

The Digital Economist

Lecture 5 -- The Standard of Living and Economic Growth

Imagine a country where the primary goal of its economic policy is to accumulate a single commodity -- gold for example. Does the accumulation of wealth in this manner generate benefits to the members of this economy? Yes, but only if another country exists that devotes its energy and resources to the production of food, clothing, and other essentials and that this second country is willing to trade these goods for the gold of our first country.

Individuals cannot directly consume commodity wealth. Gold, oil, iron ore, and the like provide no nutrition or protection from the elements. These commodities have little value in direct consumption. However if trade is possible with another nation -- a nation that realizes that the true measure of wealth is in production of necessary goods and services, then these commodities do have value.

Adam Smith was the first to realize that the *Wealth of a Nation* was not in the accumulation of commodities nor in the resource reserves that a nation may happen to possess. But rather wealth exists in the productive knowledge of its people. The ability to efficiently transform resources (factor inputs -- L_i, K_i, M_i) into desired goods and services ' X_i ' represents the true source of a nation's wealth.

$$X_i = f(L_i, K_i, M_i) \quad \text{for all } i = 1, 2, \dots, n\text{-goods}$$

and

$$Y_t = \sum_{[i=1,n]} P_{i,0} X_{i,t}$$

pre-multiplying by current market prices allow for aggregation such that:

$$\mathbf{W} = \sum_{[t=1,T]} Y_t \quad \text{A monetary measure of wealth.}$$

or

$$Y_t = \rho_t \mathbf{W}$$

Physical and human capital thus represent the true source of wealth. This wealth is properly measured as the pool of physical resources used for the production of desired goods and services

The numeric value of wealth is really less important than what it represents. The members of a given society are interested in living standards such that growth in output will at a minimum, equal or exceed the rate of population growth. Thus they are interested in a stock of human and physical capital sufficient to produce desired growth in income.

To present several examples of production and its relationship to wealth, we will examine the production of a simple restaurant meal, passenger services on an airplane, and production of housing services.

A sole proprietor operating a small restaurant uses raw materials in the form of food ingredients, capital in the form of a stove or oven, and labor input in the form of his own time. The proprietor is motivated by the fact that he is able to create a meal that is valued by his customers over-and-above the value of the individual inputs. This added value is created by his talents and know-how as a cook or chef combined with the physical capital of the restaurant. Wealth in this case is not only in the materials or factors of production but also in the proprietor's knowledge of preparing a meal. Over time this human capital will generate a stream of income for the proprietor for as long as he operates the restaurant and as long as there is a demand for his product.

An airline makes decisions to purchase an airplane based on anticipated demand for transportation services. The value of these services are based on the benefits customers receive by flying relative to other forms of travelling from one place to another. Like the restaurant the value of the airplane (a unit of physical capital) is in the provision of passenger services. Building this airplane represents an addition to wealth in that it will generate a stream of revenue (income) for the corporation generated over its physical life provided demand for passenger services remain.

Finally, the construction of an apartment building represents an addition to wealth based on the demand for apartments by those seeking housing services. The building will generate a stream of rental income over its life based on occupancy levels and rental rates. If however, the building is largely vacant--demand is lacking, its contribution to (national) wealth is close to zero. It becomes an asset with limited realized value even though its construction represents a combination of valuable materials, labor services, and land area.

The creation of wealth is based on knowledge -- the ability to take raw inputs and convert them into output with value greater than the sum of the individual parts. Additionally, this value is determined by correctly assessing the demand for the output -- how it will satisfy needs and wants. Creation of a restaurant, airplane, or apartment building (physical capital) all represent a contribution to a nation's wealth in that they all generate a future stream of income based on the willingness of the members of that nation to purchase food services, transportation services, or housing services to satisfy specific wants. Creation of a school teacher or engineer (human capital) also represent additions to a nation's wealth in that they also generate services desired by others in a given economy and thus produce a stream of income for the individual based on demand for those services.

LIVING STANDARDS

As described in lecture 4, the desire for economic growth is aimed at improvement in living standards. If we define the **Standard of Living 'SoL'** as the ratio of Real GDP and

the population of a given country (also known as per-capita Real GDP), then improvement requires that this ratio increase over time:

$$\text{SoL} = \text{RGDP} / \text{Population}$$

Such that:

$$\% \Delta \text{RGDP} > \% \Delta \text{population}$$

In a world of diminishing marginal productivity, this increase can be difficult to achieve.

Let us take another look at production relationships. In this case, we will hypothesize an aggregate production function defined as follows:

$$Y = f(L, K, M) \quad \text{--} \quad Y = \sum P_i X_i$$

Where **Y** represents the output of an economy (RGDP), and 'L', 'K', and 'M' represent the aggregate factors of production. Looking at production in the short run, holding 'K' and 'M' constant we define the following hypothetical relationship:

$$Y = f(L) = 100(L)^{0.50}$$

Table 1, An Aggregate Production Function

L	Y	MP _L	Y/L
0	0	-	-
1	100	100	100
4	200	33.3	50
9	300	20.0	33.3
16	400	14.7	25
25	500	11.1	20

We observe that as the amount of labor increases, output increases at a decreasing rate (diminishing marginal productivity). Also notice that as more labor is used in the short run, the ratio between **Y** (RGDP) and **L** is also falling.

Now suppose that the ratio between the population and the size of the labor force (the **labor force participation rate**) '**α**' is treated as a constant

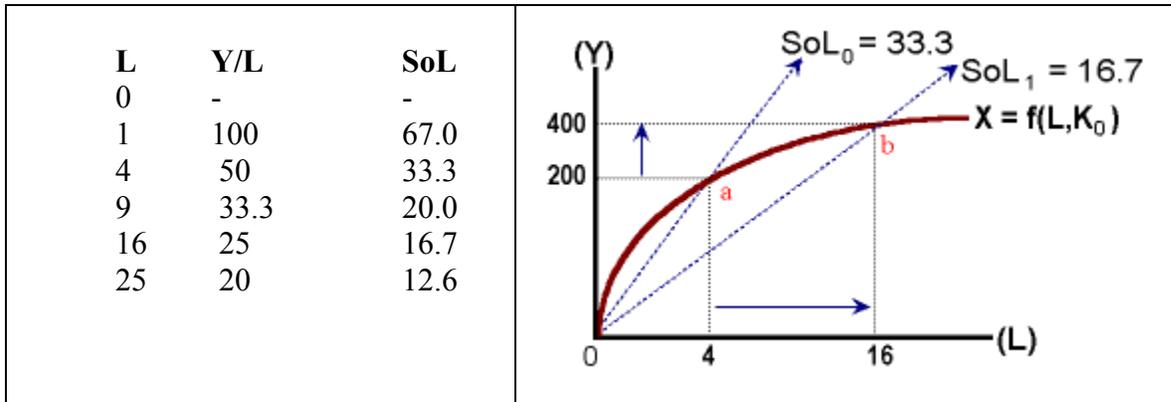
$$L / \text{Pop} = \alpha, \quad \text{and} \quad \alpha = 0.67, \quad \text{so} \quad L = 0.67(\text{Pop})$$

We can derive an expression for the Standard of Living (**SoL**):

$$\text{SoL} = Y/\text{Pop} = (Y/L)(L/\text{Pop}) = \alpha (Y/L)$$

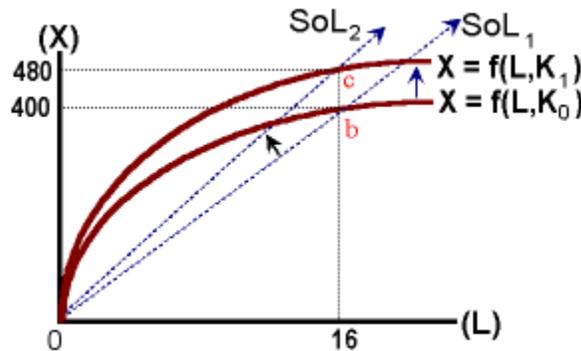
Or as more labor is applied to the production of goods and services the **SoL** declines:

Figure 1, An Increase in Labor Input



In a country with population growth and diminishing marginal productivity what is necessary are additions to the capital stock, the level of technology or both. These additions increase the productivity of workers and allow for more output for each and every level of labor input. This can be seen in the diagram below:

Figure 2, An Increase in the Capital Stock $K_0 \rightarrow K_1$



Note: overtime labor input will grow at some rate 'n' proportional or perhaps equal to the rate of population growth:

$$L_t = L_0(1+n)^t$$

Growth in capital is affected by savings rates in a given economy to support gross investment (changes in the capital stock overtime) at some rate 'g' less the rate in depreciation 'δ'. This rate of depreciation is a reflection of the fact that, over time, capital does wear out. Thus 'g-δ' represents the net growth in the capital stock over time.

$$K_t = K_0(1 + g - \delta)^t$$

Increases in living standards require more capital per unit of labor thus making each unit of labor more productive or:

such that: $(g - \delta) > n$

K_t/L_t is increasing over time.

These additions to the capital stock are not a simple task. Making resources available for producing capital (factories, machines, transportation equipment) in a world of scarcity requires that fewer final goods (food, clothing, other necessities and luxuries) be produced in the current time period. For example, looking at the table below:

Table 2, Production Possibilities (Final Goods vs. Capital Goods)

	L	Y _(wheat)	MP _L		L	K _(plows)	MP _L
A	0	0	-	F	0	0	-
B	1	80 bu	80	E	1	50	50
C	2	150	70	D	2	90	40
D	3	210	60	C	3	120	30
E	4	260	50	B	4	140	20
F	5	300	40	A	5	150	10
	6	330	30		6	150	0
	7	350	20				

As labor is transferred from the production of one type of good to the other, more and more final goods (wheat) must be sacrificed to produce additional units of capital (plows). These sacrifices might be possible for some countries, but for those nations living at the edge of subsistence (barely able to produce enough calories to support the population), this reallocation might come at the expense of starvation for some. It is this tragic tradeoff that has contributed to Economics being labeled at the *Dismal Science*.

Figure 3a, Final vs. Capital Goods

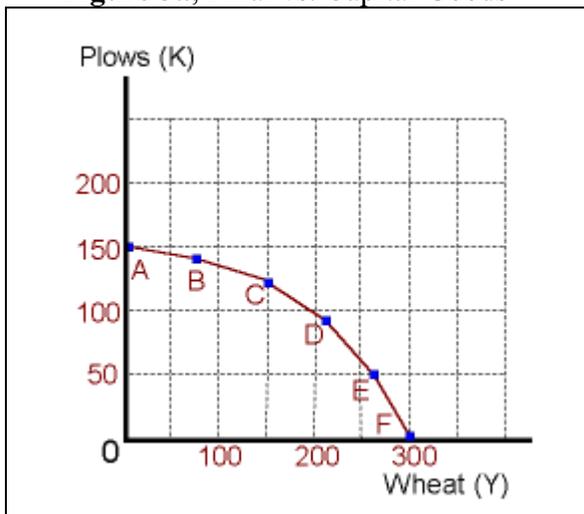
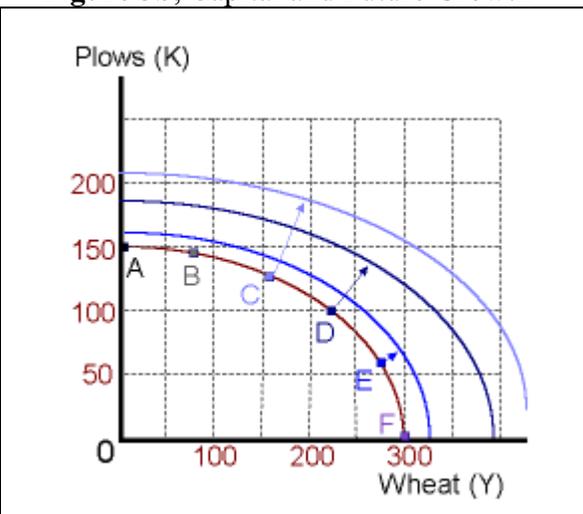


Figure 3b, Capital and Future Growth



ECONOMIC GROWTH

From our look at national income accounting, we observe that for the U.S. economy (based on the income approach), that labor income makes up roughly 70% of national income and non-labor income (proprietor's income, net rental income, corporate income, and net interest income) makes up the remaining 30% of national income. This can be written as follows:

$$\text{NGDP} = PY = wL + rK,$$

$$wL = 0.70PY, \text{ and } rK = 0.30PY$$

Using the Cobb- Douglas production function with 'L' and 'K' representing labor input and non-labor input respectively, we can write:

$$Y^* = AL^{0.70}K^{0.30}, \quad \text{-- note: 'Y*'} \text{ (Potential Output) = 'Y'} \text{ (Real GDP)}$$

Expressed differently, the rate of economic growth (assuming that it matches the growth rate in potential output -- an assumption that is valid over the long term) may be written in percentage terms as

$$\% \Delta \text{RGDP} = \% \Delta Y^* = \% \Delta A_t + 0.70[\% \Delta L] + 0.30[\% \Delta K]$$

Economic growth is thus the sum of the rate of growth in technology in addition to a weighted average of the rate of population growth and the rate in which capital accumulates. An interesting implication of this is that, holding other factors constant, a population growth rate of 1% leads to a less than one percent growth rate in output--a decline in the **Standard of Living**. In order to maintain or improve these Living Standards, there must be an accumulation of capital and/or technological progress.

Be sure that you understand the following concepts and terms:

- Standard of Living
 - Labor Force Participation Rates
 - Stock and Flow Variables
 - Aggregate Production
 - Wealth
 - Rate of Time Preference
 - Diminishing Marginal Productivity
 - Economic Growth
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