

## Macroeconomic Definitions -- Dr. Tom McGahagan -- Fall 2008

### III. ECONOMIC GROWTH

1. **Per capita GDP** - GDP per person, or GDP divided by population.

2. **Rule of 72.** The **doubling time** for any economic magnitude is approximately 72 divided by the percentage growth rate. For example, a bank account earning 3 percent interest will double in about  $72 / 3 = 24$  years. The **Rule of 70** is another (and usually slightly less accurate) approximation: if per capita GDP grows at 10 percent a year, it will take about 7 years to double.

3. **Future value.** More accurate computation of the future value of an economic magnitude is given by multiplying its present value by the factor  $(1 + g / 100)$  to the Nth power, where N is the number of years in the future. For example, if you deposit \$ 1000 in a bank now at 3 percent interest, its future value 24 years from now will be \$ 1000 times 1.03 to the 24th power or \$ 2033 (about double, as the rule of 72 predicted). GDP growth of 10 percent a year will lead to an initial per capita GDP of \$ 5000 becoming \$ 5000 times 1.10 to the 7th power = \$ 9744.

3. **Extensive growth** - an increase in GDP without significant change in per capita GDP. Because of diminishing returns, a decrease in per capita GDP is possible and will result from an increase in population without a change in technology.

4. **Intensive growth** - an increase in per capita GDP due to changing technology, more capital equipment, and a more skilled labor force, offsetting diminishing returns.

5. **Diminishing returns** - more properly, "diminishing marginal returns to a single factor". As one adds a single factor of production to a given quantity of other resources, the marginal product of that factor declines.

Note that total product may well increase; the "law of diminishing returns" applies only to the MARGINAL PRODUCT or extra product of the factor. One fisherman can catch 10 fish a day; a second fisherman on the same boat catches 5 MORE fish. The total product increases from 10 to 15, but marginal product declines from 10 to 5.

6. **Returns to scale.** The behavior of output as one increases ALL factors of production. It may be constant, increasing or diminishing.

Give the two fishermen in the previous example a second boat. Since they are not trying to catch the same fish, there is no NECESSARY reason why diminishing returns should hold. If both fishing spots are equally good, we would most likely have CONSTANT returns to scale. If having two boats to explore the lake permits the fishermen to find a better spot, there would be INCREASING returns. If two boats permits the fishermen to fish out the lake more quickly, there would be DECREASING returns to scale.

7. **Total Factor Productivity** - the increase in the productivity of all factors of production due to an improvement in the techniques of production or of the unmeasured qualitative improvement of labor, capital or land inputs.

8. **Production Function** - the mathematical relation between inputs and outputs; may be for a specific industry or for GDP as a whole. The simplest production function is the linear production function  $Q = 5 L$  which says that one unit of labor (L) produces 5 units of output (Q). The number 5 may be called the **productivity coefficient**: since  $Q / L = 5$ , it gives the average product of labor. Note that a graph of this function would show **constant returns to labor** -- doubling the input of labor will double output.

8. **Cobb-Douglas Production Function.** A production function, due to **Charles Cobb** and **Paul Douglas**, of the form

$$Q = A K^a L^b$$

where Q is the quantity of output, A is Total Factor Productivity, K is the input of capital, and L the input of labor. If a and b are each less than one, there will be diminishing marginal returns to either capital or labor.

If  $a + b$  is less than one, there will be decreasing returns to scale. Hence an increase in L alone will lead to falling per worker GDP. An increase in K alone will lead to increased GDP per worker, so investment can lead to intensive growth.

If  $a + b$  is equal to one (the usual case), there will be constant returns to scale.

Hence balanced growth in K and L alone will lead to unchanged per worker GDP.

If  $a + b$  is greater than one, there will be increasing returns to scale. This is rarely the case, so increasing returns are more likely to come from improvements in A (total factor productivity).

### **Determinants of Total Factor Productivity**

**Technology:** improvements to production techniques which enhance the productivity of either capital (more efficient engines), labor (a better spreadsheet for accountants), or land (ways to reclaim mineral deposits). Note that **inventions** are not used until and unless they reduce the cost of production: steam power for ships dates to Oliver Evans and Robert Fulton (around 1800), but most cargo ships remained under sail until after 1900 due to cost considerations. Joseph Schumpeter distinguished discoveries or inventions from **innovations**, the actual use of a new technology. Inventions and innovations depend on research and development, and since one scientific breakthrough can easily lead to more related breakthroughs, it is not clear that R and D will have diminishing returns.

**Technology transfer** makes it possible for some developing countries with appropriate levels of human capital (Japan, Korea, China) to grow very rapidly by adopting existing technology; Alexander Gerschenkron noted the "advantage of backwardness" shown in these cases. Growth rates typically slow in larger economies already at the technological frontier, leading to a possible **convergence** in levels of GDP among countries. However, differences in human and social capital may prevent convergence.

**Human capital:** the skills acquired by workers through education or on-the-job training. Typically measured by average years of education in a country; studies indicate that the highest returns come from elementary education and education for women in the early stages of development, but returns from secondary and college education are more important in advanced economies. The process of "**learning by doing**" can lead work experience to show increasing returns as an industry is first established or a new product introduced (Victory Ships in World War II, new aircraft types).

**Social capital:** the institutions and culture of a society, including importantly the legal system and the protection of **property rights**, the enforcement of contracts, the ease of forming a new business and the prevalence of corruption in the economic life of the society. Note the World Bank (Andre Shleifer and others) studies of international differences on these issues.

Policies in relation to competition and trade play an important role. Jeffrey Sachs found countries with open trade policies (low tariffs and quota coverage, no overvalued exchange rates, no government monopoly of trade as with **marketing boards**) grow more rapidly than those without.

Table from Sachs:

	Openness to trade		
	Zero	Mid	High
Growth rates			
High	6	7	24
Mid	11	9	7
Low	23	14	0

Project suggestion:

Sachs' data covers the period 1965-1990.

What happened to the countries with closed or mid-range trade policies in the years since then?

In EcLS, the names of the countries are contained in the following variables:

	Zero	Mid	High
High	n00	n01	n02
Mid	n10	n11	n12
Low	n20	n21	n22

n00 = ("Congo" "Egypt" "Rwanda" "Brazil" "China")

n10=("Algeria" "Burkina.Faso" "Burundi" "Cameroon" "Gabon" "Nigeria" "Swaziland" "Tanzania" "Togo"  
"Dominican.Rep" "India" "Pakistan")

n20=("C.Afr.Rep" "Chad" "Cote.dIvoire" "Madagascar" "Malawi" "Mauritania" "Mozambique" "Niger" "Senegal"  
"Sierra.Leone" "Somalia" "South.Africa" "Zaire" "Zambia" "Zimbabwe" "Haiti" "Honduras" "Nicaragua"  
"Trinidad" "Argentina" "Bangladesh" "Iran" "Papua.New.Guinea")

n01=("Botswana" "Tunisia" "Israel" "Syria" "Turkey")

n11=("Guinea" "Kenya" "Morocco" "Costa.Rica" "Mexico" "Chile" "Colombia" "Ecuador" "Paraguay"  
"Philippines" "Sri.Lanka")

n21=("Benin" "Gambia" "Ghana" "Mali" "Uganda" "El.Salvador" "Guatemala" "Jamaica" "Bolivia" "Guyana"  
"Peru" "Uruguay" "Venezuela" "New.Zealand")

n02=("Barbados" "Canada" "Hong.Kong" "Indonesia" "Japan" "Korea" "Malaysia" "Singapore" "Taiwan"  
"Thailand" "Austria" "Belgium" "Finland" "France" "Greece" "Ireland" "Italy" "Luxembourg" "Norway" "Portugal"  
"Spain")

n12=("Mauritius" "United.States" "Jordan" "Denmark" "Germany" "Netherlands" "Sweden" "Switzerland"  
"United.Kingdom" "Australia")

n22 = none