

Creative Mental Labor & Technological Innovations¹

The genesis & the engine of prosperity of nations

By H. Gürak

www.hasmendi.net

hasmendi@gmail.com

Abstract

The relations between the riches of nations and the riches of **Productive Knowledge (Technology)** gains increasing acknowledgment among economists. Classical economists had assumed that the key to progress was the accumulation of homogenous capital goods. But, as P. Romer, among others, claims we cannot grow rich by accumulating more of the same capital goods. So the Classical growth theory falls short of expectations.

Capitalism's inherent feature is "**destructive creation**", said Marx. Decades later, in a similar fashion, Schumpeter stated that "**Capitalist system incessantly revolutionizes the economic structure FROM WITHIN**".

What are those dynamic forces causing the incessant changes in an economy?

According to P. Drucker, A. Toffler, Baumol-McLennan and many others it is the productivity increases (growth) in general. P. Romer provides a more specific reply: technological change or the growth of new ideas. This paper goes deeper to the core and claims that all technological changes are produced by the intellectual labor of human mind. In other words, knowledge on production, i.e., technology or productive knowledge provides the premises and gives occasion to a dynamic and uninterrupted growth process, but technology itself is **the product of mental labor**.

There is practically no limit to growth in the long-run since there is no limit to human creativity. The **creative intellectual human labor** is capable of incessantly introducing new technologies, which transform (rearrange) the natural resources into so called capital and consumer goods. As long as human intellectual labor can produce new ideas, the growth will be assured and sustained, as well as, quite likely, cyclical.

The paper is "**not**" aimed for **pure academic discussions**, but to account for actual transactions, based on the intellectual labor (creativity) of human mind.

April - 2000

¹ This part composes of two articles published in YK-Economic Review, in Dec-199, Vol.10, No.2; and YK-Economic Review, June-2000, Vol.11, No.1

"Knowledge is the most powerful engine of production; it enables us to subdue Nature and satisfy our wants."

Alfred Marshall

Introduction

How an economy grows has always been a fascinating subject for the economists. For decades and for centuries numerous attempts have been made to identify the determinant(s) of growth by many able minded scholars like A. Smith, Marx, Solow and many others to find universally applicable explanations to the subject. Smith's analysis on the division of labor and correlated productivity increase, Ricardo's remarks that the primitive hunter's capital good (the weapon) was a product of labor and Marx' comments that capitalism's internal forces enforces constant technological changes were all steps in this direction. But eventually, the determinants of growth were reduced to capital accumulation and population growth by the Neoclassical school for decades to follow.

For along time, textbooks on economic growth influenced by the Neoclassical doctrine used to tell that growth process was influenced by factors;

- 1- Endogenous factor (investments),.
- 2- Exogenous factor (population growth).

The endogenous factor was assumed to bring the economy eventually to a stationary equilibrium as the Neoclassical growth models predicted. Once in equilibrium, the only factor causing growth would be the exogenous ones. The model was quite logical and consistent but at the same time, unfortunately, rather short of realistic substance for, among others, it failed to embody the technological change as an endogenous factor of growth.

Contemporary theories of growth seem to have focused on two central questions:

- Why do economies grow in the long-run?
- Why do economies grow at different rates?

The former prerequisites the objective and scientific study of the nature of growth, e.g. globally valid sources and determinants of growth, while the latter puts emphasis on the comparative analysis of different growth rates and their determinants, with due regard to historical developments, institutional/cultural infrastructure and present economic policies..

Which one is the right question to start with? The immediate and intuitive reply would be that both are important in the study of growth process, though the former seems to deserve more credit. But before attempting to answer the questions, we need to have knowledge about the initial source of long-run growth process, i.e. **the genesis of growth**. In other words, we have to have some knowledge about the initial stage of growth, before going into long-run growth analysis.

Do we have a logical and consistent theory of growth with appropriate explanatory power about its genesis, capable of accounting both the causes and the consequences of real world transactions? Unfortunately, the reply is negative.

Purpose of study

The central theme of this paper is about the **Genesis of Growth**? While making an attempt to analyze and explain the nature of the initial determinant(s) of growth, it will be inevitable to take up the issue of **Genesis of Value Generation**, as both take place simultaneously. In other words, this paper shall make an attempt to present a coherent, consistent, logical and, at the same time, a realistic account of **value generation and long-run growth**.

The central hypothesis is that all economic progress (or growth or improved living standards/wealth) is based on technological change as Marx, Schumpeter and many others would agree. But the distinctive claim would be that the origin of all technological change is the "productive knowledge" or synonymously "knowledge on production" which is the "**product of creative human mind**", i.e., "intellectual labor".

Thus, technological change originating from creative human mind (intellectual labor) has always been the source of all economic growth and value generation in past and present and will continue to be so in the future. In other words, the genesis and the engine of all-new products and new production methods is the creative knowledge of human beings, given, of course, the natural endowments, existing level of knowledge and institutional/cultural settings.

The Plan of Study

Before attempting to present a simple model of value generation and the genesis of growth, some key concepts like knowledge, science and technology will be discussed. Then, a brief review of economic ideas on growth and technology will follow. And finally, a simple model based on productive knowledge, i.e., technology, to account for the genesis of value generation and growth will be presented.

Knowledge - Science & Technology

Ideas can only be understood correctly if right definitions and expressions are used to explain them. Therefore, there seems to be a need urging us to define the key concepts like knowledge, science and technology to avoid any misunderstanding arising from divergent interpretations.

Knowledge

According to Peter Drucker and many others, the most important input of production is "**knowledge**". But what kind of knowledge is implied? Does it imply general knowledge on history, geography, literature, etc., or some specific knowledge related to the production, i.e., **technology**? Certainly Drucker refers to the latter though it is not stated explicitly. A more appropriate account of its substance would avoid confusion and the correlation between this specific kind of knowledge and the productivity growth highly praised by A. Toffler, P. Drucker, R. Lucas, P. Romer and many others, would be better evaluated.

Knowledge can be defined as a set of expressions based on facts, skills and understanding acquired through education, observation, experiments and experience. In other words, it is an intellectual product of creative human mind (brain) and being produced incessantly.

There is a distinction between information and knowledge. But often people use information as if synonymous to knowledge. **Information** seeks answers to questions of descriptive nature like what color is the sky? Where does the President live? Or what is on TV tonight? It is normally acquired by means of media or acquaintance or awareness or association. Information as such does not directly contribute to the explanation of facts and incidents or increase the prosperity of individuals or nations but might influence the receptive and the creative capacity of human mind, indirectly.

Knowledge can be divided into two categories;

- 1- Scientific knowledge; and
- 2- Productive knowledge (knowledge on production or technology).

Science or scientific knowledge

Science can be defined as **the pool of explanatory knowledge** to better understand and control the environment we are living in, often providing the commercial interests with essential ingredients to invent and/or to innovate/develop new products and production processes. It aims to discover the unknown truth behind facts and phenomena such as whether there is life in other planets or the evolution of certain species. There are some similarities but no clear distinctions between the concept of science and technology, except the distinctive profit motive of the latter. In general, science seems to deal mainly with the acquisition of knowledge as such while technology is oriented towards reshaping and controlling the environment to improve living standards. The contribution of scientific research to technological knowledge and, in some cases vice versa, is indisputable. **"Science without the by-play of technology becomes sterile while technology without science becomes moribund."** (Jones,1971,p.6)

Productive Knowledge (Technology)

In this study, we will define **technology, the productive knowledge**, as the set of specific knowledge to produce commodities or to render services responding to practical needs and wants of the community. A more concise definition would be: it is **knowledge applied to resources through human labor**. As an UNCTAD study postulates: **"Technology is the key to the progress of mankind and that all peoples have the right to benefit from the advances and developments in science and technology."** (UNCTAD,1983,p.1).

Technology does not only assist us to satisfy our material expectations but also increase our control over the environment in which we live. By combining productive skills and knowledge with natural inputs, it contributes to improve the quality and the standard of living of mankind.

Technology is usually produced by people trained in disciplines oriented to commercial exploitation sponsored by the commercial interests. The findings are most likely to be patented as both the researcher(s) and the sponsor(s) expect material rewards from its application. However, it is not always fully utilized for the benefit of mankind. Especially in developing countries various

factors are responsible for the limited utilization of even available standard technologies. (Gürak,1990)

Technological changes are normally characterized by three phases all of each can be rather costly as well as resource and time consuming, which are:

- 1- Research phase,
- 2- Invention phase, and
- 3- Innovation (development) phase.

The innovation process is usually a more time and resource consuming process than the initial research and invention phases. The innovation (development) of an invention is inherently a risky process. The longer it takes for development, the higher would be the costs and risk. Technical and commercial circumstances are the major determinants of development process. The data on the past technological expenditure indicate that all major breakthroughs have consumed enormous human and financial resources as well as time. The most important innovations follow inventions with some years' time lag. The time lag seems to be shorter for consumer goods than for methods of production.

Technology being the "**key to the progress of mankind**" is expected to pave the way to economic development and narrow the gap between the developed and developing countries. Not only in our present era, but also throughout the entire history of mankind the productive knowledge has been the key to growth process through productivity increases. It has always been the true source of improving the standards of living even in pre-commercial societies where barter trade was the common means of exchange or even in primitive hunting communities.

But there is something more important than the knowledge on production itself; the source of it; **the creative intellectual labor of human beings** who not only produce the "productive knowledge" but also apply it to specific areas to supply various commodities and services. Assume a grand pool of productive knowledge but no appropriate human resources to make use of it. Who would produce all the tangible as well as intangible output? And more importantly, who would add to this pool of existing knowledge any more? Therefore, it would be more appropriate to say, given the existing level of knowledge, institutional/cultural environment and natural resources, that the most important input of production throughout the history has been the able minded human resources, i.e., **knowledgeable and creative human resources**, or in the Neoclassical jargon, the "Human Capital".

By the way, why is it called Human Capital? Why not "**Intellectual Labor**" or "**Mental Labor**"? Could it be because of ideological clashes, a heritage from the Cold War Era?

A Brief Historical Review

Nowadays, a growing number of economists acknowledge the contribution of productive knowledge and pay more attention to it. But what was the role of technology or mental labor in the past economic analysis?

Classical economists were aware of the vital importance of both, mental labor and technological change. But, they were mainly interested on issues like value, exchange, wages, prices, profit rate, interest rate, accumulation and foreign trade. They, in general, had assumed that by accumulating more of the means of production, i.e., homogenous capital goods, a nation would become richer. **The keyword of growth was accumulation.** Highly praised free international trade was assumed to expand the markets in addition to the domestic ones, thus facilitating further investments and growth. But, by now we know, a nation cannot grow rich simply by accumulating more and more pieces of the same physical capital goods.

Now, let us see what some prominent economists had to say about economic growth in the past.

Smith

Smith (1976) had implanted the seeds of productivity growth into the economic theory by pointing out to the importance of division of labor in the creation of wealth of nations:

"The greatest improvement in the productivity powers of labor and the greater part of the skill, dexterity and judgment with which it is any where directed, or applied, seem to have been", he said, "the effects of the division of labor." (Smith,1976,Vol.I,p.13)

But according to this definition, productivity increase was a result of the division of labor only. Technological change could, at best, follow the division of labor to adjust the production process to new conditions. Surprisingly, to Smith, the division of labor was; **"not originally the effect of any human wisdom."** (Smith; 1976; Vol.I; p.25) It was entrepreneurs' drive for profits that are increased the productivity through the division of labor that gave occasion to technological change.

Ricardo

Ricardo's studies emphasized, like his contemporaries, issues like value-generation, exchange, rent, profit rate, wage rate, accumulation and foreign trade. In the analysis of value generation and exchange, he was directly referring to the correlation between hunter's (technology embodying) capital goods and increased value generation (growth). First of all, the capital-good of hunter is a product of mental labor, embodying knowledge in physical shape. And, secondly, if the value generated is an addition to the available one, it implies growth. In Ricardo's words:

"Without some weapon, neither the beaver nor the unit of Y could be destroyed, and therefore the value of these animals would be regulated, not solely by the time and labor necessary to their destruction, but also by the time and labor necessary for providing the hunter's capital, the weapon, by the aid of which their destruction was effected."

(Ricardo,1990,p.23)

In fact, hunter's capital good, the weapon, was a product of hunter's intellectual labor, which simply had combined his intellectual and physical labor to rearrange the nature's endowment. The result was the supply of his capital good that eventually increased his productivity. But, Ricardo seems to have failed to see this impact of mental labor and technological innovations or, probably, he overlooked these features for his concentration on "other" more important issues to him.

According to Ricardo, there was increasing returns in dynamic industrial sector due to constant technological innovations, but decreasing returns in "static" agricultural sector. Overall, he assumed, decreasing returns would be valid for entire economy and the growth process would come to an end due to falling profit rates.

Marx

Marxist School, on the other hand, was preoccupied with the demonstration and proof of the doctrine's major claims like creation of surplus value, exploitation, decreasing rate of profits, imperialism. Marx had pointed out to an important and inherent feature of capitalism, "**creative destruction**" of the system. Capitalist in fierce competition was under the constant pressure to find and introduce new technologies. This was the system's progressive but at the same time destructive part. Unfortunately Marx referred to technological change just to display how the exploitation rate (surplus value)

is increased. Marx and the Marxists seem to have overlooked or missed or undermined this inherent feature of capitalism, the creative destruction. If due attention were paid to the incessant technological changes, they probably would have discovered the essential role of technological change long time ago and found out why the profit rates were not declining.

Marshall

Marshall was one of the prominent scholars to point out specifically to the importance of knowledge in economic relations. Decades ago he stated that:

"Knowledge is our most powerful engine of production." (Marshall,1990,p.115) "In a sense", he continued, "... there are only two agents of production, nature and man. Capital and organization are the result of the work of man aided by nature."

(Marshall,1990,p.116)

But, unfortunately, he did not attempt to incorporate knowledge into a growth theory, either.

Keynes

To Keynes, economic growth was a matter of effective demand and investments (accumulation). The emphasis of the analysis was on equilibrium with unemployment and its restoration to full employment equilibrium. As output grew, it was assumed, further division of labor would increase productivity. Due to this assumed correlation between the effective demand and growth, the role of technological change could not get the proper attention it deserved.

Schumpeter

Decades ago Schumpeter, in a similar fashion to some Classical economists, especially to Marx, pointed out that:

"Capitalism ... is by nature a form or method of economic change and not only never is but never can be stationary." (1970,p.82)

and re-emphasized that the capitalist system;

"... incessantly revolutionizes the economic structure FROM WITHIN, incessantly destroying the old one, incessantly creating a new one. This process of creative destruction is the essential fact about capitalism."

(1970,p.83)

The result is a system of continuous disequilibria as change succeeds change in an uninterrupted fashion. The incessant revolution from within came, of course, through technological changes that implied new consumer goods as well as new methods of production. But Schumpeter, like Marshall, did make no attempt to incorporate technological change, the capitalist engine in motion, into a growth model.

Changing Trends in 1950s

Ignorance of technological impacts began to change with the contributions of scholars like Abramowitz, Denison, Solow, Schultz, Becker and many others who focused emphasis on the technological change and intellectual labor, human capital in Neoclassical jargon.

In a study on the growth of USA, Solow had found that growth was caused basically due to technological change, rather than increased capital and/or labor. His conclusions attracted more and more research on the role of technological change and consolidated its role in the economic analysis. Yet, technological change had remained, for some time to follow, as an **exogenous** factor of growth, coming like manna from heaven. As a result, the equilibrium model was not disturbed but the economic analysis was not enriched, either.

Paul Romer

This unrealistic approach to the role of technology was, at last, abandoned by another prominent scholar of the Neoclassical heritage, Paul Romer, whose contribution (1990) was characterized by **endogenous technological change**, "**the engine of growth**". To reflect its divergence from the mainstream, it was labeled as "**Endogenous Growth Theory**". The model emphasized knowledge by placing it in the center of his analysis. His endogenous growth approach has brought a new and fresh breath and dimensions to the discussions on growth theory. But it contained some serious shortages as well. One of them was that though new technology meant new idea or new design, produced by human capital, he overlooked the fact that the concept human capital refers to the qualities of labor (L). In other words, human capital and labor are not two distinct factors of production and the knowledge produced by L is embodied in the capital-goods and consumer-goods produced.

Increased Productivity (Growth)

Having elaborated the concept "knowledge" and "knowledge on production", it will be appropriate to proceed with a related and rather important concept for our analysis, "increased productivity". It has always been the source of increased economic welfare though the word in the present context of meaning could not even be found in the lexicons until five six decades ago. According to a widely used description, the concept productivity refers to the relation between output and the inputs of production. This is an unsatisfactory and misleading description of productivity. It would be more realistic and appropriate approach to treat productivity as "**ability to produce value added (wage and profit)**". Productivity growth, on the other hand, refers to a dynamic process, being synonym with growth.

In the long-run, productivity growth is always due to **new technologies**² also referred to as "**technological- or macro- productivity**". Given the technology, productivity can also be increased by various measures like improved education/training, reallocation of resources, reorganization of production, etc. in the short or medium term, which will be referred to as "micro" productivity. Thus, the decisive distinction between macro and micro productivity is the former requires "new" technologies while the latter is realized with "given" technologies. According to this classification, "resource efficiency" which indicates the utilization degree of given human-physical and natural resources (items 4-10 on Table-3) and "economic efficiency" are treated as "micro" productivity changes (see Table:1). In the absence of new technologies, micro productivity growth would reach its limits in time and economy would enter a "stationary" stage with no growth at all. Therefore, macro productivity growth is rather critical and important concept for long-run prosperity growth. Every incremental increase in productivity implies increased value-generation (value-added) with regard to inputs thus ever rising incomes and profits.

² New technologies can be classified in two groups:

- 1- "**New method of production**" for "**given**" product; or
- 2- "**New method of production**" and/or "**new**" product.

In the former case, new technology may:

- a- increase output for the same input;
- b- increase output at a faster rate than increase in inputs;
- c- increase output while inputs decline; or
- d- produce the same output while inputs decline.

Table:1 Micro and Macro Productivity and Profitability

			Technology
Macro (technological) productivity	Monetary or Quantitative	TR / TC Q^s / Q^i *	New
Micro productivity Economic efficiency	Monetary	TR/TC	Given
Profit rate**	Monetary	π / K	Given or Variable

* Q^s : quantity supplied ; Q^i quantity of inputs; TR: total revenue; TC: total cost

** Profit rate = Profit / Capital Employed. Profits are maximized at max economic and resource efficiency.

Thanks to the incessant macro productivity growth, the mankind has been able to consume ever more as well as better quality products ranging from manufactured goods to services and enjoy decreasing production costs per unit of output. In the absence of macro productivity growth, the magnitude of consumption would still be at primitive subsistence or survival levels, as it is in the animal world. Nowadays the concept productivity growth has a rather wide range of applicability from **tangible goods** like mining, manufacturing and agriculture to **intangible service** sector activities like health care, tourism, banking, etc.

With the introduction of a new technology, the producer expects to realize higher profit rate than before. If the new technology is to produce a given product with a new production method, then unit costs are highly likely to decrease and raise the rate of profit (r). If the new technology introduces new products, then the "expected" profit rate is higher than the average rate for sector. Otherwise, there would be no incentives to develop and introduce new technologies (see Table:2).

From the point of view of profit driven firms, the size or the rate of **VA** to costs is not as important as the rate (r) and size of profits (π). But for the nation as a whole the aggregate value added (**GDP**) has more significance for it consists of wages (w), profits (π) and interest (i). The higher the **GDP** the greater will be the per capita income of the nation and thus the purchasing power per capita, cet. par.

When output is measured with regard to all inputs, it is called "Total Factor Productivity" (**TFP**) (Value-added / Labor inputs + other inputs), which is not the same with Solow's **TFP**. If the productivity ratio is acquired against the use of one or more inputs, it is referred to as "Partial Factor Productivity"

(PFP). The most common denominators used in PFP analysis are the labor input, i.e., labor productivity per hour or day (LP) (Value-added / Labor inputs) and "Labor Wage Productivity" (LWP) (Value-added / Labor inputs * Wage rate).

Quantity vs. Value Approach

There are two ways to measure productivity and productivity growth. The quantitative approach displays some disadvantages with regard to the estimation of productivity growth. For instance, a given amount of output may require less unit of energy (E) compared to the previous production period ($E_{t+1} < E_t$). Though the quantity supplied has not changed ($Q_{t+1} = Q_t$) there would be no estimation problem of the productivity increase with regard to energy input ($Q_{t+1}/E_{t+1} > Q_t / E_t$). The same would apply if energy input was substituted by a unit labor input. But how to measure the quantitative productivity change with regard to two or more variable inputs, say, energy and labor?

Technological productivity analysis, on the other hand, take into consideration "new" products and/production methods. Since they are new, there is nothing to compare or measure technological productivity accurately. For it implies increases in the variety of goods and services supplied within a country. When Drucker (1995) pointed out that productivity, rising at 3-4 percent annually, lied at the foundations of all improvements in the standards of living; he actually was referring to macro economic changes. As a result of continuous and successive productivity increases, i.e., technological changes, there are now ever more commodities and services, supplied with much less labor and/or other inputs than a century or a decade or even a year ago. **"Output per hour worked in the US today is 10 times as valuable as output per hour worked 100 years ago."** (Romer;1990).

How to Increase Productivity?

Productivity can be increased through various measures and 10 of them are shown on Table: 3. Rows 1 and 2 require **new technologies** to increase the productivity. Row 3 indicates a unique situation; the transferred technology is a "known" one for the technology owner or seller, but implies a "new" technology for the buyer. But the rest from 4 to 10 indicate that productivity rise can be achieved even without introducing new technologies. In all 10 cases the rate of profit is expected to rise as a result of productivity growth, cet. par. In Row-2, normally there would be no previous data to compare with. But all the variables would be expected to move in the directions of arrows. But

sometimes, firms may introduce new technologies for defensive purposes to survive competition.

Aggregate Value Added or synonymously the Gross Domestic Product at Factor Prices (**GDP**) indicates the sum of all value added within a country. It is a rather useful criterion for comparative analysis of aggregate productivity, (**GDP / Per employee**), which is also referred to as "**National Economic Productivity (NEP)**" or alternatively, of aggregate welfare (**GDP / Per capita**) which is also called "**National Economic Welfare (NEW)**". Yet, these terms ought to be implemented carefully. For instance, as far as **NEP** is concerned, estimation of productivity not infrequently refers to the sectors with **tangible** outputs only like mining, manufacturing and agriculture. But the **GDP** normally includes all kind activities, including the **intangible** service sector activities.

Comparison of per capita **GDP** is a frequently applied criterion in comparative analysis. But it has its shortcomings as well. For instance, domestic prices in Developing Countries do not always reflect their actual values in terms of purchasing power. Therefore, a purchasing power parity criterion might offer better premises for comparative studies.

Table:2 Impacts of a New Production Method

Type of technological change	K-saving per unit q	Impact on Output	VA	Q / L	LWP	r	π / VA	W / VA
Labor saving	Yes	$q_{t+1} = q_t$	↑	↑	↑	↑	↑	↓
X_i saving (exc. L)	Yes	$q_{t+1} = q_t$	↑	The same	↑	↑	↑	↓
Q increasing	Yes	$q_{t+1} > q_t$	↑	↑	↑	↑	↑	↓
L & X_i saving while Q increasing.	Yes	$q_{t+1} > q_t$	↑	↑	↑	↑	↑	↓

- Prices (p), wage rate (w) and interest rate (i) constant
- Wage Bill ($W=w*L$)
- X_i = Inputs (excl. L) $i = 1,2,\dots,n$
- $TFP = VA / K$ (incl. L)
- $PFP = VA / X_i * p_i$ (excl. L)
- $K = p_i X_i + wL$ (Capital advanced)
- $VA = w*L + \pi$ (incl. Interest rate cost)
- $r = \pi / K$

Table: 3 10 Different Ways to Increase the Productivity ^a

	New technology	Type of change	VA/K	VA/L	r	π/VA	W^b/VA
1	Yes	New Method of Production but given product	↑	↑	↑	↑	↓
2	Yes	New Product & Prod. Method	* ↑	* ↑	* ↑	* ↑	* ↓
3	No	Transfer of Technology	↑	↑	↑	↑	↓
4	No	Reorganization	↑	↑	↑	↑	↓
5	No	Increased Capacity Util.	↑	↑	↑	↑	↓
6	No	Shift-work	↑	↑	↑	↑	↓
7	No	Reallocation	↑	↑	↑	↑	↓
8	No	Gen. Education & Training	↑	↑	↑	↑	↓
9	No	On-the-job Training	↑	↑	↑	↑	↓
10	No	Improved Health-Safety	↑	↑	↑	↑	↓

a Prices (p), wage rate (w) and interest rate (i) constant

b Wage Bill ($W=w*L$)

* There is no previous data to compare with. But expectations of the entrepreneurs would be in the directions of arrows.

Genesis of Productivity Growth

If productivity growth, whether it be at micro or macro level, is the source of a nation's increasing standard of living then **what is the genesis of productivity growth?** Since productivity growth does not come manna from heaven, there has to be an economically rational explanation about its origin.

New knowledge or new technologies are always **the products of human mind**. The productivity of mind is directly associated with the available pool of accumulated knowledge, education-training, individual talents-experience, scientific-technological infrastructure, institutional setting and economic policies applied.

Need a Value-Price Theory Embodying Productive Knowledge?

Once, advances in productive knowledge (technology) is acknowledged as the origin of all value and wealth accumulated, a related and critical question pump up; **what is the role of productive knowledge in the value-price theory?**

After having criticized the economic theories for their inadequacy to explain the actual economies, Drucker claims that none of the great non-Marxist economists of the last 100 years like Marshall, Schumpeter and 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)

The economic science still lacks an **"acknowledged"** economic theory of value and price based on productive knowledge, e.g., technological change. Price is the most important impulse and regulator of the market system as a whole. The intensity and the magnitude of demand, supply strategy of the firms, efficient allocations 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. Value-price theory needs to be urgently reconstructed incorporating productive knowledge as well as mental labor.

The following part will be an attempt to introduce an alternative growth model. The main assertion is that: 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 mental labor is the genesis 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 are 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 nor education/training yet. Assume that initially Leyla and Maria produce **X** and **Y** goods, respectively, , in a working day consisting of 10 hours, in quantities stated below;

4 units of **X** and 2 units of **Y**

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' work.

Where 1 unit of **Y** is exchanged for 2 units of **X**, i.e.,

$$1 Y = 2 X$$

The exchange rate seems to be 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"

Given Product but New Method of Production

a- Quantitative Increase

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 tool developed by Leyla is, nothing but knowledge applied through human labor to transform (rearrange) the natural resource(s).**

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 T), 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 (T^L), the total output (Q) increases;

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

New total supply/a day = $8 X + 2 Y = 20$ hours' total manual work + T^L

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. T which denotes the technological change (productive knowledge), is not identical with the qualities of laborer, 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. The initial total value of output or total income, (TR), would be:

$$TR_t = p_x \cdot q_x + p_y \cdot q_y = 3 \cdot 4 + 6 \cdot 2 = 12 + 12 = 24 \text{ TL}$$

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

$$TR_{t+1} = p_x \cdot q_x + p_y \cdot q_y = 3 \cdot 8 + 6 \cdot 2 = 24 + 12 = 36 \text{ TL}$$

The increase in total revenue (ΔTR) equals the increase of Leyla's income (ΔR^L), which is 12 TL, while Maria's income (R^M) remains unchanged. Community's total income is greater now;

$$TR_{t+1} > TR_t$$

as well as Leyla's income (R^L);

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

while

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

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 income to Leyla's mental 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**, given sufficient demand?

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 Prices:

Case-1:

Following the footsteps of 19th 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 physical labor-power, L^{α} the qualified (educated-trained) labor-power and the total labor force $L = L^{\delta} + L^{\alpha}$

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' $L^{\delta} + L^{\alpha}$

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 mental labor, 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.

Case-2:

Assume that after the introduction of new technology 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.

$$\text{Leyla's consumption} = 1 \text{ unit } Y + 2 \text{ units } X + 2 \text{ units } W = 10 \text{ hours' } L^{\delta} + T^L$$

$$\text{Maria's consumption} = 1 \text{ unit } Y + 2 \text{ units } X = 10 \text{ hours' } L^{\delta}$$

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, like the traditionally less dynamic service sector than industrial sector, in reality.

Assume that only 2 units of X out of 4 surpluses 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.

$$\text{Leyla's consumption} = 1 \text{ unit } Y + 3 \text{ units } X + 1 \text{ unit } W = 10 \text{ hours' } L^{\delta} + \delta T^L$$

$$\text{Maria's consumption} = 1 \text{ unit } Y + 3 \text{ units } X = 10 \text{ hours' } L^{\delta} + \beta T^L$$

δ and β denote parameters for the weights assigned to T .

To put the conclusions differently;

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

This outcome seems to have a closer resemblance to the reality than the prior two cases, for it allows even the less productive sector(s) of the economy (like service sectors) to benefit from the overall development originating from "dynamic" sectors. The outcome of Case-3 is, probably, the most plausible and fairest result from the point of view of social distributive justice.

Exchange with Market 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. 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. To realize 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:

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

Given the optimum utilization of productive capacity and supply- demand stability, excluding the costs of trading and transportation, how a technological innovation would affect price and income with the following hypothetical figures? The main purpose is not to show how single price is determined, but to show the impact of technological change on price and income, *cet. par.*

A hypothetical case:

Assume, once again, 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 ($p^X=3$) and Maria produces 2 units of **Y** at price 6 ($p^Y=6$). Given the tastes, income and consumption pattern, the value of consumption (C_t) would be for Leyla and Maria, respectively, as follows;

$$C_t^L = 1Y + 2X = p_t^Y * q_t^Y + p_x * q_x = 6*1 + 3*2 = 12 \text{ TL}$$

$$C_t^M = 1Y + 2X = p_t^Y * q_t^Y + p_x * q_x = 6*1 + 3*2 = 12 \text{ TL}$$

And total value of income (TR_t):

$$TR_t = C_t^{L+M} = C_t^L + C_t^M = 24 \text{ TL}$$

Case-1: (Given price and product, new production method)

Assume that Leyla doubles her productivity after the introduction of new technology. Given demand from external markets, 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

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

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

Community's new total income level is;

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

In other words, although there has been no change in price, the community is now richer due to technological productivity growth.

Case-2: (Flexible price, new technology)

What happens to terms of trade between Leyla and Maria after technological productivity growth, if Leyla cannot find a third party to trade with at given price level? The terms of trade will have to deteriorate for Leyla, if the market is to be cleared at the end of the day.

Assume that due to new technology, the labor time necessary is reduced by 50 percent for the supply of X , thus reducing the labor cost of production (LWC^L_{t+1}) by half. The new price will have to be reduced by 50 percent, e.g., $p^x_{t+1} = 1.5$, if the market is to be cleared. New incomes would look like as follows:

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

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

And total revenue or consumption:

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

This "egalitarian" outcome with regard to Classical approach fails to award Leyla for her mental contribution properly and does certainly not reflect the real world with actual transactions. What really likely to occur is that the price of X would be settled somewhere between the initial price with 20 percent profit (3 TL) and breakeven price of production, depending on the magnitude of demand.

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**. This sort of growth cannot go on forever. There is a limit to growth 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.**

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

Quantitative "Macro" Growth

Lastly, 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 had:

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

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 impact of productivity growth on the price of **W**. All one can say is that there are now entirely new 6 units of **W** at a given price.

Growth in "Macro" Value Added

Prices before the introduction of Maria's intellectual contribution were $p_x=3$ TL and $p_y=6$ TL. Total and individual incomes for Leyla and Maria respectively were:

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

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

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

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, $p_z = 5 \text{ TL}$ per unit and supplied at the quantity of six ($q_z = 6 \text{ W}$) 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:

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

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

$$TR_{t+2} = R^L_{t+2} + R^M_{t+2} = 24 + 42 = 66 \text{ TL}$$

which implies that the value of output per day by Maria has increased from 12 to 42, equivalent to the value of q_z .

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, to assist pure physical labor, 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, or 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 mental 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 use very simple tools for our present standards. But

surely they were not less important to them, as computers are to us in our age, maybe even more.

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 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 draw 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 being educated by the existing knowledge using public resources. In a sense, new productive knowledge is not an entirely new one created exclusively by some person(s) or firm from scratch. It is a marginal contribution to the accumulated pool of knowledge. No technology emerges as if manna from heaven, except in Solow's model of **re-discovery**.

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

Concluding Remarks:

Given the gifts of nature, the simple model of growth clearly suggests that the **productive knowledge** (technology), which is the mental product of mind (mental 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. In all societies, all the inputs and outputs of production are, in principle, of the same origin; labor and (transformed-rearranged) natural endowments.

The major difference between old and contemporary societies is that we 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.

Technological change is one of the key words for long-run economic growth. The other one is the quality of human resources, especially in the developing countries. The institutional infrastructure, social values, traditions as well as habits in different countries may foster or be impediments to economic growth.

LDC citizens enjoy much less prosperity than the DC citizens due to their much lower per capita productivity level. But, there is a great potential for technological productivity growth with given technologies. That implies that even without any technological change there is a great potential for global economic growth to arise from LDCs for a long time to come. To be more specific, global economy can continue to grow by transferring given technologies to LDCs without abusive clauses. (Gürak;1990). It is also of vital importance to educate/train the labor-force for efficient use of technologies, reorganize-restructure the institutional settings and to pursue appropriate economic policies. Such steps would not only help to reduce disparities among nations but also be cure for many global social and political evils.

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)

The prosperity of mankind has one unique source;

Knowledgeable & creative human beings...

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