Topics in Demand and Supply Analysis

Abstract

Keywords
Keyword1 — Keyword2 — Keyword3

12a	Calculate and interpret price, income and cross-price elasticities of demand and describe factors that affect each measure
12b	Compare substitution and income effects
12c	Distinguish between normal goods and inferior goods
12d	Describe the phenomenon of diminishing marginal returns
12e	Determine and interpret breakeven and shutdown points of production
12f	Describe how economies of scale and diseconomies of scale affect costs

Contents

1. Demand Analysis: The Consumer

The topics concerning demand analysis are: (1) elasticities or the sensivity of demand changes to endogenous variables et ceteris paribus (2) substitution and income effects (3) normal and inferior goods.

Demand Concepts

The price of a good depends of a number of factors of which perhaps the most important are **own price**, income or wealth and the price of other goods (complement or substitute). The demand function assigns a relationship between said variables to the quantity of demanded good.

$$Q_x^d = f(P_x, I, P_y) \tag{1}$$

where $P_x =$ Own price (per unit)
$I =$ Income
$P_y =$ Price of good Y (per unit)

The function that relates price of goods with quantity demanded for such good is called **inverse demand function** because it's the inverse of the demand function. The graph of the inverse demand function is the **demand curve**.

$$P_x = f(Q_x^d) \tag{2}$$

While the general model of demand and supply functions might not be purposefully useful in predicting the exact values of demand and supply, they are useful as the neoclassic model to determine how each variable affects the model and thus the outcome. The elasticity is the key concept describing the sensivity of changes between endogenous variables and the outcome.
We consider the concepts of **elasticity of demand** and **elasticity of supply** the core of microeconomics, although we can also consider the elasticity of cross price demand and elasticity of income.

The own price elasticity gauges the sensivity of the change in demand to the change in the price of the underlying good:

$$E_x^d = \frac{\%\delta Q_x^d}{\%\delta P_x} \tag{3}$$

$$E_x^d = \frac{\frac{\delta Q_x^d}{Q_x^d}}{\frac{\delta P_x}{P_x}} \tag{4}$$

Demand is said to be inelastic when it's not very sensitive to changes in price - a 1% change in price results in a lower % change in quantity demanded.
Demand is said to be unit elastic when a 1% change in price results in a 1% change in quantity demanded.
Demand is said to be elastic when it's very sensible to changes in prices - a 1% change in price results in higher change in % quantity demanded.

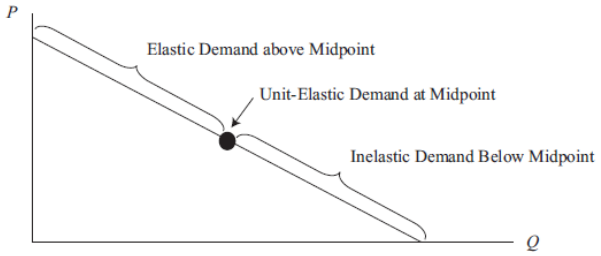

Figure 1. Elasticity change across demand function

Extremes of price elasticity

The two extremes of price elasticity are (1) when a change in price results in a ∞ change in demand and (2) when a change in price results in 0% change in demand. The first scenario is when demand is **perfectly elastic** and the second is when it is **perfectly inelastic**.

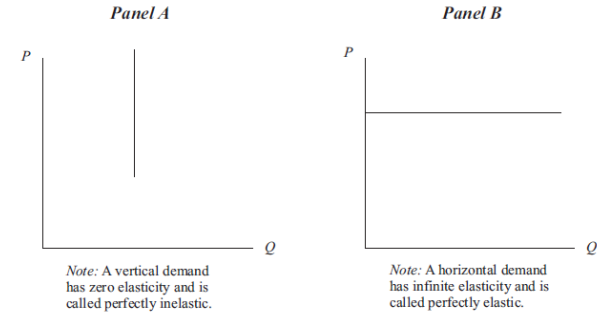

Figure 2. Perfect elastic demand (A) Perfect inelastic demand (B)

Factors affecting demand elasticity

- Availability of close substitutes: if there are available and affordable close substitutes for a good X, the more likely it is for the demand of such good to be sensible to price changes. Customers can easily substitute X for Y if the price of X increases, with the opposite also being true.
- Portion of the budget allocated: the higher the portion of consumers budgets is allocated for a good the more likely consumers are to react to changes. For example, if toothpast went up 10%, people would be more likely to support the increased costs than if energy price or home rents went up for 10% as such change could be the difference between insolvent or solvent household. For that reason, the own price elasticity would be less elastic in toothpastes.
- Discretionary and non discretionary goods: optional goods are cliche which means they are non essential and can be easily excluded from household expenses. Such goods are more elastic than necessary goods.
- Long term and short term elasticity: short and long term elasticity bear different values. If the rents went up 10% today, in the short term a tenant would be contractually enforced to live in the house whereas in the long term he would be able to move out and rent a cheaper house.

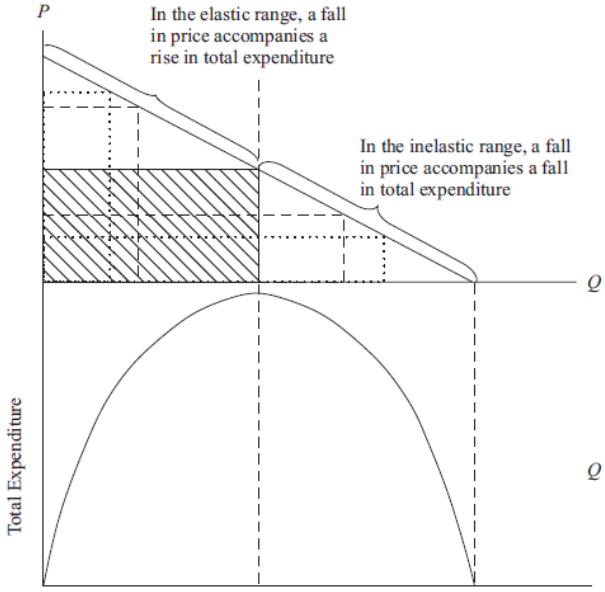

Figure 3. Relationship between elasticity and total expenditure

Elasticity and Total Expenditure

The natural law of demand states an increase in price is followed by a decrease in the number of units demanded. When it comes to total expenditure (PxQ) it little it tells. Considering the own-price elasticity, the maximum expenditure should

be when demand is unit elastic (E=1). If we take $Q_x^d = 100$ and $P_x = 100$ at point E=1, total expenditure should be 10000. That being said, if demand is inelastic (E=1.1), a 1% change in price results in 1.1% loss in demand, which results in a $Q_x^d = 98.9$ and $P_x = 101$ and $Exp. = 9988.9$. If demand is elastic (E=0.9), it results in $Q_x^d = 101$ and $P_x = 98.9$ and $Exp. = 9988.9$.
So the point of maximum total expenditure is at E=1.

Cross Price Elasticity

$$E_x^d = \frac{\%\delta Q_x^d}{\%\delta P_y} \tag{5}$$

The cross-price elasticity of demand is defined as the elasticity of demand with respect to the price of other product (P_y).
When cross-price elasticity is positive, goods are said to be substitute. An increase in the price of good Y (and thus decrease in consumption of Y) increases the quantity of goods X demanded. For example, if the price of rice increases, customers shift away from rice to similar goods such as pasta.
When cross-price elasticity is negative, goods are said to be complements. An increase in the price of good Y (and thus decrease in consumption of Y) decreases the quantity of goods X demanded. For example, if the price of tobacco increases, customers may be tempted to consume less tobacco and alcohol admitting these goods are pairs consumed together.

	Substitution Effect	Income Effect
Normal good	Buy more because the good is relatively cheaper than its substitutes.	Buy more because the increase in purchasing power raises the total consumption level.
Inferior good	Buy more because the good is relatively cheaper than its substitutes.	Buy less because the increase in real income prompts the consumer to buy less of the inferior good in favor of its preferred substitutes.

Figure 4. Normal and inferior goods

Exceptions to the law of demand

Giffen goods are goods characterized by a positive slope in demand function - increased price equals increased demand. In theory, this is possible when the income effect overwhelms the substitution effect. There are a few key assumptions when considering Giffen goods:

- Giffen goods are inferior goods (income effect results in lower consumption)
- There must be like of close substitutes
- Goods represent a large portion of buyers income
- Goods are necessary: the cost of not consuming is higher than the cost of consumption

Veblen goods are luxury goods and derive part of their utility from its higher status resemblance and uniqueness. The more expensive they are, the more exclusive they get and the more inclined consumers are of buying it.

Elasticity Calculation

Considering the following equation:

$$Q_x^d = 84500 - 6390P_x + 250I - 2000P_y \tag{6}$$

When can assume the following:

$$Q_x^d = 84500 - \frac{\delta Q_x^d}{\delta P_x}P_x + \frac{\delta Q_x^d}{\delta I}I - \frac{\delta Q_x^d}{\delta P_y}P_y \tag{7}$$

where,
$\frac{\delta Q_x^d}{\delta P_x} = 6390$, $\frac{\delta Q_x^d}{\delta I} = 250$ $\frac{\delta Q_x^d}{\delta P_y} = 2000$
and

$$E_{P_x}^d = \frac{\delta Q_x^d}{\delta P_x}\frac{P_x}{Q_x^d} \quad E_{P_y}^d = \frac{\delta Q_x^d}{\delta P_y}\frac{P_y}{Q_x^d} \quad E_I^d = \frac{\delta Q_x^d}{\delta I}\frac{I}{Q_x^d} \tag{8}$$

Substitution and Demand Effects

Substitution and income effects act simultaneously when the price of goods change. For instance, when a price of a good drops et ceteris paribus, it suddenly becomes cheaper compared to other goods and cheaper compared to the consumer. The consumer gains consumer power because now it is able to afford more and therefore it's real income rises. (this is the effect expansionary monetary policies are looking for, as first stated by Alfred Marshall. The increasing wealth provided by monetary relief, whether through the increase of jobs or salaries results in a fake sense of wealth. When it does happen, behavioral economists indicate consumers are more likely to consume more because they have a positive outlook of the future income. However, this increased consumption creates pressure in production and supply chains, creating all sorts of side effects including increased prices, shortages and scarcity. This is just a transitory effect from the lag between the moment consumers feel richer and the moment the economy prices in the shock, adapting prices and supply)
However, when the price of a good falls, the consumer is also tempted to increase its consumption by substituting other goods.

2. Supply analysis: The firm

Productivity is the relation between the quantity of inputs per unit of input, often expressed in $ per $ (ROI). It is directly related to input productivity, which is the relation between the number of input units per output unit. Inputs are directly related to the production costs and **factors of production** - mainly **labor** and **capital goods**.

$$\text{TC(L, K)} = wL + rK \tag{9}$$

where,
w = wage/hour
r = rental rate/hour
L = labor hours
K = machines

Cost is represented as a function of labor and capital (factors of production) hereby represented as hours of labor and number of machines. The rental rate of the machines is the opportunity cost - the next best employment of the capital goods which we forego since we are using such machines in the production of goods.
Cost can also be expressed as a function of output $TC(Q) = f(Q)$.

Term	Calculation
Total product	Sum of the output from all inputs during a time period; usually illustrated as the total output (Q) using labor quantity (L)
Average product	Total product divided by the quantity of a given input; measured as total product divided by the number of worker hours used at that output level (Q/L)
Marginal product	The amount of additional output resulting from using one more unit of input assuming other inputs are fixed; measured by taking the difference in total product and dividing by the change in the quantity of labor ($\Delta Q/\Delta L$)

Figure 5. Total, average and marginal product of labor

- **Total product of labor**(Q_L) is the sum of all output produced from all inputs consumed during a time period. It is the total output ($Q_L = Q$)
- **Average product of labor** (AP_L) measures the average productivity by dividing the total product for the total input. ($AP_L = \frac{Q}{L}$)
- **Marginal product** (MP_L) is the additional output produced when adding 1 more unit of input assuming all other inputs are fixed. ($MP_L = \frac{\delta Q}{\delta L}$)

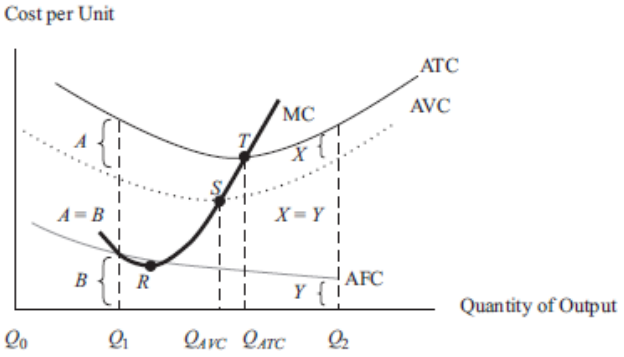

Figure 6. Total, average and marginal product of labor

Breakeven and Shutdown Analysis

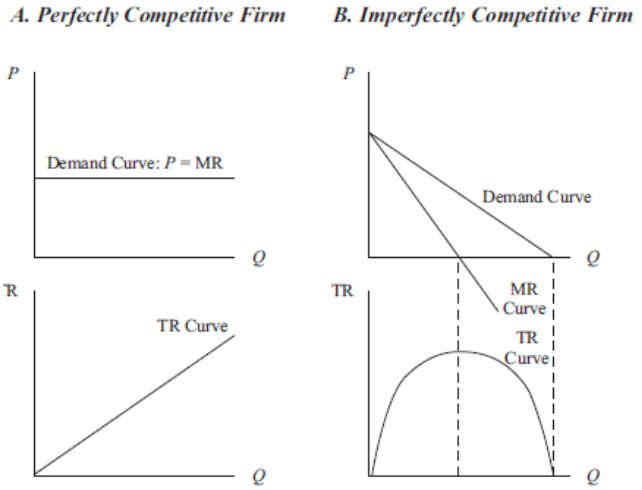

Figure 7. Total Revenue in perfect markets (A) and imperfect markets (B)

Economic profit is defined as the difference between total revenue (TR) and total economic costs. Total economic costs accrue more than explicit costs; they include implicit factors such as opportunity costs and minimum internal rate of return as well. **Accounting profit**, on the other hand, is the difference between total revenue and total accounting costs.
Marginal Revenue (MR) is the additional revenue the firm realizes from the decision of increasing output by one unit. ($MR = \frac{\delta TR}{\delta Q}$)
Marginal Cost (MC) is the increase in total cost resulting from the firm decision to increase output by one unit. ($MC = \frac{\delta TC}{\delta Q}$)
Within Total Cost we consider **Variable Costs** and **Fixed Costs**. Variable costs are all costs that fluctuate with the level of production, Average Variable Costs (AVC) is the ratio of total variable cost to total output ($AVC = \frac{TVC}{Q}$)
Total Fixed Costs (TFC) is the summation of all expenses that do not change as the level of production varies. Normal Profit is considered to be a fixed cost because it is the minimum return required by investors. Incurring in negative normal profit, although positive accouting profit is referred as

economic loss.
Total Variable Costs (TVC) is the summation of all variable expenses. (one can consider **quasi-fixed costs** as well, which usually are composed by fixed costs incurred and variable costs - wages are quasi-fixed costs)

Revenue–Cost Relationship	Short-Run Decision	Long-Term Decision
TR = TC	Stay in market	Stay in market
TR = TVC but < TC	Stay in market	Exit market
TR < TVC	Shut down production	Exit market

Figure 8. Short Run and Long Run decisions to operate, shutdown or exit

The **short-run shutdown point** is when the average revenue is less than the average variable cost in the short run. The **long-run shutdown point** is when average revenue is less that the average total cost. The **breakeven point** is when average total cost equals average total revenue and total revenue equals total economic costs.

Understanding economies and economies of scale

While plant size is fixed in the short run, in the long run firms can choose their most profitable scale of operations. The long-run average total cost (LRAC) curve represents the minimum total costs for a given plant size and scale of operations (short-run average total costs).

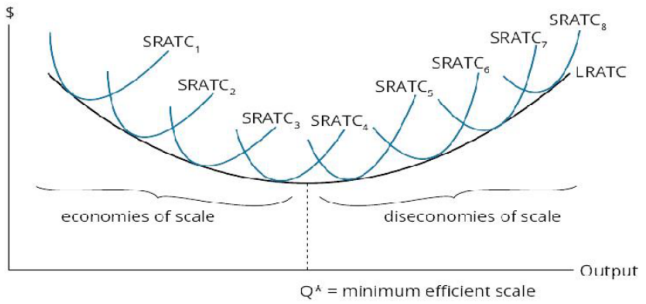

Figure 9. Economies and diseconomies of scale.

Therefore, each SRAC represents a unique plant size and intersects LRAC at the minumun total costs. The lowest point of LRAC is the **minimum efficient scale** and represents the optimal value firms must operate in the long term.
The downward segment of the LRAC represents increasing returns to scale which means economies of scale. **Economies of scale** result from factors such as labor specialization, mass production, more capital means, technology, etc. In addition, firms may also have access to factors of production with lower input prices such as dislocating facilities and quantity discounts.
The upward segment of the LRAC indicates **diseconomies of scale**. Deseconomies of scale may result from increasing bureaucracy and inefficiency, barriers to inovation and entrepreneurial activities, problems with the workforce, among other problems.

When LRAC has a flat curve it exhibits **constant returns to scale**.

References

[cfa, 2019] 2019. *CFA program curriculum*. CFA Institute.