1$ in this case, we would say that the price elasticity of demand is inelastic at this point, and the firm would actually be better off by raising their prices.

Example

- What would the price elasticity of demand be if $p = 3$?
- Again, we would need a quantity to go along with this price. Plugging $p = 3$ into the demand function yields

$$q_D = 12 - 3p = 12 - 3(3) = 3$$

and plugging both of these numbers into our price elasticity of demand formula gives

$$\varepsilon = -3\frac{3}{3} = -3$$

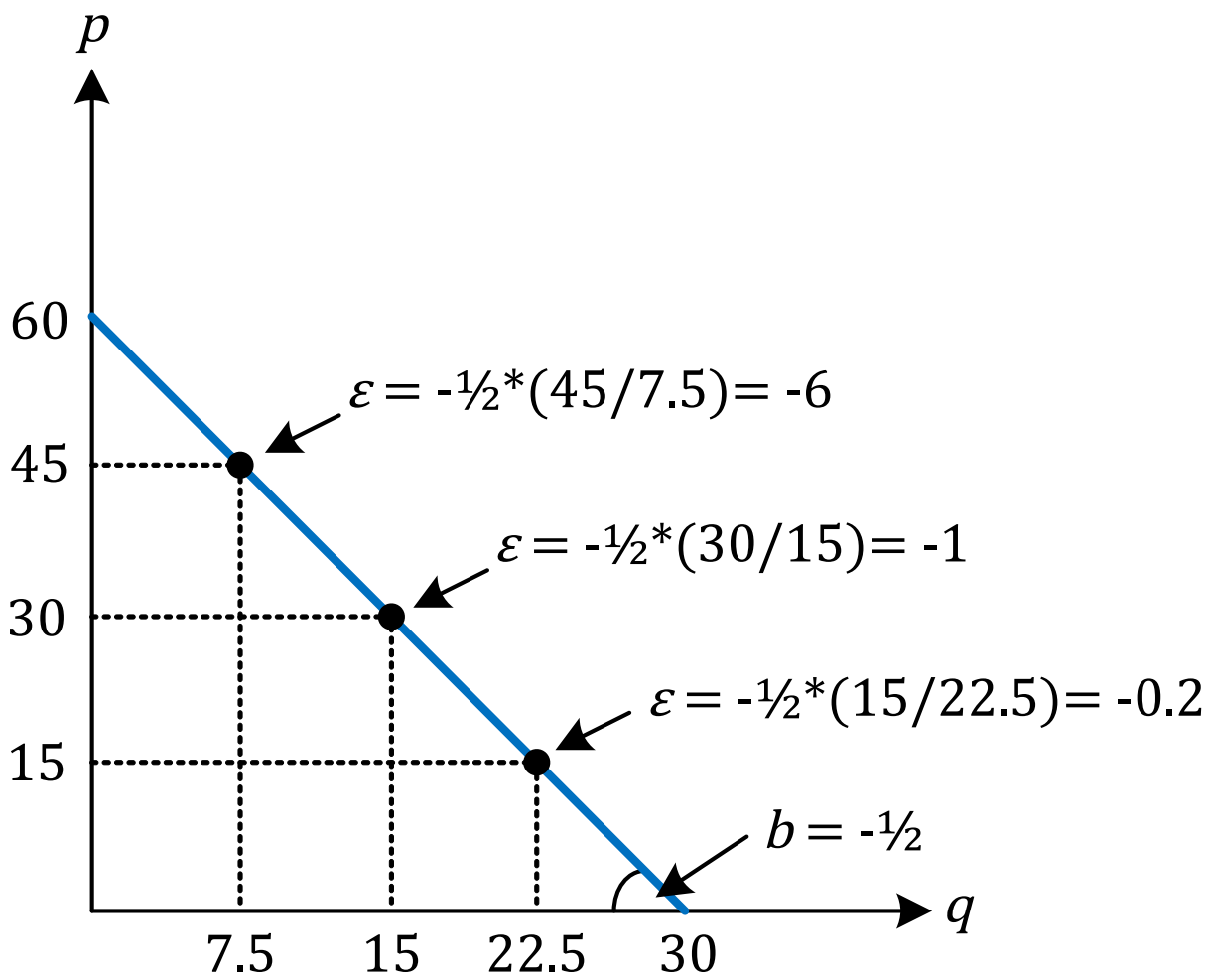
- Now, we have $|\varepsilon| = 3 > 1$. The price elasticity of demand is elastic at this point and a lower price would actually be better for the firm.

Price Elasticity of Demand

- Another important property of a linear demand function is that the price elasticity of demand is not constant along the curve.
  - As we start at the top of the curve, the elasticity will be huge, with $\varepsilon = -\infty$ at the very top of the curve.
  - As we get to the bottom of the curve, the elasticity will be very low, with $\varepsilon = 0$ at the very bottom of the curve.
  - At the midpoint of the curve, we see the intersection of the elastic and inelastic portions of the curve and $\varepsilon = 1$.
- The figure on the next slide has several elasticities calculated for the demand function

$$q_D = 30 - \frac{1}{2}p$$

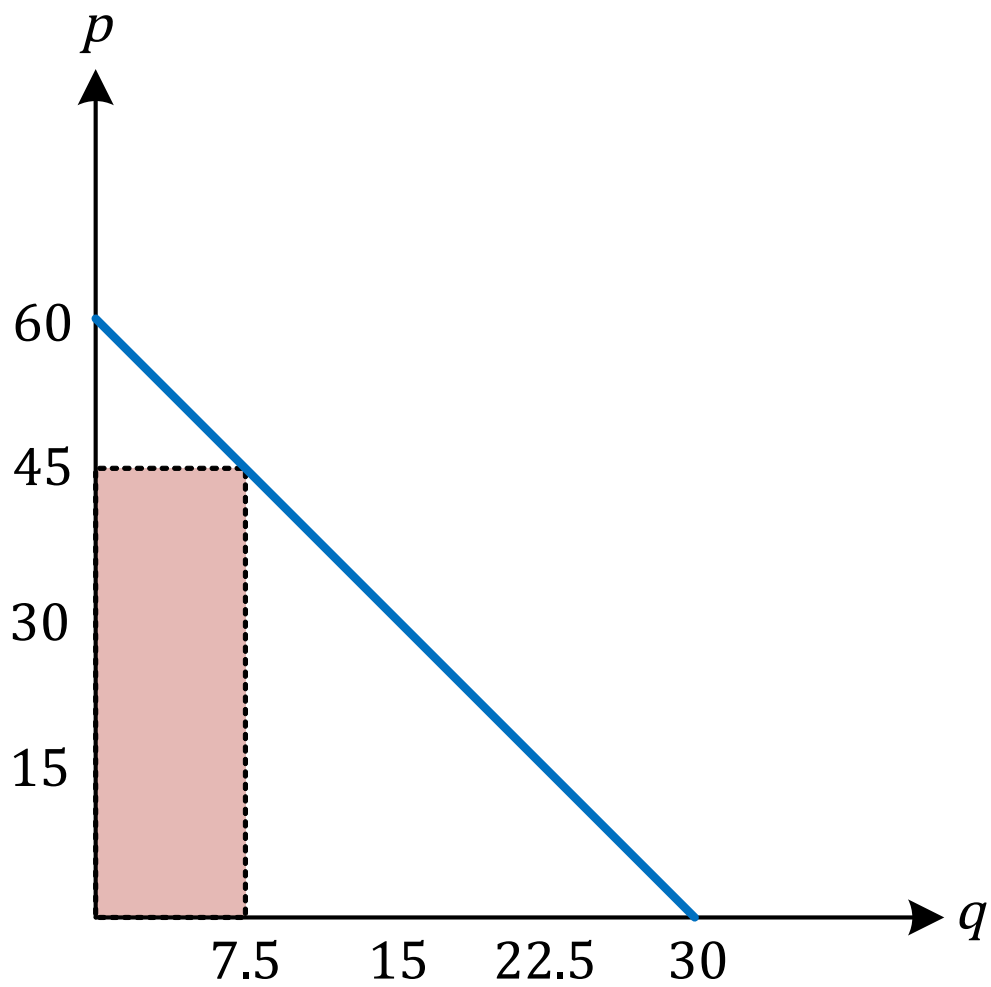
Price Elasticity of Demand



Price Elasticity of Demand

- Let's also look at it from the revenue side.
  - We can calculate total revenue by multiplying price times quantity, $p * q$.
- On our figure from before, we can shade in the respective revenues for the firm based on different points of the demand curve.

Price Elasticity of Demand



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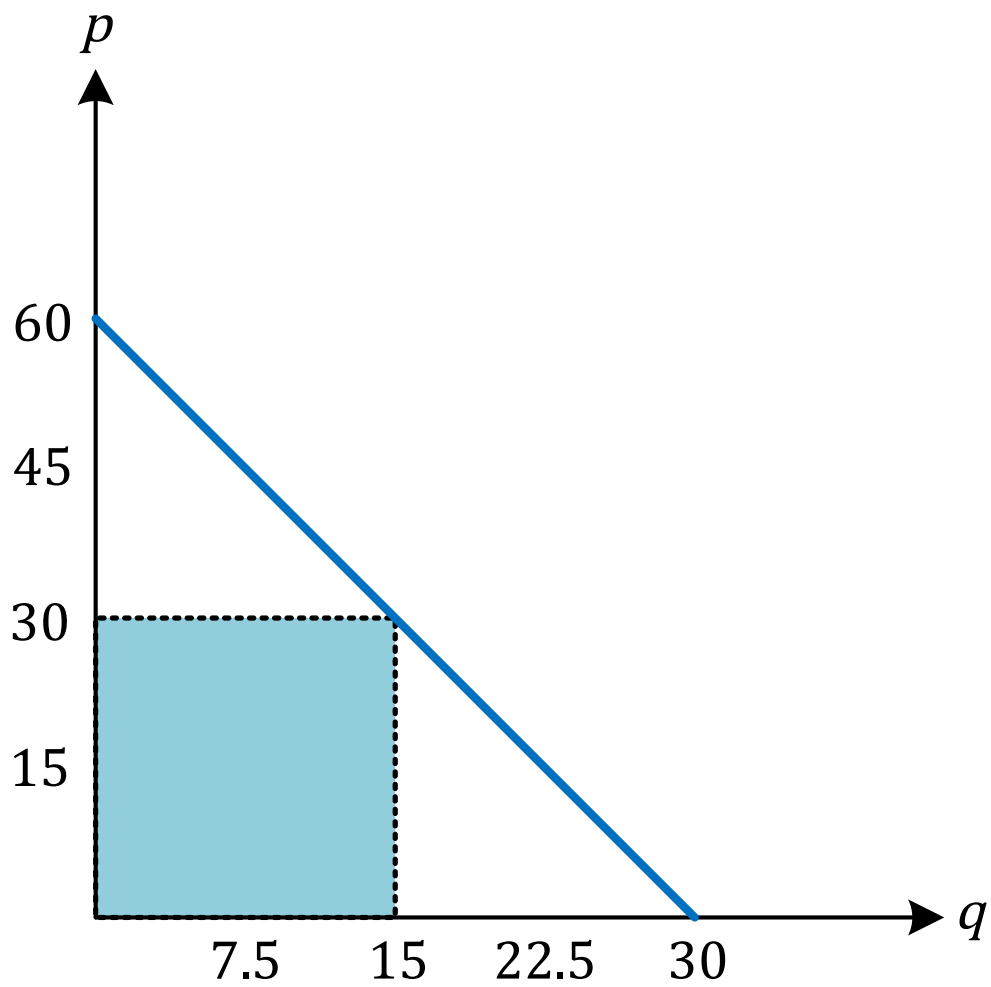
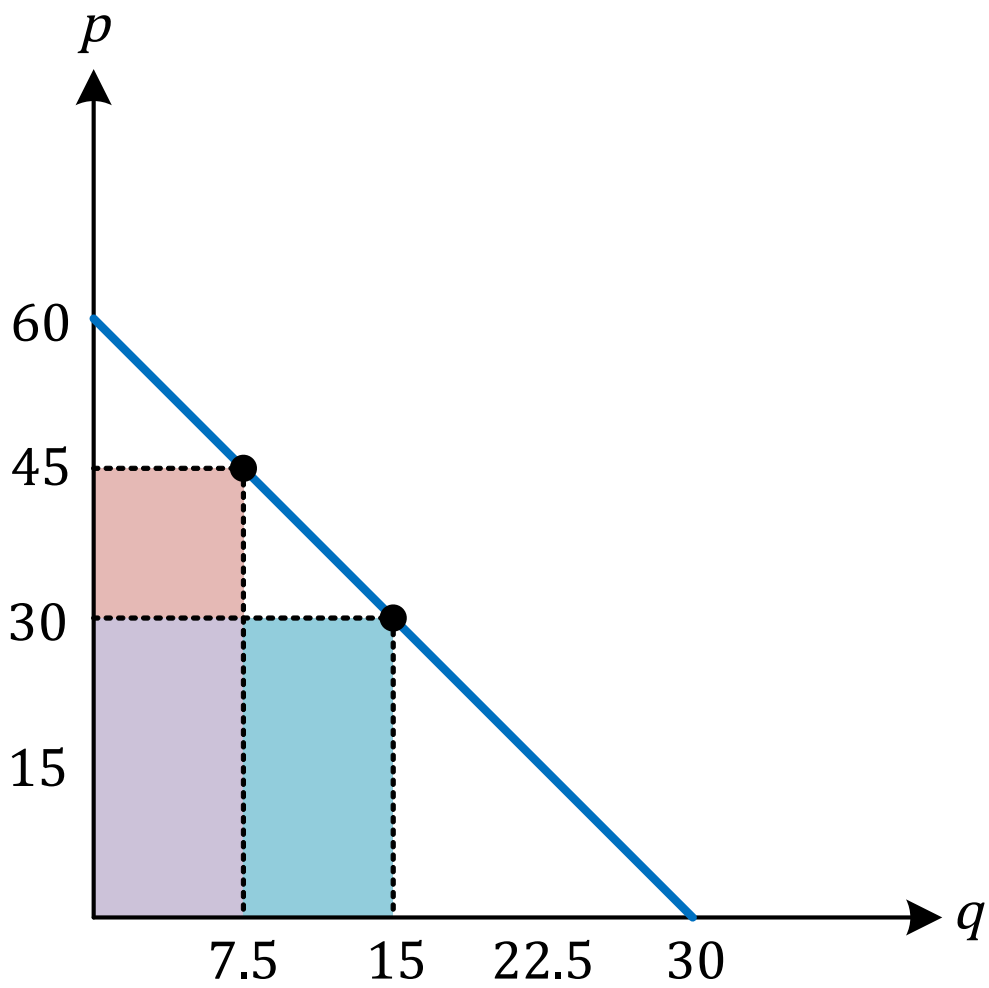


Price Elasticity of Demand



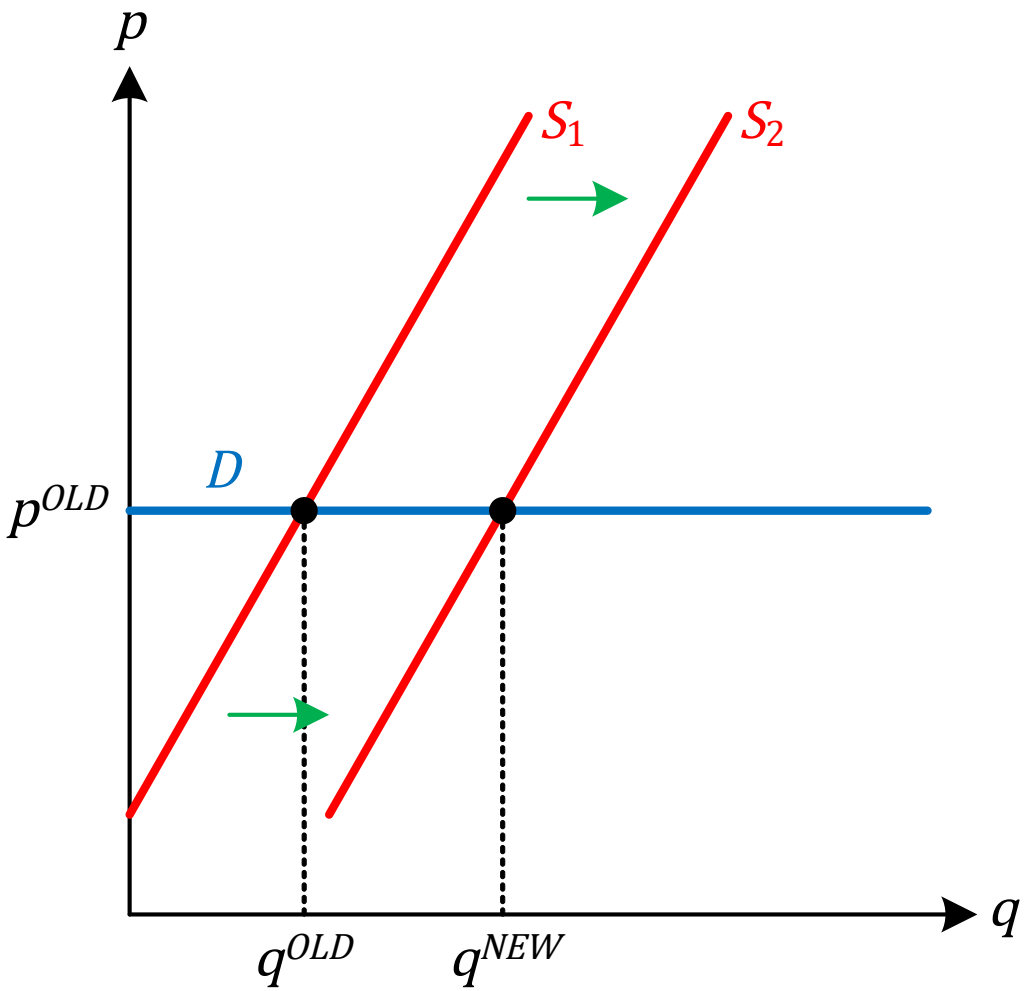
Price Elasticity of Demand

- When the price was higher ($p = 45$, $\varepsilon = -6$), the firm was receiving the red area in revenue. By lowering its price to $p = 30$ ($\varepsilon = -1$) the firm lost revenue due to the lower price charged, but also gained quantity since more people were willing to buy at a lower price. This resulted in the firm receiving the red area in revenue.
- As we can see, the amount of blue area gained is quite a bit greater than the red area lost (double, in fact) and the firm is able to get more revenue by lowering its price.

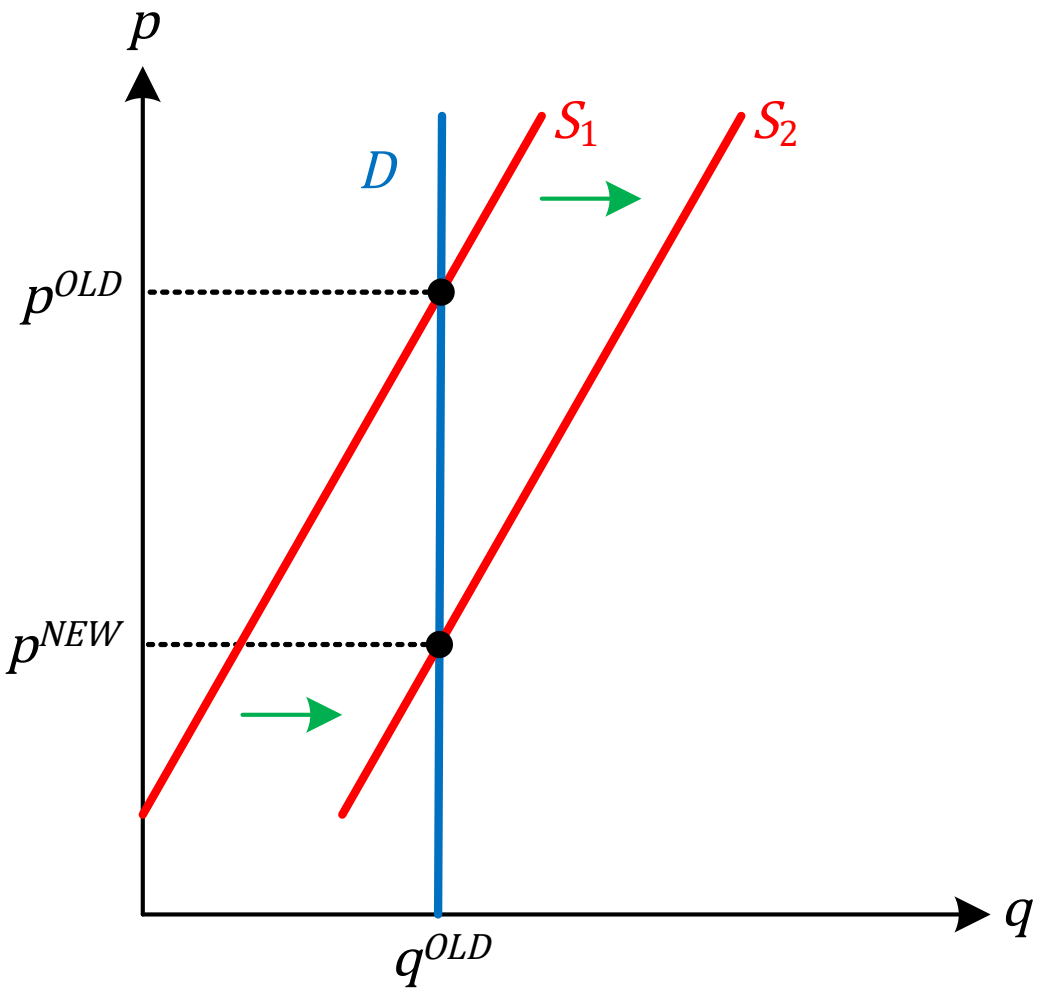
Price Elasticity of Demand

- Two special cases.
  - A horizontal demand curve has an elasticity of $\varepsilon = -\infty$. In this case, any change in supply will be met with a change in quantity demanded, but the price will not change. We call this perfectly elastic demand. Perfectly competitive goods fall into this category (a close one being the wheat that we grow around here).
  - A vertical demand curve has an elasticity of $\varepsilon = 0$. In this case, and change in supply will be met with a change in price, but no change in quantity demanded. We call this perfectly inelastic demand. There are not many goods that fall into this category (Yellow cake uranium).

Price Elasticity of Demand



Price Elasticity of Demand



Application: The US War on Drugs

- This is an actual question I gave on an exam.
- During the war on illegal drugs, the US Government has made it their priority to remove as much of the supply of drugs as possible, driving up their price. Their hope was to make illegal drugs as expensive as possible so that they would not be affordable for consumers, eventually putting the drug cartels out of business due to a lack of profits.
- An economic study was done and estimated that the price elasticity of demand for illegal drugs is somewhere between -0.51 and -0.73. (This is real data)

Application: The US War on Drugs

- An economic study was done and estimated that the price elasticity of demand for illegal drugs is somewhere between -0.51 and -0.73. (This is real data)
- Is the demand for illegal drugs elastic or inelastic?

Application: The US War on Drugs

- Since the absolute value of the price elasticity of demand is less than 1, the demand for illegal drugs in the US is inelastic.
- What does this mean?
  - It means that the consumers who purchase illegal drugs in the US are not very sensitive to price changes. When the price goes up, the quantity they purchase will only go down by a small amount.
  - Furthermore, it means that an increase in the price for illegal drugs is actually increasing the revenue for the producers.

Application: The US War on Drugs

- Is the government's policy economically effective?
  - No. Driving the price up by limiting the supply of illegal drugs in the US is actually having the opposite of the intended effect.
  - This is primarily due to the fact that the people who consumer illegal drugs typically don't have a good substitute, and won't taper off their consumption due to the rising prices.

Application: The US War on Drugs

- Some economists have suggested other means to combat the illegal drugs problem in the US.
  - An alternative solution is to drive the price down. Since the market is inelastic, it would cause a loss in revenue for the producers.
    - This is tough though, both politically and feasibly. How could the US actually drive the price of drugs down? What about the political backlash for the policy maker who recommended this?

Application: The US War on Drugs

- Much of this economic research was cited during Washington's initiative to legalize Marijuana.
- Rather than drive the price down, we could create regulated competitors. This would have the effect of creating viable, safe substitutes for those who consume Marijuana.
    - Divert the profits from the black market to the government.
    - This is actually the same way that the government broke illegal gambling rings back in the early 20th century. They created the lottery system.
- It's too early to tell if this is working. We need several years of data in order to get a good picture of the results of this policy.
    - I expect there to be several interesting papers published on this in the next 5-10 years.

Income Elasticity

- Let's look at another type of elasticity.
- When we want to see how sensitive quantity is to changes in income, we look at the **Income Elasticity**. It follows a similar formula as price elasticity of demand.

$$\xi = \frac{\Delta q}{\Delta Y}\frac{Y}{q}$$

- We can also use a similar technique to substitute for $\frac{\Delta q}{\Delta Y}$ in a linear demand function. Consider the function

$$q_D = a - bp + cY$$

- In this case, c is the slope coefficient for income, so $\frac{\Delta q}{\Delta Y} = c$ and we can substitute that value into the income elasticity formula.

Income Elasticity

- What does the value of ξ tell us about income?
  - The sign is the most important part of the income elasticity. If $\xi > 0$, that means that as income goes up, the demand for the good also goes up. We would call this a **normal** good. If $\xi < 0$, then as income goes up, demand for the good goes down. We would call this an **inferior** good.
  - We can also infer whether a good in normal or inferior based on its sign in the demand function. A negative sign is an indication of an inferior good, while a positive sign is an indication of a normal good.
  - As for the magnitude of ξ, it doesn't matter all that much. It just tells us how strongly income effects demand. An income elasticity of $\xi = 0$ would suggest that income has no effect on demand.

Example

- Consider the following demand function

$$q_D = 12 - 3p + \frac{1}{5}Y$$

- What is the price elasticity of demand when $p = 1$ and $Y = 5$?

Example

$$q_D = 12 - 3p + \frac{1}{5}Y$$

- Again, recall the formula for income elasticity

$$\xi = \frac{\Delta q}{\Delta Y}\frac{Y}{q}$$

We need to get rid of the $\frac{\Delta q}{\Delta Y}$ term. Fortunately, we can just take the coefficient of income from our demand function and substitute that into our elasticity formula, i.e.,

$$q_D = 12 - 3p + \underbrace{\frac{1}{5}}_{=\frac{\Delta q}{\Delta Y}} Y$$

- Thus, we have

$$\xi = \frac{1}{5}\frac{Y}{q}$$

Example

$$\xi = \frac{1}{5}\frac{Y}{q}$$

- Now, just like before, we need to figure out what our quantity is, given that $p = 1$ and $Y = 5$. We can find this by plugging these two values into the demand function,

$$q_D = 12 - 3p + \frac{1}{5}Y = 12 - 3(1) + \frac{1}{5}(5) = 10$$

- From here, we now just substitute all of these values into our income elasticity formula to obtain our solution

$$\xi = \frac{1}{5}\frac{5}{10} = \frac{1}{10}$$

- Since $\xi > 0$, we know that this is a normal good, and increases in income will cause the consumers to buy more of the good.

Summary

- The shape of the demand function is important and tells us how sensitive quantity demanded is to things like price and income.
- We can calculate that sensitivity as an elasticity.

Preview for Wednesday

- Cross price elasticity and elasticity of supply.
- No class on Monday - Labor Day
- Quiz
  - The question(s) will come from somewhere between lecture 2 and lecture 5.

Weekend Homework

1. Have some fun. No assignment.
   A few suggestions:
   - Read a book
     - Monday was supposedly the day that James Sirius Potter left for the first time to Hogwarts.
   - Play some video games
     - The Diablo 3 ladder is a lot of fun right now.
   - Cheer on your favorite WSU sports team
     - Prediction: WSU - 35, Portland State - 24
   - Socialize with family and/or friends!