

ECONOMIC GROWTH & PRODUCTIVE KNOWLEDGE (Technology)

A Simple Growth Model Based On Technological Change

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Abstract

Nowadays, it seems to be a common knowledge that **technology (productive knowledge)** or to be more specific, **technological change (increases in productive knowledge)** is the determinant of long-run economic growth. In the absence of technological change, there would be a limit to economic growth. Investments that do not introduce technological changes (new products) can generate growth only to a limited extent, until the markets are saturated. As a result, the Neoclassical equilibrium would be the ultimate and inevitable outcome.

But we know that creative intelligence of human mind is capable of producing new combinations of human labor and natural endowments in an incessant process. That implies that there is practically no limit to growth in the long-run since there is no limit to human creativity. Limited natural resources argument in relation to limited growth does not hold for new combinations (transformations-rearrangements) of natural resources is always possible. In other words, as long as the **creative intellectual human labor** is capable of introducing new productive knowledge, the growth will be assured and sustained.

Having identified the creative human mind (intellectual labor) as the dynamic force causing the incessant and sustained changes in an economy, there seems to be a need for a new approach to the theory of growth based on intellectual labor. Most of the disciples of Neoclassical parable continue to treat technological change as an exogenous factor, a serious shortcoming indeed. But, there has been attempts by Lucas and Romer to incorporate intellectual labor as an endogenous part of growth theory. But, like all Neoclassical theories, their models are, though rather fascinating for **academic** discussions, fall rather short in accounting for the actual relations.

This paper is aimed to introduce a more realistic alternative growth model with closer resemblance to, and capable of accounting for, the actual economic transactions based on the intellectual labor (creativity) of human mind.

"..... productivity -that is, knowledge applied to resources through human work- is the source of all economic value."

Peter Drucker

Productive Knowledge and Growth

There are, at last, models of endogenous economic growth based on (productive) knowledge (technology). But there is a serious problem economic science and economists have to tackle with. The economic science still lacks an **“acknowledged”** economic theory of value and price based on productive knowledge, e.g., technological change. Rephrasing Paul Romer’s question: **Where is the productive knowledge** (discussion of innovation, invention, discovery and technological progress) **in the theory of value and price?**

As Toffler (1992,p.96) quite rightly claimed, **no value added is generated without intellectual contribution**. That means that the term value implies something more than just natural resources and unqualified labor force, and that changes the concept of value drastically. The value-added which consists of wages and profits is a significant indicator of firm level efficiency. But even more significant indicator is the market “price” which is the most important impulse and regulator of the system as a whole. The intensity and the magnitude of demand, supply strategy of the firms, efficient allocation of resources are all susceptible to and regulated by the price signals. Thus, economic science urgently needs and requires a new theory of value and price with due credit to productive knowledge, capable of explaining technological changes in relation to value generation and price formation both in industrial and service sectors.

After having criticized the economic theories for their inadequacy to explain the actual economies, Drucker draws the conclusion that: **“The Next Economics may again have a**

Theory of Value. It may proclaim that productivity -that is, knowledge applied to resources through human work- is the source of all economic value." (1981,p.20) He claims that non of the great non-Marxist economists of the last 100 years like Marshall, Schumpeter, Keynes were "**comfortable with an economics that lacked a Theory of Value altogether. But as Keynes anecdote illustrates, they saw no alternative.**" (1981,p.21) And he expects the next economics to "**be dynamic and assume risk, uncertainty and change in technology, economic conditions, and markets.**" (1981,p.16)

The existing level of productive knowledge and, more significantly, the creative minded knowledgeable labor force distinctly arise as the most valuable assets of firms as well as of nations, as technological changes¹ appear to be the true long run determinants of the increase of wealth of nations. But the latter (**labor force**) deserves more credit as it is the **genesis as well as the eternal source** of the former (existing knowledge). Thus, economic science urgently needs a new synthesis, a new Theory of Value and Price, based on productive knowledge. Drucker (1993) claimed there was nothing at sight, yet. A more appropriate statement would be; "nothing at sight to my knowledge". There has been an attempt to introduce an alternative approach based on productive knowledge years ago as a premise for discussion and further development (Gürak,1993) but its reception was rather chilly, in fact cold. There are perhaps more attempts but unable to tear down the "scientific walls" of mind created by the dominant Neoclassical doctrine. Unless the economic science is assumed to have reached its highest stage with the Neoclassical doctrine, the ignorance of deviations from the mainline stream cannot be justified. But who can claim that ultimate stage is reached ? If economic theories can be further developed by the creative intellectual labor of human mind, just like the incessant technological developments, then a proper chance ought to be given to all new attempts, no matter how peculiar they might seem, regardless of the deviation from the mainline stream.

The following is an attempt to introduce **an alternative simple growth model**. The main assertion is: **all value generation thus economic growth has its roots in the intellectual labor of mind, given the natural resources**. The new productive knowledge (technology)

is embodied in the products supplied. In other words, **creative intellectual labor is the genesis and eternal source of all value generation and long-run economic growth.**

Value Generation & Growth

A Simple Model Based On Productive Knowledge

Having acknowledged the productive knowledge (technology) of human labor as the genesis and the infinite source of continued value generation and prosperity, in the remaining part of this paper an attempt will be made in support of this hypothesis within the framework of a simple model of value generation and growth. By assumption, there is no formal education or training and initially all value is generated by the manual labor.

New Technology and Growth

Let us start by examining a simple society consisting of two individuals, Leyla and Maria, who possess nothing but their own labor consisting of mental and manual parts. In other words, there are no means of production, the capital goods in Neoclassical jargon, and no education/training (human capital) yet. The only tools available are their bare hands and intellectual labor, i.e., the basic properties of a labor force. Assume that initially, using bare hands only, Leyla and Maria produce cheese and marmalade as follows;

4 units of **X (cheese)** and 2 units of **Y (marmalade)**

respectively in a working day consisting of 10 hours. At the end of the day, they exchange their products in accordance with a given consumption behavior and identical tastes. In other words;

Leyla works 10 hours and produces 4 units of X,

and

Maria works 10 hours and produces 2 units of Y.

Joint total supply a day is $4 X + 2 Y = 20$ hours' manual work.

where 1 unit of Y is exchanged for 2 units of X, i.e., **1 Y (marmalade) = 2 X (cheese).**

So far we assumed that both producers used bare hands only, but no productive knowledge, i.e., intellectual labor. In other words, no technological change has taken place yet. Since no schooling / training is available, there are no educated persons (no human capital) either. As both producers employ only their manual labor for 10 hours a day, it would not be difficult to determine the exchange rate and consumption of each. The exchange rate is quite fair and rational.

Given the consumption behavior and identical tastes, after the exchange

Leyla consumes $2 X + 1 Y$, (= 10 hours' manual work) and

Maria consumes $2 X + 1 Y$ (= 10 hours' manual work).

New Technology and "Productivity Growth"

Existing Product But New Method of Production

a- Quantitative Increase

Remember, no intellectual labor is put forward yet. Assume that some day one of the producers, say Leyla, utilizing her mental abilities develops a productive knowledge (technology) which enables to double her daily supply from 4 units to 8 units of X within the same 10-hour time-span a day. To be more specific, utilizing her intellectual skill, she makes a simple tool that increases her productivity of the supply of good-X. At this stage, some productive knowledge (technological change) has entered the production process in the shape of a simple tool, although the quantity of hours employed in the supply of X has

not changed.

The new simple tool (capital good in Neoclassical terminology) developed by Leyla is, of course, nothing but **knowledge applied through human labor to transform (rearrange) the natural resource(s)**. Remember the law of conservation of matter and energy; the original natural endowments do not increase or decrease but only change form. And that change can only take place with the contribution of productive knowledge, the intellectual labor, given the natural resources and manual labor.

To study Leyla's contribution in **quantitative** terms let **Q** denote the total supply, **q** each individual producer's supply and **t** the time. The initial joint supply was;

$$Q_t = q_t^L + q_t^M = 4X + 2Y$$

After the introduction of Leyla's intellectual contribution (new technology is denoted by **A**), Leyla's output doubles while that of Maria remains unchanged;

$$q_{t+1}^L = 2(q_t^L)$$

and

$$q_{t+1}^M = q_t^M$$

As a result of Leyla's productive knowledge (A^L), the total output (**Q**) increases;

$$Q_{t+1} > Q_t \quad Q_{t+1} = q_{t+1}^L + q_{t+1}^M$$

$$\text{New total supply/a day} = 8X + 2Y = 20 \text{ hours' total manual work} + A$$

Though the hours effectively worked (20 hours) have not changed, the community as a whole increases its total wealth due to productivity growth. In other words, Leyla's intellectual contribution has generated growth and increased total wealth. **A** which denotes the technological change (productive knowledge), is not identical with the contribution of qualified (educated) labor force implementing the existing knowledge in production, which will be denoted as L^a

b- Increase in terms of market values-prices.

Assume the respective prices, say $p_x=3$ TL and $p_y=6$ TL, as well as a sufficient increase in demand maintaining the supply-demand stability, thus keeping the price level stable. The initial total value of output (**TR**) is:

$$\mathbf{TR}_t = p_x * q_x + p_y * q_y = 3*4 + 6*2 = 12 + 12 = \mathbf{24 TL}$$

After the introduction of technology, the intellectual contribution of Leyla, new total income rises to:

$$\mathbf{TR}_{t+1} = p_x * q_x + p_y * q_y = 3*8 + 6*2 = 24 + 12 = \mathbf{36 TL}$$

The increase in total revenue ($\Delta\mathbf{TR}$) equals the increase of Leyla's income ($\Delta\mathbf{R}^L$) which is 12 TL, while Maria's income (\mathbf{R}^M) remains unchanged. Community's total income is greater now;

$$\mathbf{TR}_{t+1} > \mathbf{TR}_t$$

as well as Leyla's income (\mathbf{R}^L);

$$\mathbf{R}^L_{t+1} > \mathbf{R}^L_t$$

while

$$\mathbf{R}^M_{t+1} = \mathbf{R}^M_t$$

Leyla's income is now twice as big as before due to technological change that doubled her output per hour worked. Community owes its increased total prosperity to Leyla's intellectual contribution.

New Technology and "Exchange Relations"

Existing Product But New Method of Production

What would happen to the exchange relations with the other producer, Maria, in terms of **relative and absolute prices**?

With regard to the new situation, the exchange relations will have to change. Previously, there were 2 units of **Y** and 4 units of **X** in the market. Now, there are 2 units of **Y** and 8 units of **X**. What would the new exchange ratio look like?

Exchange With Relative Values

Case-1: Following the footsteps of 19. century economists like Ricardo and Marx, one could argue that it still requires 10 hours' work to produce 2 units of **Y** or 8 units of **X**.. Equal quantities of labor time are embodied in both cases, and therefore, 1 unit of **Y** should exchange for 4 units of **X** instead of 2, in order to maintain the equality of exchange of the labor-time employed. As a result, at the end of the day, Leyla would be expected to give up 4 units of **X** which equals 5 hours' labor-time for 1 unit of **Y** which also requires 5 hours' labor-time a day. Let **C** denote consumption, L^{δ} the unqualified labor force, L^a the qualified (educated) labor force and the total labor force $L = L^{\delta} + L^a$

Leyla's consumption = 1 unit of Y + 4 units of X = 10 hours' labor-time

Maria's consumption = 1 unit of Y + 4 units of X = 10 hours' labor-time

Total consumption = 2 Y + 8 X = 20 hours' $L^{\delta} + A^L$

that means;

$$C_{t+1}^L > C_t^L \quad \text{and} \quad C_{t+1}^M > C_t^M$$

If one ignores the contribution of Leyla's intellectual labor, i.e. the development and employment of some self-made tool which increased her daily output (productivity), exchanging 1 unit of **Y** for 4 units of **X** would seem like an egalitarian exchange at first sight. But Leyla has not been rewarded, yet, for her intellectual contribution to the common wealth, which increased the total available supply, by 4 units of **X**..

In terms of hours employed, combined employed labor-time still consists of 20 hours. But in terms of initial conditions, the new total output is worth 30 hours' of manual labor-time. Maria who makes intellectual contribution to increased total wealth, becomes the main benefactor of the new exchange relations based on the time spent approach for she works for 10 hours but consumes 15 hours' worth output in terms of initial conditions while Leyla, producing 20 hours' worth output in terms of initial conditions, consumes only 15 hours' worth output.

This would be neither logical nor economically rational from the point of further development of technology (productive knowledge) as well as of total wealth. The system is unable to provide any incentives for the contributions of intellectual efforts. And it does not reflect the actual relations, either.

Case-2: Initially, Maria and Leyla were exchanging 1 unit of **Y** for 2 units of **X**. Assume that after the introduction of new method developed by Leyla, which doubled her productivity from 4 to 8 units of **X**, the initial exchange relations are maintained. Maria and Leyla still exchange and consume 1 unit of **Y** and 2 units of **X** each. But now, Leyla has access to additional 4 units of **X**, which she can exchange for another product, say for 2 units of **W**.. Maria still consumes 1 unit of **Y** and 2 units of **X** (worth 10 hours' output) while Leyla now has 1 unit of **Y**, 2 units of **X** and additional 2 units of **W** at her disposal for daily consumption, due to new technology developed by her.

Total value of Leyla's consumption in terms of labor time has risen to ten hours' worth output internally acquired plus the value of two units of **W** acquired from an external source, although the hours she effectively worked have not changed.

Leyla's consumption = 1 unit of Y + 2 units of X + 2 units of W = 10 hours' $L^\delta + A^L$

Maria's consumption = 1 unit of Y + 2 units of X = 10 hours' L^δ

In other words,

$$C_{t+1}^L > C_t^L \quad \text{but} \quad C_{t+1}^M = C_t^M$$

In this case, there is no egalitarian exchange in the Ricardian or Marxist tradition of equal quantities of manual labor expressed in time-unit employed. Nevertheless, neither Leyla nor Maria consumes less, in fact, there is an increase in the total consumption due to the contribution of Leyla's productive knowledge. As a result, she is now able to consume more than ever before. This outcome seems both, more logical and economically rational, than the foregoing one, Case-1.

Case-3: Dismissing Case-1 for being unrealistic and unlikely, let us study a similar but distinct case in which also Maria benefits. Assume that Leyla cannot exchange **all** her surplus of 4 units of **X** for other products outside her own community, which consists of Maria and herself. Then even Maria might benefit from Leyla's increased productivity and enjoy increased consumption.

Assume that only 2 units of **X** out of 4 surplus are exchanged for 1 unit of **W**. Leyla would now have 6 units of **X** at her disposal in her own community before entering the exchange relations with Maria, the other member of the community. Assume that Maria after negotiations somehow "convinces" Leyla to accept a new exchange ratio; say, 1 unit of **Y** for 3 units of **X**. Now, it is not only Leyla who enjoys a greater amount of consumption but also Maria who actually did not make any contribution to the initial condition. δ and β denote parameters for the weight assigned to **A**.

Leyla's consumption = 1 unit of Y + 3 units of X + 1 unit of W = 10 hours' $L^\delta + \delta A^L$
Maria's consumption = 1 unit of Y + 3 units of X = 10 hours' $L^\delta + \beta A^L$

In other words,

$$C_{t+1}^L > C_t^L \quad \text{as well as} \quad C_{t+1}^M > C_t^M$$

This outcome seems to have a closer resemblance to the reality than the prior two cases, for it allows even the less productive person(s)/sector(s) of the economy (like employees in service sectors) to benefit from the overall development originating from "dynamic" sectors. Not only the inherently more productive manufacturing sector but also the service sector which, by its nature, is prone to relatively lower productivity growth, benefits from such developments. The outcome of Case-3 is, probably, the most plausible and fairest result from the point of view of social distributive justice. Because each specific contribution of the productive knowledge, as a product of mind, is, in principle, only a (marginal) by-product of the accumulated common (public) knowledge.

Exchange with Market (Absolute) Prices

In the foregoing part, we studied the growth and exchange relations in terms of relative prices with reference to a community consisting of two individuals. The market prices in the actual world, however, are not determined by relative exchange values. On the supply-side it partly depends on the cost of production (prices of inputs and wages) of each specific product subject to competitive environment and partly on the magnitude of demand from end-users' perspective. For the producer, the market price (exchange-value) of an individual product is expected to be above its objective value, e.g., cost of production, if sustained supply is expected. The upper limit for the market price would be what the market can bear with due regard to competition and supply-demand relations, where the purchasing power and the rank of preferences play an important role. Therefore, in order to be able to get a sound insight into the actual economic relations, the emphasis in this part will be on the determination of individual market price of a single-product enterprise, given supply-demand stability.

Sale (Market) Price (P)

Assume that there are no costs arising from the intangible service activities like marketing

and distribution. The price (**p**) reflects the sale price at factory site consisting of costs and profits. During production, the producers combine the material inputs of production like raw materials, components and means of production (capital goods) with services of labor-power, to produce commodities with exchange values. During the process, the enterprise incurs some costs called "costs of production", e.g., payments for the inputs of production. Since producers are driven by profit motive, the market price of the output supplied is, naturally, expected to exceed the initial costs of production in order to compensate for the **risks** assumed. The price including the profit is referred to as the sale price (**p**) and consists of the following components;

$$\mathbf{p = Costs\ of\ production\ (TC) + Profits\ (\pi)}$$

Given the optimum utilization of productive capacity and supply - demand stability, excluding the costs of trading and transportation, what would be the **p** with the following hypothetical figures?

$$\mathbf{TC = 50,000\ TL} \quad (=FC+OC+LWC), \text{ say } (30+10+10)$$

$$\mathbf{Q = 1,000\ pcs.}$$

where **FC** denotes fixed costs like building, machinery, **OC** the operating or variable costs which vary in accordance with output supplied and **LWC** the labor wage costs.

Costs of production, or the initial production capital (**K**) required, is say 50,000 \$, to pay for the required inputs of production including wages. The producer's revenue must exceed the initial costs of production in order to generate acceptable amount of profits. Otherwise, there would be no incentive for engaging in production. Assume that the average profit rate ($r=\pi/K$) in this particular branch of business is 20 percent of the capital advanced ($K=TC$) which also applies to our sample enterprise. The total revenue including the profits would be;

$$\mathbf{TR = TC + \pi = 50,000 + (50,000 * 0.20) = 60,000\ TL}$$

where **p** per unit is;

$$\mathbf{p = TC + \pi / q = 60,000 / 1,000 = 60\ TL}$$

and the rate of profit (r) is,

$$r = \pi / TC = 10,000 / 50,000 = \mathbf{20 \text{ percent}}$$

To summarize, the p has to be in excess of the costs of production in order to motivate the producer while TC reflects its minimum price acceptable and r indicates the degree of incentive for the entrepreneur, or the rate of profit.

Returning to our original analysis with two producers where Leyla made an intellectual contribution to the prosperity of community, the market price of the product X after the technological change would be determined partly by the cost of production and partly by the magnitude of demand which depends on tastes, purchasing power and prices of competitors.

Case-1: Assume that the initial supply conditions prevail, i.e., production costs (TC) comprise of LWC only. In other words, Leyla produces 4 units of X at the price of 3 ($p^x_t=3$) and Maria produces 2 units of Y at price 6 ($p^y_t=6$). Given the tastes, income and consumption pattern, the value of consumption (C_t) would be for Leyla and Maria, respectively, as follows;

$$C^L_t = 1Y + 2X = p^y_t * q^y_t + p_x * q_x = 6*1 + 3*2 = \mathbf{12 \text{ TL}}$$

$$C^M_t = 1Y + 2X = p^y_t * q^y_t + p_x * q_x = 6*1 + 3*2 = \mathbf{12 \text{ TL}}$$

And total value of income (TR_t):

$$TR_t = C^{L+M}_t = C^L_t + C^M_t = \mathbf{24 \text{ TL}}$$

Assume further that after Leyla doubles her productivity after the introduction of new technology. Given demand, the total value of disposable incomes for our respective members (R^L and R^M) would look like as follows;

$$R^L_{t+1} > R^L_t \quad \text{while} \quad R^M_{t+1} = R^M_t$$

because

$$R^L_{t+1} = p_{x+1} * q_{x+1} = 3 * 8 = \mathbf{24 \text{ TL}}$$

$$R^M_{t+1} = p^y_{t+1} * q^y_{t+1} = 6 * 2 = \mathbf{12 \text{ TL}}$$

Community's new total income level is;

$$\mathbf{TR}_{t+1} = \mathbf{R}_{t+1}^L + \mathbf{R}_{t+1}^M = 24 + 12 = \mathbf{36 TL} \quad ; \quad \mathbf{TR}_{t+1} > \mathbf{TR}_t$$

In other words, the community is now richer due to productivity growth, but Leyla is twice richer, given demand.

Looking at the situation from the point of value-added (\mathbf{VA}), since there are no costs other than \mathbf{LWC} , the aggregate value added (\mathbf{VA}^{L+M}) equals the total revenue (\mathbf{TR}) or labor wage costs, i.e., ($\mathbf{VA}^{L+M} = \mathbf{TR} = \mathbf{LWC}^{L+M}$), while there are no profits ($\pi=0$):

$$\mathbf{VA}^{L+M}_{t+1} = \mathbf{LWC}^{L+M}_{t+1} + \pi^{L+M}_{t+1} = 36 + 0 = 36$$

Case-2: Assume that the new technology (\mathbf{A}) reduces the labor time necessary by 50 percent for the supply of \mathbf{X} thus reducing the labor cost of production (\mathbf{LWC}^L_{t+1}) and the price by 50 percent ($\mathbf{p}^x_{t+1}=1.5$), while all supply is being consumed within the same community, e.g., no external markets. The new value of individual and total incomes would look like as follows:

$$\mathbf{R}^L_{t+1} = \mathbf{1Y} + \mathbf{4X} = \mathbf{p}^y_{t+1} * \mathbf{q}^y_{t+1} + \mathbf{p}^x_{t+1} * \mathbf{q}^x_{t+1} = 6*1 + 1.5*4 = \mathbf{12 TL}$$

$$\mathbf{R}^M_{t+1} = \mathbf{1Y} + \mathbf{4X} = \mathbf{p}^y_{t+1} * \mathbf{q}^y_{t+1} + \mathbf{p}^x_{t+1} * \mathbf{q}^x_{t+1} = 6*1 + 1.5*4 = \mathbf{12 TL}$$

And total revenue or consumption:

$$\mathbf{TR}_{t+1} = \mathbf{R}^{L,M}_{t+1} = \mathbf{R}^L_{t+1} + \mathbf{R}^M_{t+1} = \mathbf{24 TL}$$

This “egalitarian” outcome with regard to Classical approach fails to award Leyla for her intellectual contribution and does certainly not reflect the real world with actual transactions. What really likely to occur is that the price of \mathbf{X} would be settled somewhere between the initial price (3 TL) and breakeven price of production, depending on the magnitude of demand. Thus, not only Leyla, the technology producer, but also Maria, thereby the entire community would benefit from Leyla’s contribution.

In terms of value added, there would be no change after the introduction of technology, i.e.,

$$\mathbf{VA}^{L+M}_{t+1} = \mathbf{VA}^{L+M}_t = \mathbf{TR}_t = \mathbf{LWC}_t$$

New Technology and "Productivity Growth"

New Products And New Methods of Production

In the preceding parts, Leyla's productive knowledge, the new technology, had doubled her productivity of the product-**X**. She now produces 8 units of **X** compared to 4 units before. Community as a whole as well as Leyla herself enjoyed greater wealth both in terms of quantity and value. When costs are introduced into the analysis of simple model, new technology would normally be expected to reduce costs per unit output or, alternatively, increase the value added per unit monetary capital advanced which implies increased wealth produced.

However, there is a limit to increase the wealth (growth) of communities unless new products are introduced. **It is the new products**, e.g., new commodities and services, that actually **give occasion to the rising living standards (growth)**, in the long run. New products usually come along with new production methods that imply new investment and employment opportunities. In other words, growth in **GDP** due to new products (macro productivity, Gürak,2000) increases the variety of consumption goods and services, induce more investments thus increase the employment and income levels of communities.

For the sake of simplicity, assume that new products introduced are always accompanied by new production methods. How would the increase in the output of new products by new production methods would effect the wealth of a community ?

We shall not bother with relative prices any more simply because analysis based on relative prices do not accurately reflect nor account for the actual transactions.

Quantitative "Macro" Growth

Our community consisting of two members, Leyla and Maria, were producing 8 units of **X** and 2 units of **Y**, respectively, after the introduction of technological change advanced by Leyla. Together, they have now;

$$Q_i = q^L_1 + q^M_2 = 8X + 2Y \quad ; \quad i = 1,2$$

Assume that now Maria, utilizing her intellectual labor and rearranging the natural endowments, produces an all new product, say q^M_3 (6 units of **W**). The new total supply, i.e., wealth, would increase by six units of **W** to:

$$Q_i = q^L_1 + q^M_2 + q^M_3 = 8X + 2Y + 6W \quad ; \quad i = 1,2,3$$

The community is enriched by the quantity of q^M_3 . Since there was no previous output of **W** to compare with, one cannot measure the productivity growth in quantitative terms of **W** supplied. All one can say is that there are now entirely new 6 units of **W** products. But in terms of value added, a different picture emerges which also gives us the occasion to make a comparison.

Growth in "Macro" Value Added

Assume $p_x = 3$ TL and $p_y = 6$, before the introduction of Maria's intellectual contribution which introduces a new product (q_3) where $TC^M_t = LWC^M_t$ and the total and individual incomes for Leyla and Maria respectively were;

$$R^L_{t+1} = p_{x,t+1} * q_{x,t+1} = 3*8 = 24 \text{ TL}$$

$$R^M_{t+1} = p_{y,t+1} * q_{y,t+1} = 6*2 = 12 \text{ TL}$$

$$TR_{t+1} = R^L_{t+1} + R^M_{t+1} = 24 + 12 = 36 \text{ TL}$$

$$VA_{t+1} = TR_{t+1} = LWC_{t+1}$$

Maria continues to work 10 hours a day but she is more productive now due to her increased productivity as a result of her intellectual contribution. Say, the new product is sold at price, $p_z = 5$ TL per unit and supplied at the quantity of six ($q_z = 6$ W) and costs consist of LWC only, as in the previous cases. Given demand at the prevailing price level, the total and individual incomes after the technological change would be:

$$R_{t+2}^L = p_{x,t+2} * q_{x,t+2} = 3 * 8 = 24 \text{ TL}$$

$$R_{t+2}^M = p_{y,t+2} * q_{y,t+2} + p_{z,y,t+2} * q_{z,y,t+2} = 6 * 2 + 5 * 6 = 42 \text{ TL}$$

$$TR_{t+2} = R_{t+2}^L + R_{t+2}^M = 24 + 42 = 66 \text{ TL}$$

which implies that the value of output per day worked of Maria has increased from 12 to 42, equivalent to the value of q_z . Since costs comprise of labor inputs only, total value added equals to total revenue, i.e.,

$$VA_{t+1} = TR_{t+1} = 66 \text{ TL}$$

The incremental change in the value added (ΔVA) equals the market value of Maria's intellectual contribution (q_z), given demand of course.

What would change when other costs than LWC are included ?

In the long-run, the prosperity of individuals as well as of the nation as a whole can only be increased through technological changes, e.g., by introducing new products and production methods which are the transformed natural endowments. The transformation process requires both, mental (intellectual) and manual (physical) manpower. But its genesis and incessant source is the former, the intellectual labor. As indicated above, both micro and macro productivity growth is obtained through intellectual contributions of Leyla and Maria, respectively where no other costs than labor input existed. Would the outcome change if other input costs and profits are included, with regard to role of intellectual contribution in growth process? The answer is negative.

Let us examine a case where the following initial conditions for a given product prevails:

$$p_t = 15 \text{ TL}$$

$$TC_t = FC_t + VC_t + OC_t + LWC_t + \pi_t = 50+20+20+30 = 120 \text{ TL}$$

$$q_t = 10$$

$$LWC_t = 30 \text{ TL}$$

$$TR_t = p_t * q_t = 15*10 = 150 \text{ TL}$$

$$\pi_t = TR_t - TC_t = 150 - 120 = 30$$

$$r_t = 25 \text{ percent } (\pi_t / TC_t)$$

$$VA_t = LWC_t + \pi_t = 30*30 = 60 \text{ TL}$$

Further assume that after the intellectual contribution (the new technology) which increases the output from 10 units to 12, ceteris paribus, some initial values would change as follows:

$$q_{t+1} = 12$$

$$TR_{t+1} = p_{t+1} * q_{t+1} = 15*12 = 180 \text{ TL}$$

$$\pi_{t+1} = TR_{t+1} - TC_t = 180 - 120 = 60$$

$$r_{t+1} = 41 \text{ percent } (\pi_{t+1} / TC_{t+1})$$

$$VA_{t+1} = LWC_{t+1} + \pi_{t+1} = 30 + 30 = 60 \text{ TL}$$

where;

$$\pi_{t+1} > \pi_t$$

but also,

$$VA_{t+1} > VA_t$$

due to increased productivity originating from intellectual contribution. The community is richer now (or the cake became larger) but all increase in generated value accrues to the capital owner in form of increased profits, until the new round of negotiations with the labor force. The impact of intellectual contribution was to increase the quantity supplied from 10 to 12, a 20 percent rise. But it could also be to reduce the quantity of inputs demanded for the same quantity of output. Or it could introduce all new products which never existed before. Regardless of its kind, the technological change and economic growth originates from the same human resources which reshape or rearrange the existing natural endowments. **The source of change is the creative intellectual labor.**

Accumulation of Knowledge

Knowledge was defined as a product of human mind, the intellectual labor of Homo Sapiens. Scientific knowledge tells us that the evolution of human brain has been going on for tens of thousands of years. Once upon a time the neo-cortex of brain was much smaller, less developed and less functional. Environmental aspects and evolutionary changes made the human brain much more productive in time. Some day, human beings learned to make use of flints and bones as hunting weapons, the hunter's capital for Ricardo. Making simple tools from nature's gifts like flints and bones to use in hunting or otherwise, in addition to their bare hands, was a giant step forward and clear distinction from the rest of species. The earmark of this distinction was the application of productive knowledge on how to transform (rearrange) natural endowments to make simple tools to meet the basic needs and control the immediate environment in order to make life easier.

There was at that time, certainly, no formal schooling or training, nor written material to pass on the useful knowledge to next generations except the verbal transfer of wisdom of elderly and of more experienced members of the community. Nevertheless, the mankind continued to benefit from the intellectual faculties of mind and kept producing new knowledge that kept improving the conditions of living and productivity. It did take thousands of years to invent and apply rather simple tools for our present standards and they surely were not less important to them as communication is in our age, maybe even more important regarding the living conditions. Once upon a time, the new productive knowledge had certainly no commercial value since man had not yet entered the stage of commercialization yet and not invented the means of property for the output of mind, e.g., the intellectual property rights.

Centuries and millenniums past by and the human brain continued to produce and accumulate more and more new knowledge, not only to enrich the material standards of living but also the standards of spiritual life by introducing poetry, music, painting, etc. In

time, human beings learned how to pass on the accumulated knowledge to next generations in the form of written objects, thus facilitating the further and faster advancement, accumulation and distribution of knowledge. Meanwhile, human beings had also learned to produce products in excess of their immediate needs for exchange with other goods which further helped to increase the total welfare. By the time of industrial revolution mankind had accumulated sufficient productive knowledge, experience and financial resources to start manufacturing commodities for exchange only. The intellectual contributions of brain accelerated the productivity growth and the transition to a money economy with enhanced property rights. In our era, not only tangible objects like land and material things, but also the productive knowledge is subject to proprietary ownership.

Nobody, no matter how brilliant his/her mind is, does acquire the knowledge "manna from heaven". The present pool of productive knowledge is accumulated through thousands of years and is a common heritage. In the absence of accumulated productive knowledge, there would be no products to be exchanged. In our era, acquiring the appropriate knowledge for production through schooling and training is very important to sustain as well as to improve the wealth of nations. There is a rather close correlation between knowledgeable labor force and per capita productivity level, for the better and longer education and training improves the productivity of individuals as well as of nations as a whole. If it were possible by magic to move all the production facilities in Germany over one night to Turkey, the total output would diminish both in terms of quality and quantity simply because the Turkish labor force is not as well educated / trained as the German labor force. In other words, the quality of the labor force is a very important aspect in the productivity and prosperity of nations.

However, although necessary, it is not sufficient to have a well-educated labor force. Countries like Russia and Ukraine have more-educated labor force than the US counterpart in terms of hours of education invested (so called human capital). Yet, per capita value-added of a Russian worker is much lower than the US-worker. That is because the institutional and cultural settings in the sense of competitive firms, contemporary

entrepreneurs / managers, government's economic policies, technical-financial and legal infrastructure, are all rather important factors for the efficient functioning and success of the system as a whole. Education/training of the appropriate labor force is a long process, but the development of an appropriate institutional and / or cultural environment might take even longer and be more troublesome.

Some Ethical Remarks and Questions

In our simple community with two producers, Leyla's contribution was a new technology. It was a small step, a tiny drop in the ocean, but the available productive knowledge has been accumulated for tens of thousands of years through such marginal contributions. Now we have access to a grand pool of knowledge to drain off which is, in fact, a common heritage of mankind. The existing knowledge is being further developed by the creative contributions of inventors who are educated by the existing knowledge and public resources. In a sense, every new productive knowledge is never an entirely new one being created exclusively by some person(s) or firm from scratch, but a marginal contribution.

Under such circumstances, if some persons or firm acquire patent for a new technology, to what extent should be the exclusiveness of patent rights? To what extent the new ideas would or should belong to individual marginal contributor(s)? And to extent is the present society entitled to new patented knowledge as the provider of proper education, skills and (scientific-technical) environment? And finally, to what extent are the past contributors to the grand pool of knowledge entitled to rights in the patented product?

CONCLUDING REMARKS:

The simple model of growth suggests clearly that the **productive knowledge** (technology), which is the mental product of mind (the intellectual labor), is **the genesis** as well as the **eternal source** of all man generated prosperity, e.g., **value generation and growth**. The initial inputs of production are the natural endowments and the labor of man while the latter consists of both mental and manual components. In all societies, all the inputs and outputs of production are, in principle, of the same origin; labor and (transformed-rearranged) natural endowments. The only difference is that men have now access to a tremendous amount of means of production (transformed natural endowments) embodying accumulated productive knowledge to assist the labor of man in production. In other words, there is more productive knowledge, more means of production and more products to

consume, but no less or more natural endowments. They neither increase nor decrease in quantity but only change shape by human labor. Judging from this angle, there is no distinction in substance between **the means of production** (capital goods) and **consumer goods**; both are **transformed natural products embodying productive knowledge**.

Technological change is the key word for long-run economic growth. But, one should not confuse the improvement of skills and abilities of the labor force through training, education, on-the-job learning with the advances in technology. Improved quality of human resources is a necessary condition, especially in the developing countries, to climb the ladders of development and to produce the contemporary commodities and services. Increasing productivity by improving the skills of human resources does not require any technological changes, though it might pave the way for it. But, **for technological change and long run growth**, the contribution of **creative intellectual labor is imperative**.

To conclude, given the natural endowments and the level of existing knowledge, the **creative mind of the labor force (intellectual labor)**, is the **only value-producing source** of all past, present and future prosperity **in the long-run**. To put it in William Petty's words;

"... labor is the father of (material) wealth, the earth is its mother."
(in Marx, Vol. I, pp.133-134)

or; as Marshall indicated;

"In a sense there are only two agents of production, nature and man."
(Marshall, 1990, p.116)

Final remark: The global prosperity of mankind depends on the same source;

the producer as well as the user of productive knowledge, that is the

knowledgeable & creative human resources.....

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¹ Technological progress, though necessary, is not alone sufficient to secure economic progress. Existence of **globally competitive firms and appropriate institutional-cultural environment**, i.e., economic policy pursued by the governments, the cultural and social business environment, appropriate technical and financial infrastructure, globally oriented business strategies of firms, patent rights system, play an important role in the efficient operation of the system.