Text transcription of Chapter 5 – Elasticity and Its Application

Chapter 5

Elasticity and Its Application

Welcome to the Chapter 5 Lecture on Elasticity and Its Application. We are going to start the quantitative portion of the course in chapter 5. The math in this chapter is not complicated, but it is important that you use the correct formulas when doing the calculations.

Elasticity

- Elasticity measures responsiveness.
- Definition: Measure of the responsiveness of quantity demanded or quantity supplied to one of its determinants.
- Elasticity allows us to look at changes in quantity demanded or quantity supplied quantitatively.
- Four types of elasticity:
  - Price elasticity of demand, income elasticity, cross-price elasticity and price elasticity of supply

The title of the chapter is elasticity. Very simply elasticity is a way to measure responsiveness. The book definition of elasticity is the measure of responsiveness of quantity demanded or quantity supplied to one of its determinants. By calculating elasticity we can look at changes in quantity demanded and quantity supplied quantitatively. Chapter five will cover four types of elasticity: price elasticity of demand, income elasticity, cross-price elasticity and price elasticity of supply.

Price Elasticity of Demand

- Law of Demand: Consumers respond to higher prices by decreasing Q_d or increasing Q_d with lower prices.
- Question: How much more or less?
- Price elasticity of Demand measures how "responsive" consumers are to price changes.
  - Elastic Demand
    - Consumers are relatively responsive to price changes
  - Inelastic Demand
    - Consumers are relatively unresponsive to price changes

Let's start with price elasticity of demand. You should remember the law of demand from chapter four. The law of demand expresses the inverse relationship between price and quantity demanded. Consumers respond to higher prices by decreases quantity demanded or increasing quantity demanded with lower prices. The question that we want to answer is by how much more or less does quantity change by? Does a 5% change in price result in a 3% change in quantity demanded or a 13% change in quantity demanded. Price elasticity of demand measure how responsive consumers are to price changes. Elastic demand means that consumers are relatively responsive to price changes. Inelastic demand means that consumers are relatively unresponsive to price changes.

- E_d = price elasticity coefficient (measures the degree of responsiveness)

$$E_d = \frac{\text{Percentage Change in Quantity Demanded}}{\text{Percentage Change in Price}}$$

- It is common practice to drop the negative sign since we should already understand the inverse relationship between price and quantity demanded.

Ed is the coefficient that we are going to solve for. Ed is called the price elasticity coefficient and measures the degree of responsiveness. Ed is calculated by taking the percentage change in quantity demand divided by the percentage change in price. It is common practice to the drop the negative sign with price elasticity of demand since we should already understand that there is an inverse relationship between price and quantity demanded.

Numeric Example:

- Suppose that a 10% increase in the price of ice cream causes the amount of ice cream demanded to fall by 20%.

$$E_d = \frac{\text{Percentage Change in Quantity Demanded}}{\text{Percentage Change in Price}}$$

$$E_d = \frac{20\ \%}{10\ \%} = 2$$

Let's go through a quick numerical example. Suppose that a 10% increase in the price of ice cream causes the amount of ice cream demanded to fall by 20%. When I work on math problems, I like to write out my formula before I do anything. Price elasticity of demand equals the percentage change in quantity demanded divided by the percentage change in price. Now, I'll put in the numbers. There was a 20% change in quantity demanded and a 10% change in price. Therefore, the price elasticity of demand coefficient is 2. Right now the number "2" does not mean anything. In a few moments, we'll go over the meaning of the coefficient.

- Midpoints formula:

$$E_d = \frac{(Q2 - Q1)}{[(Q2 + Q1)/2]} \div \frac{(P2 - P1)}{[(P2 + P1)/2]}$$

- Numeric Example: Suppose you buy 120 ice cream cones a year when the price is $4. If the price increases to $6, you will only by 80 ice cream cones a year.

$$E_d = \frac{(80 - 120)}{[(80 + 120)/2]} \div \frac{(6 - 4)}{[(6 + 4)/2]} = 1$$

More often, you will have to use the midpoints formula to calculate the price elasticity coefficient. The midpoints formula is essentially the same as the original formula. In most cases, you'll be given price and quantity data, rather than the percent change. The midpoints formula allows you to easily input the price and quantity data to solve for the coefficient. The midpoints formula is Q2 minus Q1, divided by Q2 plus Q1 divided by two, divided by P2 minus P1, divided by P2 plus P1 divided by 2. Order of operations is crucial with this formula. If you just type everything straight into your calculator, you will come up with the wrong

answer. Let's over an example: Suppose you buy 120 ice cream cones a year when the price is $4 per cone. If the price increases to $6, you will only buy 80 cones a year. We can already see the law of demand in action; high prices translate to a smaller quantity demanded. Let's use the midpoints formula to measure to degree of responsiveness. Since we are dealing with data, we need to make sure we label everything correctly. P1 is the first price, $4. P2 is the second price, $6. Q1 is the first quantity, 120. Q2 is the second quantity, 80. Plug this data into the formula. 80 minus 120, divided by 80 plus 120 divided by 2, divided by 6 minus 4, divided by 6 plus 4 divided by 2. Again, order of operations is crucial. Be sure to simplify your fractions before you divide. If you do your math correctly, you should get an answer of 1.

Interpretations of E_d

- Elastic Demand ($E_d > 1$)
  - If % change in price results in a greater % change in quantity demanded = responsive demand.
- Inelastic Demand ($E_d < 1$)
  - If % change in price results in a smaller % change in quantity demanded = unresponsive demand.
- Unit Elastic ($E_d = 1$)
  - If % change in price results in the same % change in quantity demanded

What does a coefficient of 1 or 2 mean? Being able to interpret the coefficient is very important. If you do your math correctly, you ultimately want to number what the number you are solving for means. Elastic demand will occur when the coefficient (Ed) is greater than 1. This means that the percentage change in price resulted in a GREATER percentage change in quantity demanded. An example would be a 5% change in price causes consumer to change quantity demanded by 15%. Therefore, consumers are very responsive to price changes. Inelastic demand will occur when the coefficient (Ed) is less than one. This means that the percentage change in price resulted in a SMALLER percentage change in quantity demanded. An example would be a 5% change in price caused consumer to change quantity demanded by 2%. Therefore, consumers are relatively unresponsive to price changes. Unit elastic demand occurs when the coefficient (Ed) equals one. A percentage change in price results in the SAME percentage change in quantity demanded. An example would be a 5% change in price causes consumers to change quantity demanded by 5%.

Extreme Cases

- Perfectly Inelastic ($E_d = 0$)
  - If % change in price results in no change in quantity demanded.
- Perfectly Elastic ($E_d = \infty$)
  - If % change in price results in an infinite change in quantity demanded.

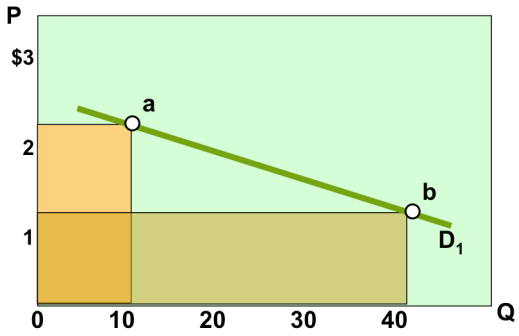
There are two extreme cases that are mathematically possible. The first is perfectly inelastic demand in which the coefficient equals zero. The percentage change in price results in no change in quantity demanded. An example of this might be someone who is diabetic and needs insulin. If the price increases, the person still needs the same quantity of insulin as before, therefore demand does not change. The other extreme case is perfectly elastic demand in which the coefficient is infinity. The percentage change in price results in a infinite change in quantity demanded. Very small changes in price lead to huge changes in the quantity demanded.

Elasticity and Total Revenue

- Why are we studying price elasticity of demand?
  - Valuable information for producers.
  - Effect of changes in demand on total revenue:
    - Total Revenue = Price x Quantity
    - TR = P x Q
  - Firms want to know how TR is going to change when demand changes.

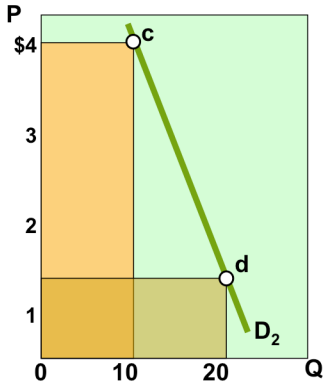
Elasticity is related to the total revenue that a firm brings in. You might be thinking, why are we studying price elasticity of demand? Measuring how responsive consumers are to changes in price can be very valuable information for producers. As demand for a product changes, so does total revenue. The formula for total revenue is price times quantity. TR equals P times Q. Firms want to know how total revenue is going to change when demand changes.

- Elastic Demand
  - $\%\Delta Q_d > \%\Delta P$
  - $\downarrow P \Rightarrow \uparrow TR$
  - $\uparrow P \Rightarrow \downarrow TR$



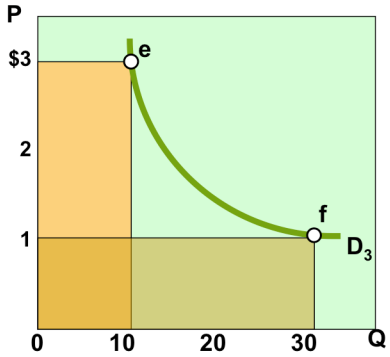
Let's first look at elastic demand. Remember, elastic demand means that consumers are relatively responsive to prices. The percentage change in quantity demanded is greater than the percentage change in price. If price decreases, consumers are very responsive and increase quantity demanded, causing total revenue to increase. If price increases, consumers are very responsive and decrease quantity demanded, causing total revenue to decrease. Let's also look at elastic demand graphically. Remember, price is always on the vertical axis and quantity is always on the horizontal axis. All demand curves are downward sloping. At point A, price is $2 and quantity demanded is 10. Total revenue is the shaded area, which would be equal to $20. If price decreases and we end up at point B, price is $1 and quantity demand is 40. Total revenue is the shaded area, which would be equal to $40. We can see that total revenue increases when prices fall OR that total revenue decreases when prices rise.

- Inelastic Demand
  - $\%\Delta Q_d < \%\Delta P$
  - $\downarrow P \Rightarrow \downarrow TR$
  - $\uparrow P \Rightarrow \uparrow TR$



Next, let's look at inelastic demand. Remember, inelastic demand means that consumers are relatively unresponsive to prices. The percentage change in quantity demanded is less than the percentage change in price. If price decreases, consumers do not respond very much, therefore total revenue decreases. If prices increase, consumers do not respond very much, therefore total revenue increases. Let's also look at inelastic demand graphically. Remember, price is always on the vertical axis and quantity is always on the horizontal axis. All demand curves are downward sloping. At point C, price is $4 and quantity demanded is 10. Total revenue is the shaded area, which would be equal to $40. If price decreases and we end up at point D, price is $1 and quantity demand is 20. Total revenue is the shaded area, which would be equal to $20. We can see that total revenue decreases when prices fall OR that total revenue increases when prices rise.

- Unit Elastic
  - $\%\Delta Q_d = \%\Delta P$
  - $\downarrow P \Rightarrow$ same TR
  - $\uparrow P \Rightarrow$same TR

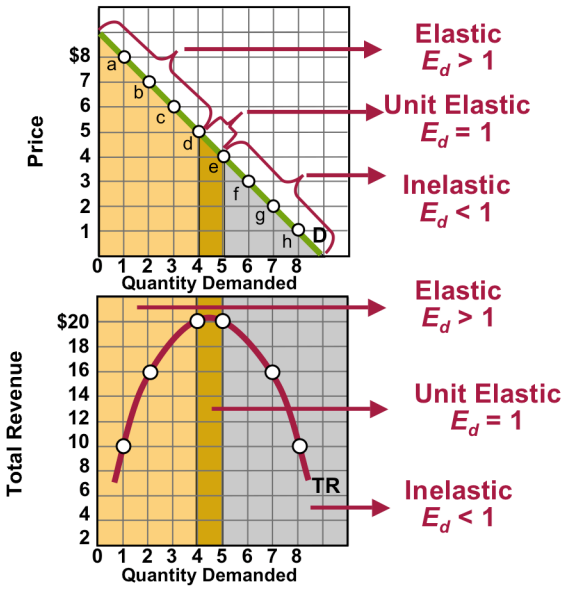


Lastly, let's look at unit elastic demand. The percentage change in price results in the same percentage change in quantity demanded. If price increases, total revenue is the same. If price decreases, total revenue is the same. Let's also look at unit elastic demand graphically. Remember, price is always on the vertical axis and quantity is always on the horizontal axis. All demand curves are downward sloping. This demand curve has a bend. At point E, price is $3 and quantity demanded is 10. Total revenue is the shaded area, which would be equal to $30. If price decreases and we end up at point F, price is $1 and quantity demand is 30. Total revenue is the shaded area, which would be equal to $30. We can see that total revenue stays the same when prices fall or when prices rise.

Hold on, not so easy….

Elasticity changes ALONG a linear demand curve.

Rationale:
$1 price change on in item that cost $1000 vs $1



Okay, it's actually not that easy. We can actually have elastic, unit elastic and inelastic demand ALL on one demand curve. Elasticity changes along a linear demand curve. Linear means a curve without any bends. The reason why elasticity changes along a downward sloping demand curve is due to the fact that a one unit change with large numbers is a relatively small percentage change, while a one unit change with smaller numbers is a relatively large percentage change. Think about a $1 price change on an item that costs $1000 compared to a $1 price change on an item that costs $1. A $1 change on a $1000 item is a relatively small percentage change, but a $1 change on an item that costs $1 is a relatively large percentage change. Let's look at this graphically. The top diagram shows the demand curve, the bottom diagram shows total revenue, which is what we just discussed on the last few slides. The top portion of the demand curve is elastic. The percentage change in quantity demanded is greater than the percentage change in price. As price decreases, total revenue increases. The middle of the demand curve is unit elastic. The percentage change in quantity demanded is the same as the percentage change in price. Total revenue does not change. The bottom portion of the diagram is inelastic. The percentage change in quantity demanded is less than the percentage change in price. When price decreases, total revenue decreases. You might find it helpful to use the midpoints formula to solve for the coefficients in each of the three sections. The top portion will have a coefficient greater than one. The middle will have a coefficient equal to one and the bottom portion will have a coefficient less than one.

Determinants of Price Elasticity of Demand

- Availability of Substitutes
  - More substitutes ⇒ More elastic
  - Less substitutes ⇒ More inelastic
- Luxuries versus Necessities
  - Luxuries ⇒ More elastic
  - Necessities ⇒ More inelastic
- Definition of the Market
  - Narrowly defined market ⇒ More elastic
  - Broadly defined market ⇒ More inelastic
- Time Horizon
  - Long run ⇒ More elastic
  - Short run ⇒ More inelastic

Now that we know what elastic and inelastic demand means, what determines if a good is in fact elastic or inelastic? There are four determinants of price elasticity of demand. One: Availability of substitutes. The more substitutes that are available for a good allows consumers to be more responsive to price changes, therefore demand is more elastic. Think of running shoes, if the price of Nike's goes up, consumers will be responsive; they won't buy Nike's. Instead they'll buy a pair of New Balances or Adidas or Pumas or Reeboks. If there are less substitutes available, demand is more inelastic. Think of gasoline. Really isn't any substitute for gas. If the price goes up, consumers are relatively unresponsive to the price change because they still have to drive to work, school, run errands, etc. Two: Luxuries versus necessities. Luxury items are more elastic. Since you don't really need a luxury item, consumers are more sensitive to price changes. Necessities are more inelastic. Since we need them, we are less sensitive to price changes. Third: Definition of the market. Narrowly defined markets are more elastic. A narrowly defined market would be something like ice cream. If the price of chocolate ice cream increases, consumers would be responsive and just change flavors. Broadly defined markets are more inelastic. A broadly defined market would be something like food. Since "food" doesn't have many substitutes, consumers are less responsive to price changes. Lastly: Time horizon. Over the long run, consumers have more elastic demand compared to the short run in which demand is more inelastic. Think of gasoline. In the short run, consumers are relatively unresponsive to price changes. If you went to the gas station today because you tank was almost empty and gas was $6 a gallon, you would probably still fill up because you have places to go. However, over the long run, consumers are more responsive to the higher price. They can form car pools, learn the bus routes or purchase a more fuel-efficient car.

Income Elasticity

- Used to determine if goods are normal or inferior.
- Income elasticity of demand = How responsive demand is to changes in income.
- E_I = % Δ Q_d / % Δ income
- Normal Goods
  - $E_I > 0$
- Inferior Goods
  - $E_I < 0$
- Luxury Goods (vintage wines, upscale cars)
  - $E_I > 1$

Income elasticity is the next type of elasticity. Income elasticity is used to determine if goods are normal or inferior. Remember from chapter 4 that as income increases, demand for normal goods will rise and as income increases, demand for inferior goods will fall. Income elasticity of demand is measuring how responsive demand is to changes in income. The formula for income elasticity is the percentage change in quantity demanded divided by the percentage change in income. For normal goods the coefficient will be positive. Inferior goods will have a coefficient that is negative. Luxury goods, like vintage wines or upscale cars) will have a coefficient greater than one.

Numeric Example

- Suppose your income increases by 15% and as a result you purchases 20% more of good X. What is income elasticity? Is the good normal, inferior or luxury?
  - E_I = % Δ Q_d / % Δ income
  - E_I = 20% / 15%
  - E_I = 1.33 = Luxury good

Let's go through a quick numeric example. Suppose your income increased by 15% and as a result you purchased 20% more of good X. What is the income elasticity coefficient and is the good normal, inferior or luxury? First, the formula – Income elasticity is equal to the percentage change in quantity demanded divided

by the percentage change in income. Quantity demanded changed by 20% and income changed by 15%. The coefficient is equal to 1.33, therefore good X is a luxury good.

Cross-Price Elasticity of Demand

- Use to determine if goods are complements or substitutes.
- Cross-Price elasticity of demand = How responsive demand for good 2 is to changes in the price of good 1.
- E_{CP} = % Δ Q_d of Good 1 / % Δ Price of Good 2
- Substitutes
  - $E_{CP} > 0$
- Complements
  - $E_{CP} < 0$
- Unrelated
  - $E_{CP} = 0$

The next type of elasticity is cross-price elasticity of demand. Cross-price elasticity is used to determine if goods are complements or substitutes. Cross-price elasticity of demand measures how responsive demand for good 2 is to changes in the price of good 1. The formula is the percentage change in quantity demanded of good 1 divided by the percentage change in the price of good 2. Substitute goods will have a positive cross-price coefficient, complements will have a negative coefficient and unrelated goods will have a coefficient equal to zero.

Numeric Example

- Suppose the price of good 2 decreases by 14% and as a result you purchase 10% more of good 1. What is the cross-price elasticity? Are the goods complements, substitutes or unrelated?
  - E_{CP} = % Δ Q_d of Good 1 / % Δ Price of Good 2
  - E_{CP} = 10% / -14%
  - E_{CP} = -0.7143 = complements

Let's go over an example. Suppose the price of good 2 decreases by 14% and as a result you purchase 10% more of good 1. What is the cross-price elasticity coefficient and are the goods complements, substitutes or unrelated? First, the formula – Cross-price elasticity equals the percentage change in the quantity demanded of

good 1 divided by the percentage change in price of good 2. Good 2 changed by 10% and good 1 prices decreased by 14%, therefore it is negative 14%. The coefficient is equal to -0.7143, therefore the two goods are complements.

Price Elasticity of Supply

- Elasticity concept as applies to supply.
- Price elasticity of supply = How responsive firms are to changes in price.
  - Depends of the flexibility of producers to shift resources between alternative uses.
  - Time is a big factor.
    - Short run = more inelastic
    - Long run = more elastic
- E_S = % Δ Quantity Supplied / % Δ Price
- Midpoints formula also works.

The last type of elasticity is price elasticity of supply. The first three types of elasticity were all related to demand, but the concept of elasticity can also be applied to supply. Price elasticity of supply measures how responsive firms are to changes in price. Supply elasticity depends on how flexible producers are to shift resources between alternative uses. Time is a huge factor with this. In a short period of time, producers are less flexible to shift resources. However, over a longer period of time, producers are more flexible to shift resources. The formula for price elasticity of supply is the percentage change in quantity supplied divided by the percentage change in price. The midpoints formula can also be used to calculate supply elasticity.

- Elastic Supply
  - $E_S > 1$
- Inelastic Supply
  - $E_S < 1$
- Unit Elastic Supply
  - $E_S = 1$
- Perfect Elastic
  - $E_S = \infty$
- Perfect Inelastic
  - $E_S = 0$

Elastic supply occurs when firms are responsive to price changes. The coefficient will be greater than one. Inelastic supply occurs when firms are relatively unresponsive to price changes and the coefficient will be less than one. Unit elastic supply occurs when the coefficient equals one. The extreme case of perfectly elastic supply occurs when the coefficient equals infinity and the extreme case of perfectly inelastic supply occurs when the coefficient equals zero.

Numeric Example

- Suppose the price of milk increases from $2.85 to $3.15 a gallon. As a result, farmers increase production from 9,000 to 11,000 gallons. What is price elasticity of supply?
- Midpoints formula:

$$E_S = \frac{(Q2 - Q1)}{[(Q2 + Q1)/2]} \div \frac{(P2 - P1)}{[(P2 + P1)/2]}$$

$$E_d = \frac{(1100 - 9000)}{[(1100 + 9000)/2]} \div \frac{(3.15 - 2.85)}{[(3.15 + 2.85)/2]} = 2$$

Let's go over one final example. Suppose the price of milk increases from $2.85 to $3.15 a gallon. As a result, farmers increase production from 9,000 to 11,000 gallons. What is the price elasticity of supply? Start with the midpoints formula: Q2 minus Q1, divided by Q2 plus Q1 divided by 2, divided by P2 minus P1, divided by P2 plus P1 divided by 2. $2.85 is P1, $3.15 is P2, 9000 is Q1 and 11000 is Q2. Plug in the numbers into the formula, simplify the fractions and you should come out to answer of 2. I highly suggest working through this on scratch paper to ensure that you can do the math correctly. The coefficient is 2, therefore supply is considered to be elastic. The farmers are relatively responsive to the change in price.

- End of slideshow :)

This is the end of the chapter 5 lecture on elasticity. I am not covering the applications at the end of the chapter. You will not be quizzed on the material at the end of the chapter. If you have any questions about elasticity, please post them in “Ask Professor Pakula”.