Lecture notes

Managerial Economics

B ECON 300

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Managers, Profits, Markets

Overall goal of managers: maximizing profits (Π)

Accounting profits: Total Revenues – Explicit Costs

Economic profits: Total Revenues – Explicit Costs – Implicit Costs = Accounting Profits – Implicit Costs

Accounting profits usually overstate economic profits (but make sure you check the baseball example in the book)

Opportunity Cost: value of next best foregone alternative

Explicit Costs (not owner supplied)	Implicit Costs
Cost of resources purchased in the market, taxes Leases Wages Capital – plant, machinery, equipment	Value of owner-supplied resources - Value of time of owner-manager - Forgone returns on owner's equity capital - Opportunity cost of using owned equipment, plant, machinery

Market structure: market characteristics that determine the economic environment in which a firm operates. Characteristics:

- Number and size of firms (size refers to % of industry output supplied)
- Degree of product differentiation
- Barriers to entry (high vs. low/no barriers to entry)

Market power: a firm is said to have market power when it can raise the price of its output without losing all of its sales.

Price taker: firm in the industry take the market price for their output as given: must charge the same market price as everyone else or demand will drop nearly to zero. *The price-taking firm faces a perfectly elastic (horizontal) firm demand curve.*

Price setter: a price setting firm has some degree of market power, i.e., some ability of increasing price without losing all sales. *The firm faces a downward sloping demand curve.*

	Perfect Competition	Monopolistic Competition	Oligopoly	Monopoly
Market Power	No market power			High degree of market power
Number and Size	Large # of small firms supplying small % of output	Large # of small firms supplying small % of output	A few firms control the bulk of industry output	One firm supplies the entire industry output
Product Differentiation	No product differentiation/ homogeneous	High degree of product differentiation	Sometimes homogeneous, sometimes different	
Barriers to Entry	Low barriers to entry	Low barriers to entry	Fairly high	High barriers to entry

Demand, Supply and Market Equilibrium

General demand function → **Direct** demand function → **Inverse** demand function → **Graph**

(Sometimes the inverse demand function is called indirect demand function)

Analogously,

General supply function → **Direct** supply function → **Inverse** supply function → **Graph**

(Sometimes the inverse supply function is called indirect supply function)

Ultimately, the goal is to **forecast** the new market price and quantity as a result of demand and/or supply shifts.

The general demand function can be expressed as:

$$Q_d = f(P, M, P_R, \mathcal{T}, P_e, N)$$

Where:

P – (own price) price of the good for which we are estimating the demand

M – income

P_R – price of related goods

$\mathcal{T}$ – tastes

P_E – expected future prices

N – number of consumers

A linear form of the demand function is:

$$Q_d = a + bP + cM + dP_R + e\mathcal{T} + fP_e + gN$$

Note that the demand function is not necessarily linear, but it will be in most cases in this course and in all cases of this chapter.

In the linear equation, *b, c, d, e, f* are called coefficients and/or slope parameters.

$$\frac{\Delta Q_d}{\Delta \mathrm{P}} = b < 0$$

$$\frac{\Delta Q_d}{\Delta M} = c, c < 0 \text{ if the good is inferior}, c > 0 \text{ for a normal good}$$

Complements in consumption: consume the goods together.

Substitutes in consumption: consumers **either** consume on good **or the other** good

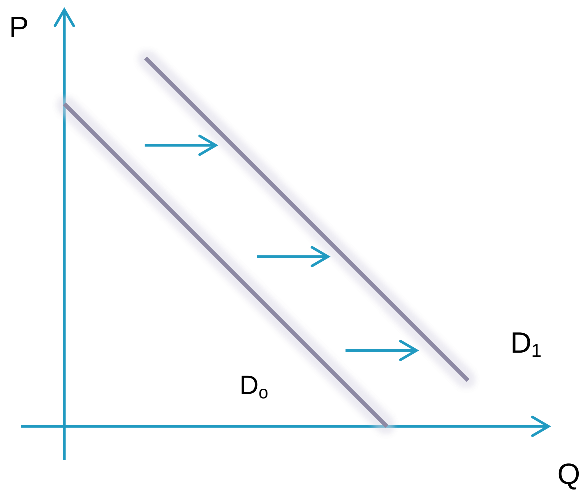
$$\frac{\Delta Q_d}{\Delta P_R} = d, d < 0 \text{ if the good is a complement}, d > 0 \text{ for a substitute}$$

$$\frac{\Delta Q_d}{\Delta \mathcal{T}} = e > 0$$

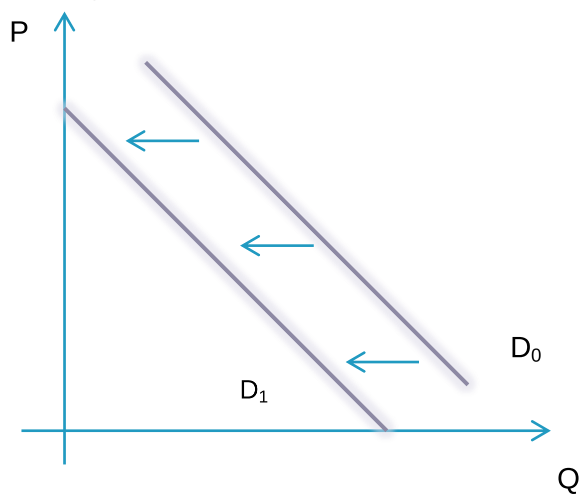
$$\frac{\Delta Q_d}{\Delta P_e} = f > 0$$

$$\frac{\Delta Q_d}{\Delta N} = g > 0$$

A change in demand – increase in demand from D_0 to D_1:



A change in demand – decrease in demand from D_0 to D_1:



The general supply function can be expressed as:

$$Q_S = f(P, P_I, P_R, T, P_e, F)$$

Where:

P – (Own price) price of the good for which we are estimating the supply

P_I – price of inputs

P_R – price of related goods

T – technology

P_E – expected future prices

F – number of firms

A linear form of the supply function is:

$$Q_S = h + kP + lP_I + mP_R + nT + rP_e, +sF$$

$$\frac{\Delta Q_S}{\Delta \mathrm{P}} = k > 0$$

$$\frac{\Delta Q_S}{\Delta P_I} = l < 0$$

Complements in production: produce good X and good Y together (for example, as a result of the production, for instance steak and ground beef for a meat processing plant)

Substitutes in production: either produce and sell good X or produce and sell good Y (for example, wheat and corn)

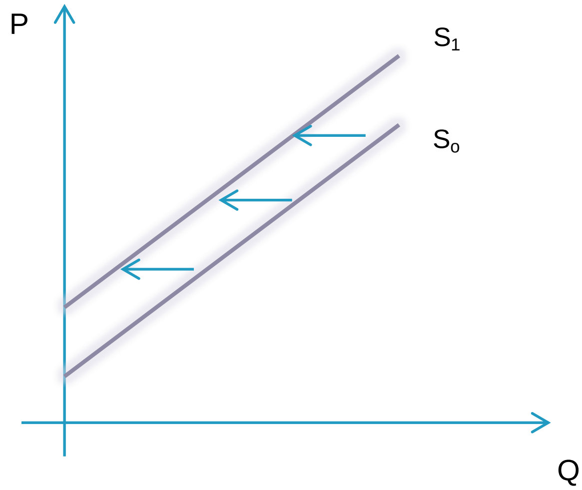
$$\frac{\Delta Q_S}{\Delta P_R} = m, m < 0 \text{ if the good is a substitute}, m > 0 \text{ for a complement}$$

$$\frac{\Delta Q_S}{\Delta T} = n > 0$$

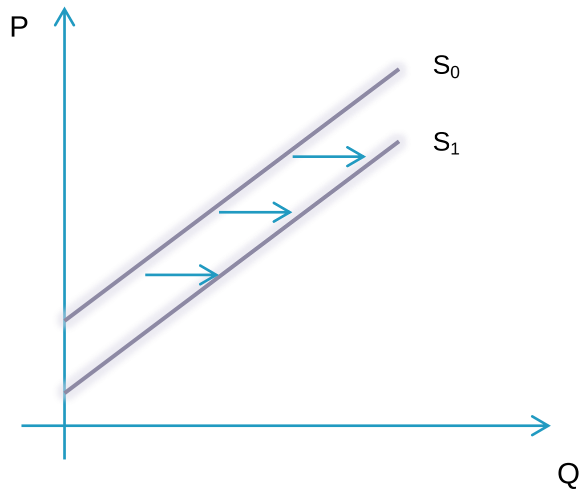
$$\frac{\Delta Q_S}{\Delta P_e} = r < 0$$

$$\frac{\Delta Q_S}{\Delta F} = s > 0$$

A change in supply – increase in supply from S_0 to S_1:



A change in supply – decrease in supply from S_0 to S_1:



Market equilibrium:

$$Q_D = Q_S$$

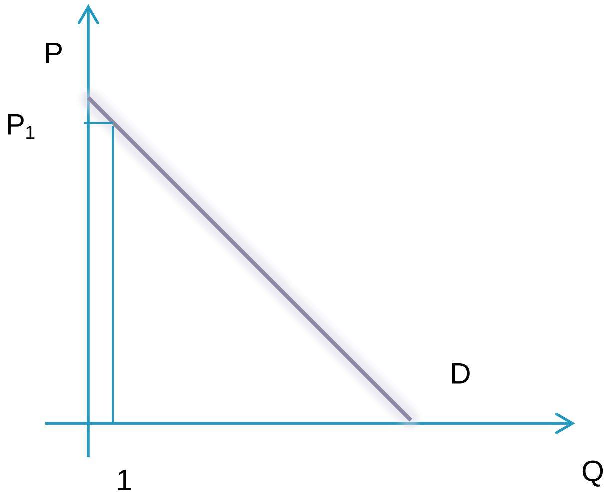
Consumer and Producer Surplus

Price ceiling: legal maximum limit for a price. When set below the market clearing (equilibrium) price, creates a shortage, as suppliers would require a higher price to produce more. In order to determine the shortage, substitute the ceiling price in Q_S and in Q_D. $Q_D - Q_S$ determines the shortage.

Price floor: legal minimum limit for a price, usually set by the government, who buys the supply at that set price if no one else does. When set above the market clearing (equilibrium) price, creates a surplus, as consumers would require a lower price to consume more. In order to determine the surplus, substitute the ceiling price in Q_D and in Q_S. $Q_S - Q_D$ determines the surplus.

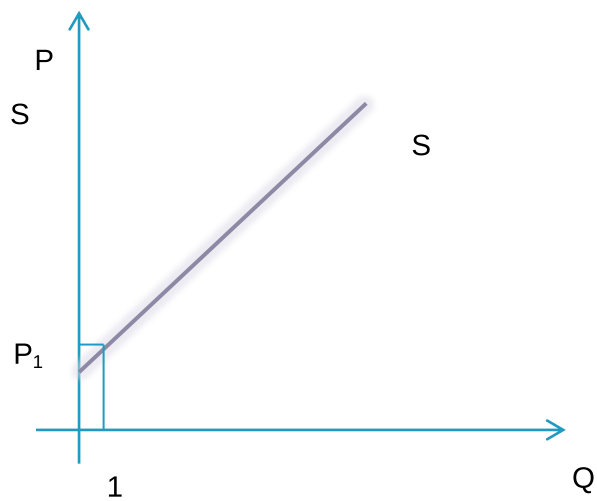
Consumer and Producer Surplus

Demand price: the maximum price a consumer would pay for a particular unit of a product.

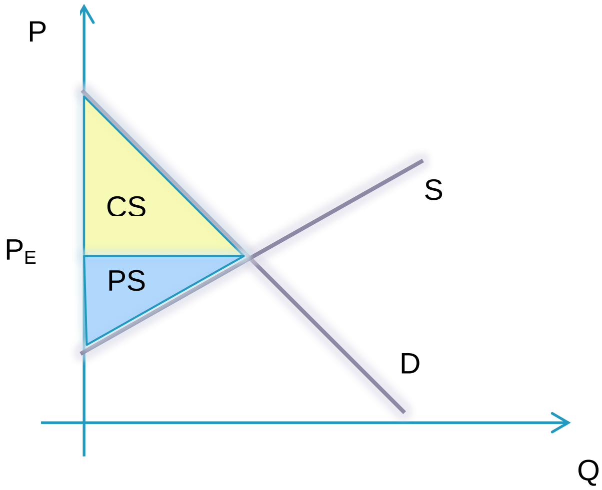


For instance, in the graph above, the consumer would pay up to P_1 for the first unit.

Supply price: the minimum price a supplier would require to supply for a particular unit of a product.



For instance, in the graph above, the supplier would supply one unit if the price was P_1.



CS

In the graph above, P_E is the market equilibrium price. The yellow triangle represents **consumer surplus**. In order to calculate the amount of consumer surplus, you need to find the area of the yellow triangle. Similarly, the blue triangle represents **producer surplus** and its area represents the amount of producer surplus created by this market.

Simultaneous shifts in supply and demand

When doing **quantitative** analysis, if you have the general supply and general demand curves and the values of the relevant variables, you **can** determine what happens with the equilibrium price and quantity by solving for equilibrium twice: once for before the changes, and once for after the changes.

When doing **qualitative** analysis (for instance, reading a newspaper article), you usually won't have the curves and the values of the variables. You can still determine the direction of **either** price or quantity, according to the table below:

		Demand	
		LEFT	RIGHT
Supply	LEFT	Quantity moves left Price indeterminate	Quantity indeterminate Price goes up
	RIGHT	Quantity indeterminate Price goes down	Quantity moves right Price indeterminate

Note that the demand tells you the direction that the variable will shift. Also, note that if both supply and demand move in the **same direction**, you can tell what happens to **quantity**. If they move in **opposite directions**, you can tell what happens to **price**.

Marginal Analysis for Optimal Decisions

The goal of marginal analysis is to help managers to make optimal decisions for the problems they face. In general, the problems can be represented by an **objective function.** The objective function is the function that the decision-maker wants to maximize or minimize. A profit function is a common example of an objective function.

The objective function can have one or more variables. Some of these variables are under the control of the decision maker. Those are called **choice variables** (they may also be called decision variables). Some variables are outside of the control of the decision maker, those are **exogenous** variables.

Problems can be **unconstrained** (when the decision-maker can choose any value for the **choice variable**) or **constrained** (when the decision-maker has restrictions on the values he or she can choose).

Marginal Analysis

A common example comes from the theory of the firm. Firms want to maximize $\Pi(\mathrm{Q}) = TR(Q) - TC(Q)$, where Π(Q) is the firm's profit as a function of quantity. TR(Q) is total cost as a function of Q and TC(Q) is total cost as a function of Q.

One experiment that can be run is the following: If the firm increases Q by a small amount, what happens to the profits? Do they increase, decrease or stay the same? Managers would want to keep increasing production as long as the profit increases and stop when the profit stops increasing.

Mathematically, this means that to maximize profit, we will set the derivative of the profit function to zero.

$$\max \Pi = TR(Q) - TC(Q)$$

$$\frac{\Delta\Pi}{\Delta \mathrm{Q}} = \frac{\Delta \mathrm{TR}}{\Delta \mathrm{Q}} - \frac{\Delta \mathrm{TC}}{\Delta \mathrm{Q}} = 0$$

Making $\frac{\Delta \mathrm{TR}}{\Delta \mathrm{Q}} = MR$ (marginal revenue) and $\frac{\Delta \mathrm{TC}}{\Delta \mathrm{Q}} = MC$ (marginal cost), we have:

$$MR - MC = 0$$

Another way of writing $\frac{\Delta \mathrm{TR}}{\Delta \mathrm{Q}} - \frac{\Delta \mathrm{TC}}{\Delta \mathrm{Q}} = 0$ is to write $\frac{\mathrm{dTR}}{\mathrm{dQ}} - \frac{\mathrm{dTC}}{\mathrm{dQ}} = 0$.

Note: the derivative of any **Total** function is the **Marginal** function.

Elasticity and Demand

Jan 20, 2011 – Southwest airlines is making more money on more traffic and higher ticket prices: 15% jump in revenue.

$$\epsilon_P = \frac{\%\ change\ in\ quantity\ demanded}{\%\ change\ in\ price}$$

Where ϵ_P represents the "own price elasticity of demand".

A more mathematical way of representing this:

$$\epsilon_P = \frac{\%\Delta Q}{\%\Delta P} = \frac{\frac{\Delta Q}{Q}}{\frac{\Delta P}{P}}$$

Moreover:

$$\epsilon_P = \frac{\frac{\Delta Q}{Q}}{\frac{\Delta P}{P}} = \frac{\Delta Q}{\Delta P}\frac{P}{Q} = \frac{dQ}{dP}\frac{P}{Q}$$

Note that in the demand function the price coefficient needs to be negative.

Therefore, the sign of ϵ_P is **negative**.

Another example of elasticity is the cross-price elasticity of demand. The cross-price elasticity of demand describes the sensitivity of the demand function to the change in the price of a related (complement or substitute) good.

$$\epsilon_{PR} = \frac{\%\Delta Q}{\%\Delta P_R} = \frac{\frac{\Delta Q}{Q}}{\frac{\Delta P_R}{P_R}} = \frac{\Delta Q}{\Delta P_R}\frac{P_R}{Q} = \frac{dQ}{dP_R}\frac{P_R}{Q}$$

The sign of the cross-price elasticity of demand is positive if the related good is a substitute and negative if the related good is a complement.

Another one that is in the book is the elasticity of income: what happens to demand if income changes? Similarly:

$$\epsilon_M = \frac{\%\Delta Q}{\%\Delta M} = \frac{\frac{\Delta Q}{Q}}{\frac{\Delta M}{M}} = \frac{\Delta Q}{\Delta M}\frac{M}{Q} = \frac{dQ}{dM}\frac{M}{Q}$$

The sign of the income elasticity of demand is positive for normal goods and negative for inferior goods.

Lastly, we also have the advertising elasticity of demand.

$$\epsilon_A = \frac{\%\Delta Q}{\%\Delta A} = \frac{\frac{\Delta Q}{Q}}{\frac{\Delta A}{A}} = \frac{\Delta Q}{\Delta A}\frac{A}{Q} = \frac{dQ}{dA}\frac{A}{Q}$$

Where A is the amount spent in advertising.

The flatter the demand curve, the more quantity changes for a given price change.

Elasticity Rules

If $\left|\frac{\%\Delta Q}{\%\Delta p}\right| > 1, |\%\Delta Q| > |\%\Delta P|$, we say that the demand is elastic. The quantity effect is larger than the price effect. One example is when there is a lot of substitutes.

If $\left|\frac{\%\Delta Q}{\%\Delta p}\right| < 1, |\%\Delta Q| < |\%\Delta P|$, we say that the demand is inelastic. The quantity effect is smaller than the price effect.

If $\left|\frac{\%\Delta Q}{\%\Delta p}\right| = 1, |\%\Delta Q| < |\%\Delta P|$, we say that the demand is unit elastic.

Price Elasticity	$\lvert\epsilon_P\rvert$	Effect on Total Revenue	Marginal Revenue
Elastic	$\lvert\epsilon_P\rvert > 1$	P↑.Q↓↓ = TR ↓ P↓.Q↑↑ = TR ↑	MR > 0
Unit Elastic	$\lvert\epsilon_P\rvert = 1$	Very small effect	MR = 0
Inelastic	$\lvert\epsilon_P\rvert < 1$	P↓↓.Q↑ = TR ↓ P↑↑.Q↓. = TR ↑	MR < 0

Factors Affecting the Price Elasticity of Demand

- The higher the number of available substitutes, the more elastic the demand.
- The higher the percentage the item takes on one's budget, the more elastic the demand.
- Timeframe of product decision and/or usage

Marginal revenue and inverse demand

$$P(Q) = a - bQ$$

$$TR = P(Q).Q \Rightarrow TR = (a - bQ)Q \Rightarrow TR = aQ - bQ^2$$

$$MR = \frac{dP(Q)}{dQ} = a - 2bQ$$

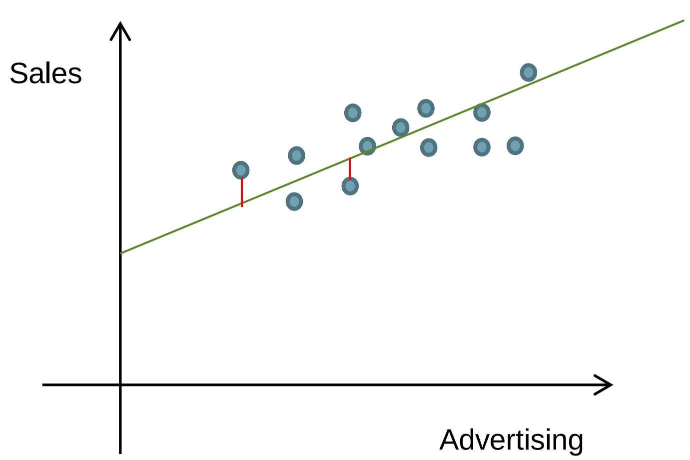
1) Marginal revenue and inverse demand curve will have the same vertical axis intercept.

2) The slope of the marginal revenue is twice as steep as the inverse demand curve

Basic Estimation Techniques

Starting with an example, suppose that theoretically, $Sales = \hat{a} + \hat{b} \times Adversisting$, and that you have data for Sales and Advertising but you don't know the values of $\hat{a}$ and $\hat{b}$. Therefore, you want to estimate the values of the coefficients $\hat{a}$ and $\hat{b}$.

For this course, this will be done by a tool (usually Excel's Analysis ToolPak) that estimates the "best" values for these coefficients by using least-squares, that is, finding the values for $\hat{a}$ and $\hat{b}$ for which the sum of squares of the errors between the observed values and the estimated values is minimized.



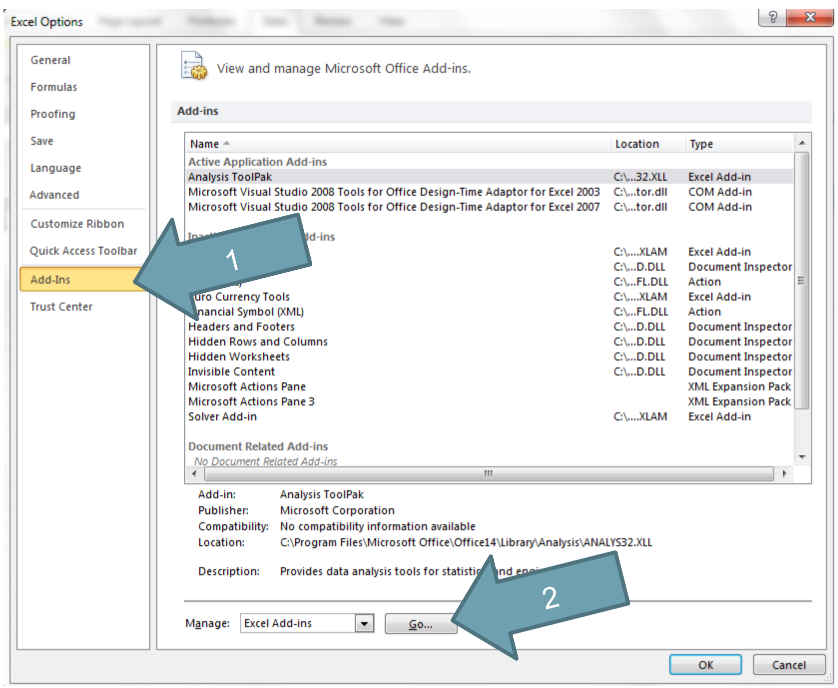
In the figure above, blue dots are the observed values, the green line is the estimated equation once the estimation tool finds $\hat{a}$ and $\hat{b}$ and the red lines indicate the estimation errors. The estimation errors are squared to eliminate negative numbers.

Once $\hat{a}$ and $\hat{b}$ are found, the estimation tool also tell you the t-statistic of $\hat{a}$ and $\hat{b}$. The t-statistic will give you a number that you could use to look on a t-statistic table and find a p-value, a number that tells you what is the probability that $\hat{a}$ and $\hat{b}$ could be zero instead of the value provided by the tool. Note that if $\hat{b}$ was zero, there would be no relation between sales and advertising in the example. The p-values can be used to provide you with the level of confidence that the estimates of $\hat{a}$ and $\hat{b}$ are correct. Fortunately, most estimation tools will also provide the p-values, so you don't have to look on a table.

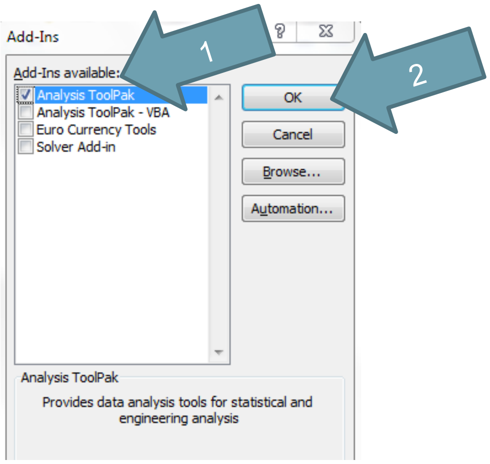
You can choose the significance (α) that you are comfortable with. As a matter of tradition, in most sciences, p-values lower than α=1% are considered to be **strongly** significant and p-values lower than α=5% are considered to be significant.

In this course, we will use the Analysis Toolpak in Excel 2010 for Windows (which is provided through the technology funding). If you have a Mac, you can use a function called LINEST() or download StatPlus from the web.

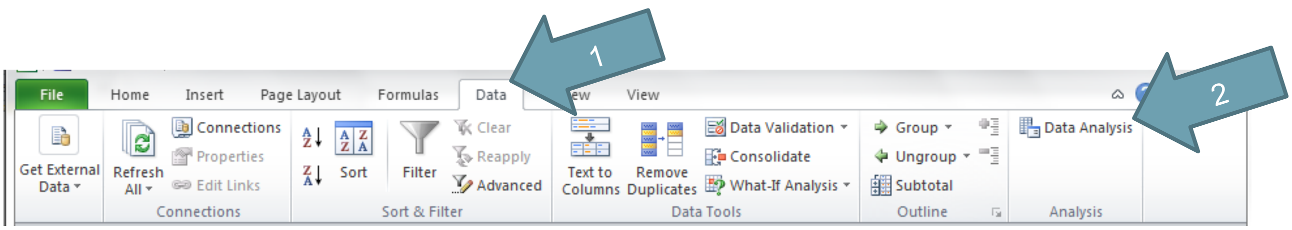
To enable the Analysis Toolpak, you have to configure the Excel Add-ins:



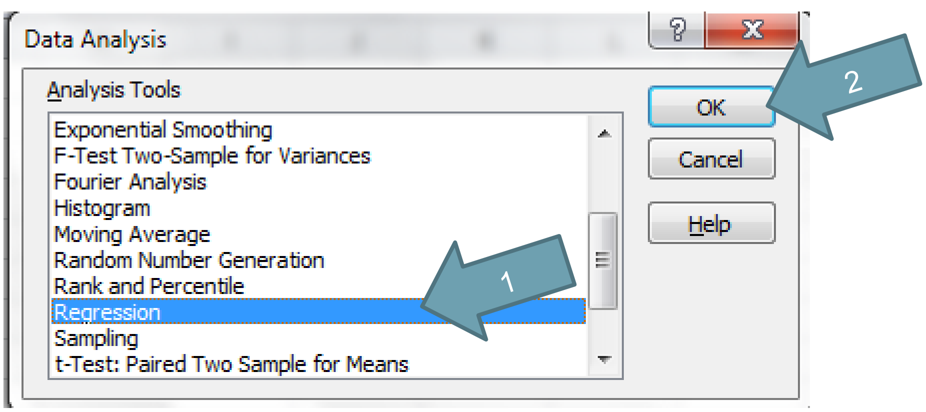
Mark the Analysis ToolPak and click Ok until you are back to Excel.



The Analysis ToolPak is going to be available under the Data tab on the Excel Ribbon. In order to access it, click on Data Analysis.



Choose “Regression” and click OK:



To run a regression with data, you need to have a theory that tells you what the function you are estimates look like (for example, Sales = a + b*Advertising, or Q = a + bP + cM).

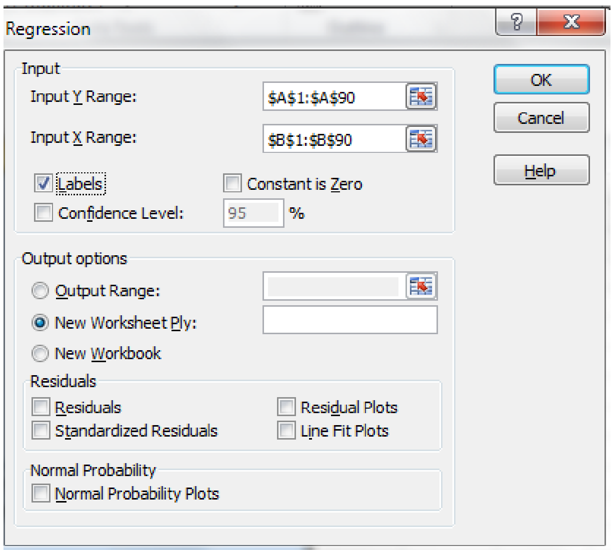
In Excel, the left-hand side of your equation is called Y and the right-hand side variables are called X. So if you have data for Advertising in cells B2 to B90 and data for Sales in A2 to A90, either select them with your mouse or type A2:A90 for “Input Y Range” and B2:B90 for “Input X Range”. Optionally, if your data includes a label (and you want to select it), make sure to include it with the values (therefore, A1:A90 for Sales and B1:B90 for Advertising) and check the “Labels” checkbox.

Look at the example below:

A snapshot of the first few rows of the data:

	A	B
1	Sales	Advertising
2	96	4.3
3	109	4.1
4	91	3.6
5	99	4.2
6	105	4.1
7	108	3.9

Using the “Regression” dialog box:



The output is:

	A	B	C	D	E	F	G	H	I
1	SUMMARY OUTPUT								
2									
3	*Regression Statistics*								
4	Multiple R	0.12837864							
5	R Square	0.01648108							
6	Adjusted R Square	0.00517626							
7	Standard Error	5.31032429							
8	Observations	89							
9									
10	ANOVA								
11		*df*	*SS*	*MS*	*F*	*Significance F*			
12	Regression	1	41.11158	41.1115801	1.457881	0.230539934			
13	Residual	87	2453.3603	28.199544					
14	Total	88	2494.4719						
15									
16		*Coefficients*	*tandard Errc*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
17	Intercept	90.63	7.09	12.78	0.00	76.54	104.73	76.54	104.73
18	Advertising	2.15	1.78	1.21	0.23	-1.39	5.69	-1.39	5.69

The intercept (a) is estimated to be 90.63 and the slope (b) is estimated to be 2.15. So the best equation estimated by Excel is:

$$Sales = 90.63 + 2.15 \times Advertising$$

You can use the t-statistic (I've painted them yellow) and find the p-value in a table, or look at the cells I've painted blue.

If you have more than one variable on the right hand side of the equation you want to estimate and you have data for it, just make sure to select it when choosing the "Input X Values".

Theory of Consumer Behavior

Introduces a constrained maximization problem: assumes that individuals maximize their utility function subject to (constrained by) their budget constraint.

From this maximization problem, we'll derive the individual's demand curves for goods X and Y.

$$\max U(X, Y) \text{ subject to (s.t.) } M = p_x X + p_y Y$$

Where U is utility/happiness, X represents the quantity of good X consumed, Y represents the quantity of good Y consumed, M is the income/wealth, p_x is the price per unity of good X, p_y is the price per unity of good Y.

Assumptions:

1) **Completeness:** if the consumer prefers A to B and prefers B to A, they are **indifferent** between A and B.
2) **Transitivity:** if the consumer prefers A to B and B to C, then they prefer A to C.
3) **Non-satiation:** more is preferred to less ("pig-principle").

Indifference curve: level curve of the individual's utility function.

Typical indifference curve will be negatively sloped and convex

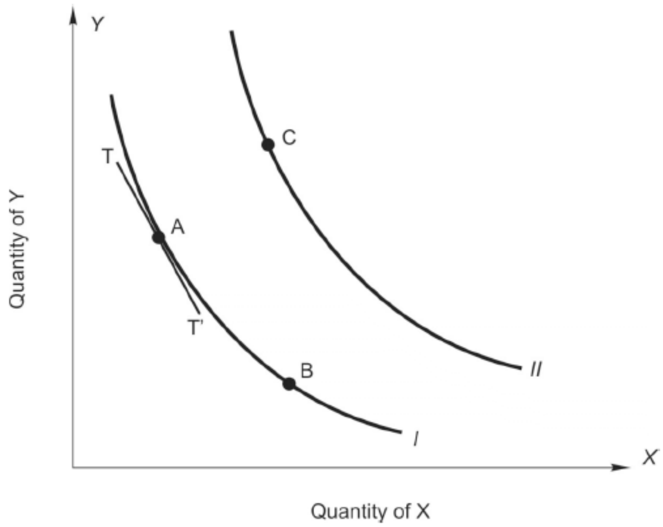
Different bundles along an indifference curve only differ in terms of how much X and Y is consumed.

In the picture below, I and II are indifference curves. The consumer is indifferent between A and B and prefers C to both A and B.

In an indifference curve, all bundles of goods along a given indifference curve have the same utility.

Negative slope means that if order to gain some units of a good, the individual needs to give up some units of the other good.

Convexity: as the individual moves from bundle A to bundle B below, the individual is less and less willing to give up units of A in order to gain units of B.



Higher indifference curves have higher utility, so all points in curve II have more utility than any point in curve I.

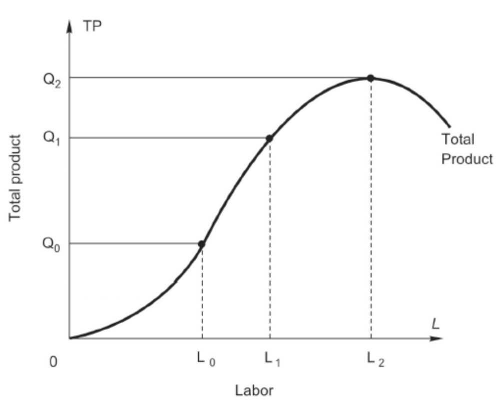
Income Effects and Substitution Effects

Two effects of a price change of good X:

1) **Substitution Effects:** as the price goes up (down), the quantity demanded go down (up).

2) **Income Effect:** for a normal good, as purchasing power goes up (down) due to a change in prices, the quantity demanded goes up (down). For an inferior good, as the purchasing power goes up (down), the quantity demanded goes down (up).

Supply in the Short Run



A firm's production is a function of its economic capital **K** (plant, equipment) and labor **L**. A general production function is $Q = f(L, K)$. In the short run, we assume that capital is fixed. Fixed variables are usually denoted with a bar, so the production function in the short run is $Q = f(L, \bar{K})$.

A usual short run production function is represented left.

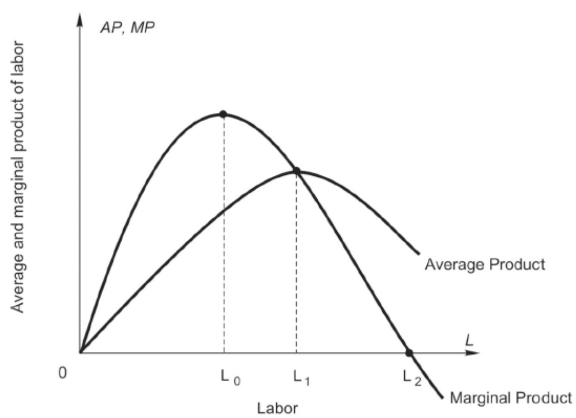
The Law of Diminishing Returns

As we add more and more variable input (labor) to production, production starts increasing at a decreasing rate (after L_0 in the previous figure) and ultimately declines (after L_2 in the previous figure).

The relationship between the increment of product that is obtained by a change in labor is represented by the marginal product of labor (sometimes called only marginal product or MP), and its function is: $MPL = \frac{\Delta Q}{\Delta L} = \frac{dQ}{dL}$. The average product of labor (sometimes called only average product or AP) is defined by $APL = \frac{Q}{L}$.

Relationship between average product of labor and marginal product of labor

The marginal product crosses the average product curve at its maximum. This is no coincidence and can be proved by calculus – this relationship enables you to determine the maximum average product later.



Costs in the short run

A firm's costs will be divided between fixed costs and variable costs. Therefore, the total costs will be $TC = TFC + TVC$, where TC are total costs, TFC are the total fixed costs and TVC are the total variable costs. The firm's average fixed costs are given by $AFC = {}^{TFC}/_{Q}$. The firm's average variable costs are given by $AVC = {}^{TVC}/_{Q}$. Therefore, the firms' average total cost can be given by $ATC = {}^{TC}/_{Q}$.

The shutdown decision

A perfectly competitive firm will produce Q > 0 where P = SRMC as long as:

$$\pi(Q > 0) = PQ - FC - VC(Q) > \pi(Q = 0) = PQ - FC - VC(Q)$$
$$PQ - FC - VC(Q) > -FC$$
$$PQ - VC > 0 \text{ or } TR > VC$$
$$\text{dividing by } Q, P - AVC > 0 \text{ or } P > AVC$$

Short-Run Profit Maximization

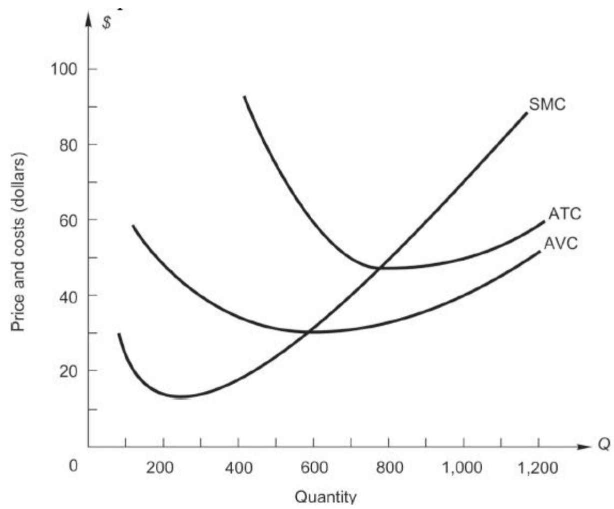
In the short-run, a perfectly competitive profit-maximizing firm chooses Q such that

$P = SRMC = MR$, as long as $P > AVC$. As shown above, if $P < AVC$ the firm will shut down temporarily.

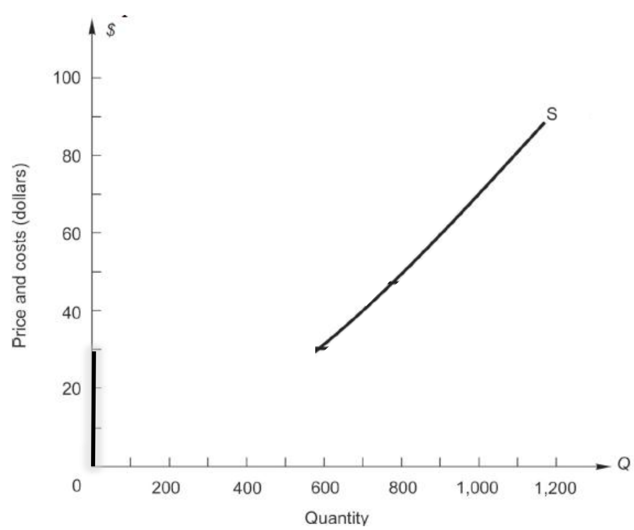
A firm's supply curve

A firm's supply curve depicts the profit maximizing output associated with each possible market price. Therefore, the firm's **supply curve** will be the firm's **short-run marginal cost curve** for all points where price is higher than the firms' average cost. Remember that the SRMC curve crosses the AVC curve at its minimum.

For example, in the graph below, note that the minimum AVC is 30. The firm's supply curve will start at Q = 600 and P = 30 and continue to the right.



Then the firm's supply curve will be as follows. Note that the quantity produced at prices less than 30 will be zero and there's a discontinuity between Q = 0 and Q = 600.



Supply in the Long Run

In the long run, all the inputs are variable. Therefore, all decisions will be made based on variable cost.

A firm will minimize the cost of producing the level of output it wants. In the long run, the firm faces both costs of employing capital (the costs of capital are denoted by *r*) and costs of employing labor (as in the previous chapter, defined as *w*). The firm's cost will be $C = rK +$The firm's minimization problem, as stated by its budget constraint, then, will be:

$\min_{\text{choose } K,L} rK + wL$ subject to Q = f(K,L)

Isoquants and Isocosts

In a graph where capital and labor are the axes, an isoquant is a curve that depicts all the combinations of inputs (capital and labor) needed in order to produce the **same** quantity. For example, in the figure below, the curve shows all the combinations that the company can choose to produce Q = 2000. Higher isoquants represent higher quantities. The slope of the isoquant is called marginal rate of technical substitution (MRTS), and it's formally defined as $MRTS = \frac{MP_L}{MP_K} = -\frac{\Delta K}{\Delta L}$. The numerical value of the MRTS tells the firm how much labor it can substitute for capital holding output constant.

Isocosts represent the company's budget constraint C: different combinations of capital and labor that cost the same. In the graph below, we have 4 isocosts. Higher isocosts represent higher costs. The isocosts intersect the axes at $C/_r$ (for the capital axis) and $C/_w$ (for the labor axis). The slope of the isocost is given by $-{}^{w}/_{r}$. The ratio $-{}^{w}/_{r}$.

In the particular case where the company is at an optimal point, the isoquant is tangent to an isocost and $\frac{MP_L}{MP_K} = \frac{w}{r}$. This is point D in the figure below.