MANAGERIAL ECONOMICS

LECTURE 2: DEMAND

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This lecture

- Study the importance of market demand in the determination of profit
- Study price elasticity: how demand reacts on price changes
- Calculate optimal price to maximize profits

Managers

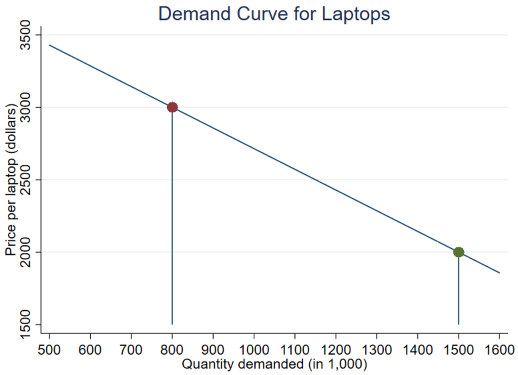
The role of managers in controlling and predicting market demand:

- Managers can influence demand by controlling price, advertising, product quality, and distribution strategies
- Managers cannot control, but need to understand, elements of the competitive environment that influence demand.
  This includes the availability of substitute goods, their pricing, and advertising strategies employed by others.
- Managers cannot control, but need to understand how the macroeconomic environment influences demand.
  This includes interest rates, taxes, and both local and global levels of economic activity.

How to use this chapter

- For most students almost everything in this chapter is well-known.
- Later, I will assume that students do know these concepts.
- I will present only a small part of the chapter.
- Students should read the chapter carefully, if they see problems.

Demand is downward-sloping



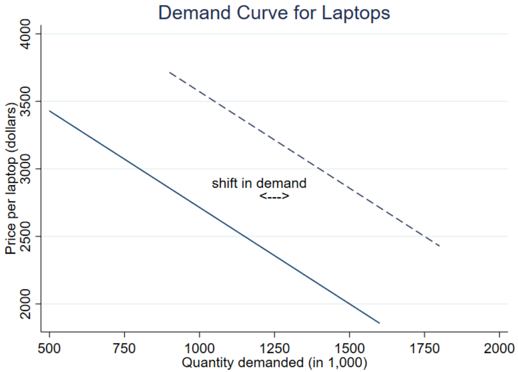
Notes: A graphical representation of the numbers above. A represents $(Q = 800, P = 3000)$ and B represents $(Q = 1500, P = 2000)$. (You should be able to draw this with paper and pencil!) The code for this graph is given on this Stata slide . How to solve this problem algebraically is given on this Algebra slide .

Market demand

Characteristics of the market demand curve

- Quantity demanded is for the output of *the entire market*, not of a single firm
- For most products and services, a higher price results in less demand
- Quantity demanded is not fixed, but may change over time
- Consumer tastes determine the position and the slope of the demand curve

A shift in consumers’ preferences



Notes: If consumers are willing to pay more for a good, the demand curve shifts to the right.

Other important aspects

- Population size?
- Consumers' incomes?
- Product characteristics?
  - Normal (superior) or inferior goods?
  - Substitutes or complements?

Market demand function

The market demand function

is the relationship between the quantity demanded and the various factors that influence this quantity.

Quantity $(Q) = F($potentially many different factors$)$,
for example,

- Price
- incomes of consumers
- tastes of consumers
- prices of other goods
- population
- advertising expenditures

An Example

Assume: Population is constant; the function $Q = F(\cdot)$ is linear:
$Q = b_1 P + b_2 I + b_3 S + b_4 A$,

where

Q	quantity demanded
P	price per unit
I	(disposable) income per capita
S	price of software
A	advertising (in €)
b_1,	b_2, b_3, and b_4 are parameters that are estimated using econometrics, perhaps obtained in experiments

Interpretation

Interpretation of $Q = b_1 P + b_2 I + b_3 S + b_4 A$:

- b_1: if the Price changes by one unit, quantity demanded changes by b_1 units, holding all other factors constant
- Example:
- $Q = -5P + 10I - 2S + 0.1A$
- If the price rises by 1€, demand is reduced by 5 units.

The firm's demand curve — in contrast to industry's demand curve

- Negative slope with regard to price
  - Slope may not be the same as that of the market demand curve.
- Typically smaller than total market demand (industry demand)
- Reacts to same market and macroeconomic factors as the market demand curve
- In addition to Market Demand: Directly related to the prices of substitute goods provided by competitors
  - Increase in competitor's price will cause a increase in a firm's demand.

The own-price elasticity of demand

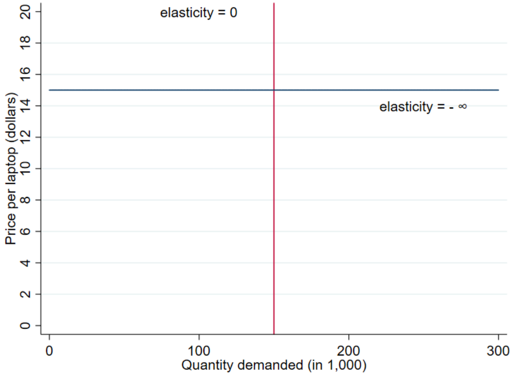
The own price elasticity of a demand function, η

is the percentage change in quantity demanded in response to a 1 percent increase in a firm's price,

$$\eta = \left(\frac{P}{Q}\right)\left(\frac{\Delta Q}{\Delta P}\right).$$

- $|\eta| > 1$, demand is elastic.
  $\eta = -\infty$, demand is perfectly elastic.
- $|\eta| < 1$, demand is inelastic.
  $|\eta| = 0$, demand is perfectly inelastic.
- $|\eta| = 1$, demand is unitary.

Extreme Elasticities



Notes: At $\eta = 0$, demand is perfectly inelastic and the demand curve is vertical. At $\eta = -\infty$, demand is perfectly elastic and the demand curve is horizontal.

Keeping life simple

Assume: The demand curve is linear, $P = a - bQ$.

- The slope of a linear demand curve is constant (-b)
- The price elasticity differs with the price:
  - At the midpoint of a linear demand curve, $\eta = -1$.
  - At prices above the midpoint, demand is elastic, $\eta < -1$.
  - At prices below the midpoint, demand is inelastic, $\eta > -1$.

Know thy elasticity!

Every manager ought to know the elasticity of demand!

How can you calculate it?

- If the demand function is known (or estimated): η is calculated at specific values, "*point estimate*", $\eta = (P/Q)(\Delta Q/\Delta P)$.

- If only two (P and Q) realisations are known, we may use the *arc elasticity*:
$$\eta = \frac{(Q_2 - Q_1)}{(P_2 - P_1)} \frac{(P_1 + P_2)/2}{(Q_1 + Q_2)/2} \quad .$$

A numerical example

Consider the following demand function and realisations of different variables:

$Q = -700P + 200I - 500S + 0.01A$, where

- Q Quantity demanded
- P Price = 3,000
- I Consumers' Income = 13,000
- S Software = 400
- A Advertising = 50,000,000

Solving the example

We derive the demand curve, i.e., $Q = F(P)$:

- $Q = -700P + (200)(13000) - (500)(400) + (0.01)(50000000)$
- $Q = 2900000 - 700P$

We determine Q:

- $Q = 2900000 - (700)(3000) = 800000$

We calculate η:

- $\eta = \frac{P}{Q}\frac{\Delta Q}{\Delta P} = (3000/800000)(-700/1) = -2.62$

Price changes are important for profit determination

If you increase the price, how will total revenue react? (How does cost react?)

Total Revenue, TR, is given by $P \times Q$.

Remember: we are on falling demand terms, i.e. Quantity depends on Price

Total change in revenues is given by the change in revenues due to the change in quantity sold and the change in revenues due to the change in prices (we need the product rule for differentiation):

- $\Delta TR/\Delta P = Q(\Delta P/\Delta P) + P(\Delta Q/\Delta P)$ = $Q + P(\Delta Q/\Delta P)$
- Simplify: $(1/Q)(\Delta TR/\Delta P) = 1 + (P/Q)(\Delta Q/\Delta P) = 1 + \eta$.

So, of you increase the price, how will revenue react?

Q is always positive, so we can easily check the sign of the expression (i.e. positive or negative)

- If $\eta = -1$: $\Delta TR/\Delta P = 0$, a change in P will have no effect on total revenue.
- If $\eta > -1$ (inelastic): $\Delta TR/\Delta P > 0$, an increase in P will decrease sales somewhat, but increase total revenue.
- If $\eta < -1$ (elastic): $\Delta TR/\Delta P < 0$, an increase in P will decrease sales a lot and also total revenue.

Remember these important insights!

- Markets are not perfect — pricing and advertising will influence sales!
- Know thy demand curve!
- Price elasticity: do not set price where demand is inelastic (between -1 and 0)!
- This is a very important insight. Why is this?
- Optimal prices? — comes next

Example: Public transport

Background information:

- Many public transport systems lose money.
- Public transport systems are funded by federal, state, and local governments, all of which have budget problems.
- Price (fare) elasticity of demand for public transport in the United States is about -0.3.

How to fund public transport?

- Revenue from sales will increase if fares are increased, because demand is inelastic, $\eta = -0.3$.
- Costs are likely to decrease if fares are increased, because quantity demanded (ridership) will fall.
- Managers of public transport system will therefore increase fares if they do not receive enough public funds to balance their budgets.

- Public funding might be used to prevent price hikes (among the pursuit of other goal, e.g., protection of the environment or distributional aspects).

Further determinants of the own-price elasticity of demand

- Number and similarity of available substitutes
- Product price relative to a consumer's total budget
- Time period available for adjustment to a price change

- Examples: Cell phone contracts, gasoline, soft drinks, ...

Selected examples

Good/service	η
Apples	-1.16
Beer	-2.83
Bread	-0.26
Cars: Domestic (US)	-0.78
Cars: European (US)	-1.09
Cigarettes	-0.11
Potatoes	-0.13
Wine	-1.12

Notes: Numbers from Table

Why are there markets with low elasticity of demand?

- Elasticity is calculated for the market (as a whole)
- What is elasticity if the firm changes the price alone?
- Competitive situation in the industry has to be taken into account
- It seems that markets with relatively low elasticities are markets where unilateral price hikes are difficult
- Firm-specific price elasticity of demand is the one which is important for price setting!

Strategy and the price elasticity of demand

Consider the pricing of airline tickets:

- Elasticities for different quality differs: first class (η= -0.45), regular economy (η= -1.30), and (advance purchase) excursion (η= -1.83) airline tickets between the United States and Europe

- First class prices should be relatively high because demand is inelastic
- Regular economy and excursion prices are relatively low because demand is elastic

Numerical Example

Type of ticket	η	η_I
First class	-0.45	1.50
Economy	-1.30	1.38
Excursion	-1.83	2.37

Notes: Numbers from Table

Strategy: Change the price elasticity of demand!

Use differentiation strategies to change the price elasticity of demand for a product

- Differentiation strategies convince consumers that a product is unique, and therefore has fewer substitutes
- If consumers perceive that a product has fewer substitutes, then their price elasticity of demand for the product will decrease (become less elastic) in absolute value
- Differentiation strategies do not require actual differences in products, only a perceived difference
- Role of advertising and marketing

Total revenue

A firm's total revenue, TR

is equal to the total amount of money consumers spend on the product in a given time period, $P \times Q$.

- Assume a linear demand curve: $P = a - bQ$
- Corresponding total revenue:
  $TR = PQ = (a - bQ)Q = aQ - bQ^2$

Marginal revenue

Marginal revenue

The additional revenue from selling one additional unit, “the marginal unit”, of output.

$$
\begin{aligned}
MR = \Delta TR/\Delta Q &= \Delta(PQ)/\Delta Q \\
&= P(\Delta Q/\Delta Q) + Q(\Delta P/\Delta Q) \\
&= P[1 + (Q/P)(\Delta P/\Delta Q)] = P(1 + 1/\eta).
\end{aligned}
$$

Marginal revenue depends on price and elasticity of demand

What happens if elasticity $\eta = -\infty$?

Price elasticity

With $P = a - bQ$, $\eta = (-1/b)[(a - bQ)/Q]$:

- If $Q = a/2b$, then $\eta = -1$
- If $Q > a/2b$, then η is inelastic; if $Q < a/2b$, then η is elastic.

- If product is price elastic ($\eta < -1$), marginal revenue must be positive
- Example: Calculate MR when the price is €10 and $\eta = -2$!
  10(1+1/(-2)) = €5.
- What happens, if your product is extremely price elastic $(\eta = -\infty)$?

Simple rules

Do not price so low that demand is price-inelastic ($\eta > -1$):

- Marginal Revenue is negative, i.e., by raising the price, total revenue will decrease.

Optimal Price: Set prices so that marginal costs are equal to marginal revenues

$$\text{Pricing rule: } MC = MR = P(1 + \frac{1}{\eta})$$

$$\text{Optimal price: } P = MC(\frac{1}{1 + 1/\eta})$$

$\Rightarrow$ optimal price depends on MC and price elasticity

$\Rightarrow$ The higher (the absolute value of) price elasticity, the lower the optimal price (Why? What type of market is this?)

Elasticity in Use

Prices for the exact item differ (substantially) in stores of the same chain:

- Elasticity of demand differs by location
- Rather than mark-up cost, or guessing, optimal pricing uses data on consumer choices
- Transaction prices from scanners allow the easy estimation of demand curves for different products

If marginal costs are equal across locations, we can equate marginal revenues:

- $MR_1 = P_1[1 + (1/\mu_1)] = P_2[1 + 1/\mu_2)] = MR_2(= MC)$
- If the marginal revenue in shop 2 is greater than in shop 1, you would like to shift some sales from shop 1 to shop 2!

Relationship between Price Elasticity, Marginal Revenue, and Total Revenue

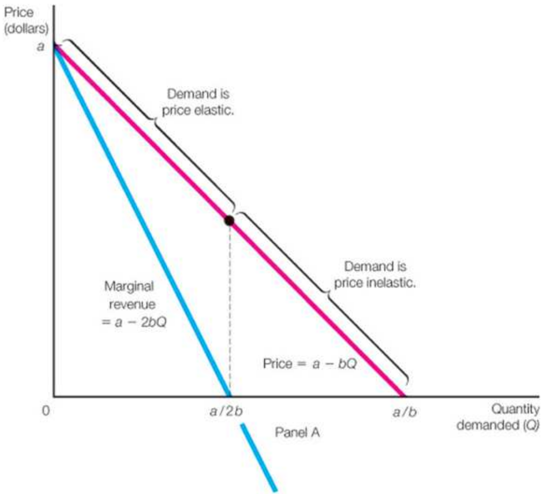


FIGURE 02-07a

Managerial Economics, 7e

The income elasticity of demand

Income elasticity of demand, η_I

is the percentage change in quantity demanded (Q) resulting from a 1 percent increase in consumers' income (I).

- Income is defined as aggregate consumer income or as per capita income, depending on circumstances.
- $\eta_I = \left(\frac{\Delta Q}{\Delta I}\right)\left(\frac{I}{Q}\right)$
- $\eta_I > 0$ for normal goods
  On average, goods are normal, since increases in aggregate income are associated with increases in aggregate consumer spending.
- $\eta_I < 0$ for inferior goods.

Strategy and the income elasticity of demand

- The demand for a product with a large income elasticity of demand will vary widely with changes in income caused by economic growth and recessions.
- Portfolio decision: use products with both high and low income elasticity to reduce risk for business downturn
- Managers can lessen the impact of economic changes on such products by <u>limiting fixed costs</u> so that changes in production capacity can be made quickly.
- Managers can <u>forecast demand</u> for products using the income elasticity of demand combined with forecasts of aggregate income.

Selected examples: Income elasticity of demand

Good/service	η
Apples	1.32
Bread	-0.17
Cars: Domestic (US)	1.62
Cars: European (US)	1.93
Potatoes	0.15

Notes: Numbers from Table

Effect of COVID-19 on demand for products

Income Elasticity: \ Consumer Purchases:	"Gone Forever"	"Snap-Back"
High Income Elasticity	Air Travel, Tourism, Gyms, Sporting Events, Restaurants, Concerts, Kids Sports, Uber	Automobiles, Bicycles, Watercraft, Furniture, Appliances, Real Estate, Durable Goods
Low Income Elasticity	Haircuts, Public Transport, Rent, Fast Food, Baby Sitting, Arcades, Bowling Alley	Higher Education, Clothing, Laptops, Home Repair, Elective Surgery, Dentists

- orange: lost profit from abandoned purchases and low future demand because income down
- green: delayed profits from postponed purchases and relatively high future demand
- blue: in-between

The cross-price elasticities of demand

The cross-price elasticity of demand, η_{XY}

is the percentage change in quantity demanded of one good (Q_X) resulting from a 1 percent increase in the price of a differnt good (P_Y).

The cross-price elasticity of demand:

$$\eta_{XY} = \left(\frac{\Delta Q_X}{\Delta P_Y}\right)\left(\frac{P_Y}{Q_X}\right).$$

- $\eta_{XY} > 0$: the two products are substitutes.
- $\eta_{XY} < 0$: the two products are complements.

Selected examples: Cross-price elasticity of demand

Change of price of	Changed quantity $\eta_X Y$	
Foreign cars (US)	Domestic cars (US)	0.28
Domestic cars (US)	European cars (US)	0.61
US durum wheat	US hard wheat	0.04
UK beef	UK pork	0.000
UK mutton	UK beef	0.25

Notes: Numbers from Table

Strategy: Cross-price elasticities of demand

- Managers use the cross-price elasticity of demand to predict the effect of competitors’ pricing strategies on the demand for their own product.
- Antitrust authorities use the cross-price elasticity of demand to determine the likely effect of mergers on the degree of competition in an industry:
  - If two goods are good substitutes: a merger could significantly *reduce competition* in the industry.
  - If two goods are strong complements: a merger could give the merged firm *excessive control* over the supply chain.

The advertising elasticity of demand

The advertising elasticity of demand, η_A

is the percentage change in quantity demanded, Q, resulting from a 1 percent increase in advertising expenditure, A.

$$\eta_A = \left(\frac{\Delta Q}{\Delta A}\right)\left(\frac{A}{Q}\right).$$

Example:

- Given: $Q = 500 - 0.5P + 0.01I + 0.82A$; $A/Q = 2$.
- Calculate η_A: $(0.82/1)(2) = 1.64$