Chapter 3
Elasticity

CHAPTER SUMMARY

The elasticity of demand measures the responsiveness of demand to changes in a factor that affects demand. Elasticities can be estimated for price, income, prices of related products, and advertising expenditures. The own-price elasticity is the ratio of the percentage change in quantity demanded to the percentage change in price, and is a negative number. Demand is price elastic if a 1% increase in price leads to more than a 1% drop in quantity demanded, and inelastic if it leads to less than a 1% drop in quantity demanded.

The own-price elasticity can be used to forecast the effects of price changes on quantity demanded and buyer expenditure. Elasticities can be used to forecast the effects on demand of simultaneous changes in multiple factors. All elasticities vary with adjustment time. The long-run demand is generally more elastic than the short-run demand in the case of nondurables, but not necessarily for durables.

Elasticities can be estimated from records of past experience or test markets by the statistical technique of multiple regression.

KEY CONCEPTS

elasticity of demand	income elasticity	cross section
own-price elasticity	cross-price elasticity	dependent variable
arc approach	advertising elasticity	independent variable
point approach	short run	multiple regression
elastic	long run	
inelastic	time series	

GENERAL CHAPTER OBJECTIVES

1. Describe the concept of elasticity.

2. Describe the arc approach and the point approach when deriving the own-price elasticity of demand and discuss the properties of own-price elasticity.
3. Discuss the intuitive determinants of price elasticity.
4. Introduce the relationship between own-price elasticity and total revenue when there is a price change for an elastic and inelastic item.
5. Describe the application of income elasticity, cross-price elasticity, and advertising elasticity, as well as forecasting the effects of multiple factors on demand.
6. Explain the importance of time on elasticity.
7. Discuss the statistical estimation of elasticities.

NOTES

1. **Elasticity of demand**.
   (a) **Definition** - the responsiveness of demand to changes (increase or decrease) in an underlying factor (e.g., price of the product itself, income, prices of related products, advertising).
   (b) Changes in any of these factors will lead to a movement along or shift of the demand curve.
   (c) There is an elasticity corresponding to every factor (i.e., measuring the responsiveness of demand to changes in each factor) that affects demand.
   (d) Elasticities depend on the time available for adjustment.
   (e) With elasticities, managers can forecast the effect of single or multiple changes in the factors underlying demand.
   (f) **Construction.** The two ways of calculating the elasticity of demand with respect to *all* the factors that affect demand:
      i. Arc approach: calculates the percentage change in the quantity demanded divided by the percentage change in the underlying factor. This approach calculates the elasticity between two points on the demand curve.
      ii. Point approach: calculates the coefficient from a mathematical equation, in which the quantity demanded is a function of the underlying factor being examined and other variables. This approach calculates the elasticity at a specific point on the demand curve.
      iii. For an infinitesimally short arc, the arc and point approaches produce identical numbers.

2. **Own-price elasticity of demand (price elasticity or demand elasticity)**.
   (a) Definition.
      i. Percentage by which the quantity demanded will change if the price of the item rises by 1%.
      ii. Percentage (proportionate) change in the quantity demanded divided by the percentage (proportionate) change in price.

(b) Every demand curve (including the individual demand curve, market demand curve, and the demand curve faced by an individual seller) has a corresponding own-price elasticity.

(c) Construction.

    i. Arc approach: calculates the percentage change in the quantity demanded (change in quantity demanded/average quantity demanded) divided by the percentage change in price (change in price/average price).

    ii. Point approach: calculates the coefficient from a mathematical equation, in which the quantity demanded is a function of the price and other variables. The own-price elasticity is the coefficient of price.

    iii. For an infinitesimally small change in price, the arc estimate equals the point elasticity.

(d) Properties.

    i. It is a negative number (sometimes reported as an absolute number),

    ii. It is a ratio of two proportionate changes, and hence a pure number independent of units of measurement,

    iii. It ranges from 0 (where a large % change in price causes no change in quantity demanded) to negative infinity (where an infinitesimal % change in price causes a large change in quantity demanded).

    iv. Demand is considered price *inelastic* if a 1% increase in price leads to less than a 1% drop in the quantity demanded;

    v. Demand is considered price *elastic* if a 1% increase in price leads to a greater than 1% drop in the quantity demanded.

(e) Intuitive factors affecting own-price elasticity.

    i. Availability of direct or indirect substitutes affects the elasticity of demand.

        (1). The fewer substitutes are available, the less elastic the demand.

        (2). The more specifically defined the item (a particular brand of cigarettes), the more elastic will be its demand. A product category (cigarettes as a whole) will be relatively less elastic.

    ii. Buyer's prior commitments.

    iii. Cost relative to the benefit from searching for better prices (buyers have limited time so they focus on items that account for relatively larger expenditures). Note: the balance between the cost and the benefit of economizing also depends on a possible split between the person who incurs the cost of economizing and the person who benefits.

    iv. Changes in any of the other factors affecting demand.

(f) Own-price elasticity of demand and the slope of a demand curve.

    i. Own-price elasticity describes the shape of only one portion of the demand curve.

      ii. Whether the demand curve is a straight line or curved, the own-price elasticity can vary with changes in the price of the item.

      iii. Even when the slope remains constant, the proportional changes in price and quantity demanded along the demand curve mean the own-price elasticity will vary.

      iv. The steeper is the demand curve, the less elastic is demand, and vice versa.

(g) Forecasting quantity demanded and expenditure.

      i. Given the own-price elasticity of demand, a seller (both an individual seller or the entire market) can forecast the effect of price changes on:

           (1). quantity demanded (i.e., sales from the viewpoint of an individual seller); and

           (2). expenditure (quantity demanded x price)(i.e., revenue from the viewpoint of an individual seller).

      ii. If demand is price inelastic, a seller can increase profit by raising price:

           (1). A price increase causes the drop in quantity demanded (i.e., the drop in sales) to be proportionally smaller than the increase in price;

           (2). Expenditure (and revenue) will increase; and

           (3). As production is reduced, costs are lowered and profit increased.

      iii. If demand is price elastic, and a seller raises the price:

           (1). The drop in quantity demanded will be proportionally greater than the increase in price; and

           (2). Expenditure will be reduced.

      iv. Accordingly, it is in the best interest of a seller to raise the price until the demand becomes price elastic.

(h) Forecasting the effect of price changes on quantity demanded and expenditure: accuracy.

      i. Use of demand curve: more precise forecasts.

      ii. Use of own-price elasticity.

           (1). Not as precise as using the full demand curve as own-price elasticity may vary along a demand curve.

           (2). Does not provide as much information as the full demand curve.

           (3). Generally, the error in a forecast based on the own-price elasticity will be larger for larger changes in the price and the other factors that affect demand.

           (4). But managers seldom know the entire demand curve, as their information is limited to the quantity demanded around the current values of the factors that affect the demand.

           (5). Elasticities provide sufficient information for most business decisions.

3. **Income elasticity of demand.**
    (a) Definition.
        i. Percentage by which the quantity demanded will change if the buyer's income rises by 1%.
    (b) Construction.
        i. Arc approach.
        ii. Point approach.
        iii. For an infinitesimally small change in income, the arc estimate equals the point elasticity
    (c) Properties.
        i. With properties similar to those of own-price elasticity, but note a difference in that income elasticity can be a positive number.
        ii. It is a ratio of two proportionate changes, and hence a pure number independent of units of measurement
        iii. Can range from negative infinity to positive infinity.
            (1). Normal products (positive income elasticity): if income rises, demand rises.
            (2). Inferior products (negative income elasticity): if income rises, demand falls.
        iv. Demand is considered income *inelastic* if a 1% increase in income leads to less than a 1% change in the quantity demanded;
        v. Demand is considered income *elastic* if a 1% increase in income leads to a greater than 1% change in the quantity demanded.
    (d) Factors affecting own-price elasticity.
        i. Demand for necessities tends to be relatively less income elastic than the demand for discretionary items.
        ii. Changes in any of the other factors (including price) affecting demand.
    (e) Forecasting quantity demanded and expenditure. A major difference between income and some of the other variables that affect demand such as price and advertising is that, generally, sellers have no control over buyer's income.

4. **Cross-price elasticity of demand**.
    (a) Definition.
        i. Percentage by which the demand of the first item will change if the price of a second item (a related product) rises by 1%;
        ii. Other things equal (including the own price of the first item).
    (b) Properties.
        i. Can range from negative infinity to positive infinity.
            (1). Substitutes (positive cross-price elasticity): an increase in the price of one will increase the demand for the other. The more two items are substitutable, the higher their cross price elasticity.

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(2). Complements (negative cross-price elasticity): an increase in the price of one will reduce the demand for the other.
  ii. Demand is considered *inelastic* with respect to the price of a second item if a 1% increase in the price of the second item leads to a less than 1% change in the demand of the first item.
  iii. Demand is considered *elastic* with respect to the price of a second item if a 1% increase in the price of the second item leads to a greater than 1% change in the demand of the first item.

5. **Advertising elasticity**.
   (a) Definition.
       i. Percentage by which the demand will change if the seller's advertising expenses rise by 1%.
   (b) Most advertising is undertaken by individual sellers to promote their own business. By drawing buyers away from competitors, advertising has a much stronger effect on the sales of an individual seller than on the market demand. Advertising elasticity of the demand faced by an individual seller tends to be larger than the advertising elasticity of the market demand.

6. **Factors affecting all elasticities.**
   (a) Buyers need time to adjust. Adjustment time is a factor that affects all elasticities (e.g., own-price elasticity).
       i. Distinguish between short run and long run.
       ii. Short run for the buyer - the time horizon within which a buyer *cannot adjust* at least one item of consumption or usage.
       iii. Long run for the buyer - the time horizon long enough to adjust all items of consumption or usage.
       iv. The long run demand is generally more elastic than the short run demand for in the case of nondurables, but not necessarily for durables.
   (b) Replacement frequency effect: affects all elasticities. For instance, with respect to income elasticity,
       i. Short run – a drop in income will cause demand to fall *more sharply* in the short run.
       ii. Long run – the effects on sales will be muted.
   (c) Nondurables (including goods and services, e.g., commuter train services): the longer the *time* that buyers have to adjust, the bigger will be the response to a price change, and therefore the relatively *more* elastic the demand in the long run.
   (d) Durables (e.g., automobiles): the difference between short- and long-run elasticities of demand depends on a *balance* between the need for *time* to adjust and the *replacement frequency effect*.

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(e)   Just as short-run elasticities can be used to forecast the effect of multiple (short-run) changes in the factors that affect demand, we can also apply the same method to forecast the effect of long-run changes, using long-run elasticities in place of short-run elasticities.

7. **Forecasting the effect of multiple factors**. We can predict the percentage change in demand due to changes in multiple factors (sometimes pushing in different directions) by simply summing the percentage changes due to each separate factor, using elasticities.

8. **Estimating elasticities**. Elasticities can be estimated from records of past experience or test markets by the statistical technique of multiple regression.
   (a)   Businesses sell different products and or cater to different buyers, and face different demand curves.
   (b)   Data.
      i.   Types of data.
         (1).   Time series: a record of changes over time in one market, obtained by focusing on a particular group of buyers and observing how their demand changes as the factors affecting demand vary over time.
         (2).   Cross section: a record of data at one time over several markets, obtained by comparing the quantities purchased in markets with different values of the factors affecting demand.
      ii.   Compilation of data.
         (1).   Past experience (e.g., statistics and records, public or private).
         (2).   Surveys and experiments (e.g., test markets on genuine buyers making actual purchases).
   (c)   Specification.
      i.   Dependent variable: the variable whose changes are to be explained.
      ii.   Independent variable: a factor affecting the dependent variable.
   (d)   Multiple regression: a statistical technique to estimate the separate effect of each independent variable on the dependent variable.
      i.   Aims to estimate values for constant and coefficients of independent variables.
      ii.   Estimated coefficients minimize the sum of the squares of the residuals (residual = difference between actual value of dependent variable and predicted value).
   (e)   Interpretation.
      i.   Use estimated coefficients to calculate corresponding elasticities.
      ii.   F-statistic and R-squared measure overall significance of equation.
      iii.   t-statistic measures significance of particular independent variable.

ANSWERS TO PROGRESS CHECKS

3A.   The residential demand for water is relatively less elastic than the industrial demand.

3B.   The demand curve is a straight line. At a price of $11,000, the quantity demanded would be 14,000 while at a price of $12,000, the quantity demanded would be 12,000. Accordingly, the proportionate change in the quantity demanded is -2,000/13,000, and the proportionate change in the price is 1,000/11,500. Hence, by the arc approach, the own-price elasticity of demand is -1.77.

3C.   The demand for liquor is relatively more income elastic than the demand for cigarettes.

3D.   For a durable, the short-run demand could be more or less elastic than the long-run demand.

3E.   The advertising elasticity of demand is 0.03 x 446.67/88.93 = 0.15.

ANSWERS TO REVIEW QUESTIONS

1. Many business travelers are traveling at the expense of others, so they spend less effort in economizing on price. Also, business travel is less discretionary and more of a necessity than leisure travel.

2. The person who decides on the service (doctor/patient) may be separate from the person who pays (medical insurer/health maintenance organization). Hence, the person who decides on the service spends little effort in economizing on price.

3. It is the percentage change in the quantity demanded divided by the percentage change in price. The percentage change in the quantity demanded is the change in quantity demanded divided by the average quantity demanded, and hence has no units. The percentage change in the price is the change in price divided by the average price, and hence has no units. The own-price elasticity is negative because a price increase leads to a decrease in the quantity demanded.

4. [omitted]

5. Expenditure would rise.

6. [omitted]

7. (a) True; (b) True.

8. Complements.

9. The elasticity with respect to changes in the price of Ferragamo shoes would be a smaller number.

10. The increase in quantity demanded would be 1.3 x 5 = 6.5%.

11. Advertising by one product brand will draw customers from customers of other brands as well as increase the demand for beer in general. Advertising of beer in general can only increase the market demand.

12. More elastic in the long run.

13. For a nondurable item, demand takes time to adjust, hence the long-run demand is more elastic than the short-run demand. For a durable item, there is a countervailing effect: in response to changes in price or income, buyers adjust their replacement times and these adjustments cause larger changes in short-run demand than long-run demand.

14. By minimizing the sum of the squares of residuals, the method aims to minimize *both* instances of the predicted value exceeding the actual value of the dependent variable, and instances of the predicted value falling short of the actual value of the dependent variable. A method that minimized just the sum of the residuals would ignore instances of the predicted value falling short of the actual value of the dependent variable.

15. A cross section records all the data at one time, while a time series records changes over time.

WORKED ANSWER TO DISCUSSION QUESTION

Stanford economics professor Robert Hall provided an expert report in the litigation between the recording industry and Napster. Professor Hall concluded that: "the evidence suggests that exchanges facilitated by Napster and others stimulate the overall demand for recorded music". One piece of evidence he cited was that, between the first quarters of 1999 and 2000, U.S. CD sales grew by 6.7% as

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compared with a 5% increase in the real gross domestic product (GDP) over the same period.

  a. How would the increased penetration of computer systems equipped with fast CD drives and high-quality speakers have affected the demand for music CDs?
  b. The income-elasticity of the demand for music CDs has been estimated to be 0.8. Using this elasticity, calculate by how much the real GDP growth would have raised CD sales.
  c. How would you use the price-elasticity of the demand for music CDs and the change in the average CD price to estimate the impact of price changes on the demand for CDs?
  d. Provide a formula that incorporates (a)-(c) above to correctly measure Napster's impact on music CD sales.

Answer

  (a) These computers are a complement to music CDs. The increased penetration would have raised the demand for music CDs.
  (b) The real GDP growth would have raised CD sales by 0.8 x 5% = 4%.
  (c) The effect would be the price-elasticity of demand times the average change in the CD price.
  (d) The change in CD sales, 6.7% = 4% + impact of price change + impact of computer penetration + impact of Napster. Hence, Napster's impact = 2.7% - impact of price change - impact of computer penetration.