

Technological Progress & Growth

"Technological Productivity"¹ and Long-term Growth

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¹ The concept "Technological Productivity" has been analyzed and used in some articles previously published. It refers to increase in productivity due to technological progress, which is the determining force behind the long-term economic growth.

Introduction

The relations between growth, technological progress, productivity and labor(-er) were analyzed in other works (Gürak, 2000-a, 2000-b, 2004-a, 2004-b), according to which inputs of production like labor(-er), capital-goods, intermediaries, raw-materials were regarded as **"factors employed in production"**. There were only **"two productive factors"**; **"nature"** and **"labor(-er)"**, and the latter was assumed to be the only productive factor capable of producing **"exchange-value"** or **"value-added"**. In this analysis, the same assumptions will be valid. Thus, given the necessary supplies of nature for output, the analysis shall focus on the relation between **"technological progress"** and **"economic growth"**.

The labor of human being can be analyzed in two categories;

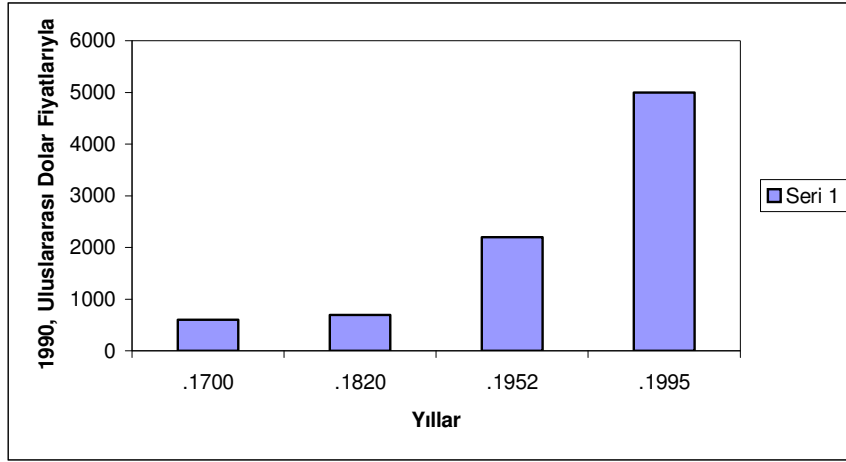
1. mental; and
2. physical;

The physical labor contributes only to a limited extent to value creation, while mental labor, the actual source of value-creation with its creative capabilities, makes indispensable contribution to incessantly growing productivity and welfare. The mental labor makes its **"long-term"** contribution by introducing **"new productive knowledge"** (technologies). The new productive knowledge utilized by mental and physical labor(-er) help to transform the natural supplies to produce either means-of-production to increase labor(-er) productivity or to supply consumption items with utilities.

If mental labor had made no contributions to the ever growing pool of knowledge by incessantly introducing **"new productive knowledge"** (e.g., new technologies), thus increasing the total supply of useful products, the living standards of the human beings would not be any different than hundreds of years ago. Quite likely, the basic behaviors of the human beings would comprise of nourishment, protection, to take shelter, etc. In fact, until about 300 years ago the living standards of human beings were not much different than the living standards in previous centuries (see Figure-1).

"The estimates indicate that per capita GDP in 1700 was rather similar around the world and there were minor differences between USA, China and India. There was nearly no change in the per capita GDP between 1700 and 1820. (Vasquez, 2003, p.90)

Figure: 1 World per capita GDP



Source: A. Maddison, Monitoring the World Economy: 1820-1992;
in Vasquez, I.O (2003), Kapitalizm ve Küresel Refah, p.90, Figure: 5.1.

Since 1700s, the productivity growth and standards of living began to diverge between countries.

“Per capita income doubled in Europe and the USA, in comparison to China, Japan or Russia... Then, the economic expansion in 19 th. Century multiplied the living standards by three times in Europe and four times in the USA.”

(Vasquez;2003;p.90).

Table:1 displays very clearly how the 25 extra-ordinary events in the USA affected the total welfare and qualitative structure of society in 20th century only.

Due to the “new technologies” originating from mental labor, both individual and total welfare increases continuously. In spite of various environmental problems, the mother nature continues to supply the necessary inputs of production, while labor(-er) transforms them into useful products with assistance of technologies. This process will, apparently, continue as long as the creative capabilities of mental labor last.

Table-1 25 Extra-ordinary events in the USA in 20. century

Events	1900-20 ^a	1995-98 ^b
Life expectancy (years)	47	77
Infant mortality (per 1000 birth)	100	7
Deaths from contagious diseases (per 100,000 persons)	700	50
Heart diseases (per 100,000 persons-age-adjusted mortality)	307 (1950)	126
Per capita GDP (1998, US \$)	4,800 \$	31,500 \$
Wages in manufacturing sector (1998, US \$)	3.40 \$	12.50 \$
Assets per household (1998, trillion US \$)	6 \$ (1945)	41 \$
Poverty rate (as % of US households)	40	13
Weekly work-period (hours)	50	35
Agricultural labor force (as % of total labor force)	35	2.5
TV-set ownership (as % of US households)	0	98
House ownership (as % of US households)	46	66
Electrification (as % of US households)	8	99
Phone calls (per capita annual calls)	40	2,300
Transport vehicles (as % of US households)	1	91
Patents granted	25,000	150,000
High school graduation (as % of adults)	22	88
Deaths from accidents (per 100,000 persons)	88	34
Wheat price (worked hours per kilogram)	4.1	0.2
Faculty degrees granted to women (as % of total)	34	55
Income of blacks (annually, per capita, in 1997, US \$)	1,200 \$	12,400 \$
Resident population in the USA (millions)	76	265
Air pollution (microgram lead per 100 m ³ air)	135 (1977)	4
Computer speed (million directives per second)	0.02 (1976)	700
Computer ownership (as % of US households)	1 (1980)	44

a: Values refer to eldest data available.

b: Values refer to newest data available.

Source: Vasquez, I.O (2003), Kapitalizm ve Küresel Refah, s.62, Table 4.1.

Purpose

The purpose of this work is to analyze the interrelation between the rise (growth) in the value-added² (VA) output for exchange and the technological innovations of producers.

The products supplied for personal consumption are beyond the scope of this work. For instance, a value created by cooking at home for personal needs or repairing the broken leg of table is not considered as VA-creation. Eating in a

² Value-added (VA) = wage (w) + profit (π)

restaurant or having the broken table leg fixed by professionals, on the other hand, shall be within the scope of analysis. According to this definition, as the produced **VA** increases both, individual and total riches shall increase. In other words, attempts of firms to increase productivity³ in order to increase the profits, leads to economic growth, *cet. par.*

One of the subjects to be discussed within the concept of long-term increase in productivity (growth) is how the value-added (**VA**), price of product (**p**), rate of profit (**r**) and functional income distribution is affected by **technological innovations**, which are a product of "**mental labor**".

The term products refer to "physical" goods (commodities), as is traditionally done in economic models. Yet, in modern societies, the service sector constitutes a larger share of the *GDP* than the industrial or agricultural sectors and its share is increasing. As the service sector production relations display different features, the impacts of technological innovations on price-formation, **VA**-creation, profit-rate and income distribution shall be studied separately.

Assumptions:

- "fair" competitive environment (does not have to be perfect);
- no shortage of qualified labor(-ers), e.g. human capital;
- no shortage of natural or financial sources;
- contemporary institutional and cultural infrastructure;
- no market interventions;
- optimum level efficiency⁴ (micro-productivity);
- no inflation;
- gross profits contain interest payments;
- total costs contain depreciation costs;
- supply-demand is stable (no shortage or insufficiency of demand).

We shall start with some basic definitions/explanations regarding the concept "productivity" and its measurement. Then, the relations between **mental labor and productivity** will be studied, which is crucial to understand the growth process. Afterwards, the key concepts like "efficiency" and "technological productivity" will be discussed. As technological innovations are the cause of long-run economic growth, the concept "technological productivity" will be studied thoroughly.

³ The concepts like macro and micro productivity will be discussed in following sections.

⁴ Optimum use of human, physical and financial resources, with given the technology..

A concise note on demand:

The role played by demand in growth process is naturally rather significant. However, in the absence of technological innovations introducing "new products", demand for goods/services cannot alone secure long-run growth. Assume that "given product" is produced by a "given technology". In time, as the markets gradually saturate, demand will gradually decline and eventually there will be production for the replacement of depreciated goods, only. In other words, there will be "equilibrium" in markets. Assume that only cost-reducing technological innovations take place and are used in production. The consequence will be the same as in previous case, i.e., as markets saturate, the growth process will gradually decline until equilibrium, given purchasing power. Therefore, in both cases, in the absence of technological innovations introducing "new products", demand will not be a sufficient condition to sustain long-run growth.

In this work, the emphasis will be on revealing the source of long-run growth. Therefore, a thorough analysis of the impact of demand on growth process shall be ignored.

Productivity, productivity growth and measurement⁵

Productivity⁶ (V)

Productivity is a static concept and refers to the relations between "inputs" and "outputs" of production. Therefore, productivity can be described as "**capability to produce**" or rather, within the context of economics, as the "**capability to produce VA**".

The analysis of "productivity" can be carried out from two different angles:

1. quantities; and
2. values.

Quantitative analysis of "productivity":

Quantitative analysis of productivity contains some inconveniences and difficulties. For instance, assuming only one type of output, e.g., homogenous

⁵ For detailed analysis of productivity/productivity growth see Gürak (2004-b)

⁶ Important note: there is a distinction between the concepts "**productivity**" and "**productivity growth**".

product, there would not be serious difficulties in measuring the productivity per employee, or "partial" (KV) productivity in terms of "one given input". But, when heterogeneous outputs or more than one input is involved, measurement becomes cumbersome, even unlikely. Assume that 110 tires are produced in a plant and the inputs of production are 10 workers, 20 Kg rubber, 100 Kw energy and two machineries. Partial productivity (KV) with reference to employee can be shown as output per employee.

$$KV = \text{Output} / \text{Employees} = 110 / 10 = \mathbf{11 \text{ Tires} / \text{Per employee}} \quad (1)$$

Or, alternatively:

$$KV = 110 / 20 \text{ Kg Rubber} = \mathbf{5.5 \text{ Tires} / 1 \text{ Kg Rubber}} \quad (2)$$

Equation (1) shows that one employee produces 11 pieces of tires, and equation (2) shows that 5.5 pieces of tires are produced with 1 Kg rubber.

But, what if the inputs are more than one? Would it still be feasible to measure total or partial productivity? Equations (3) and (4) give the answer.

$$V = 110 \text{ pieces tires} / 10 \text{ employees} + 10 \text{ Kg rubber} + 2 \text{ machineries} = ??? \quad (3)$$

$$KV = 110 \text{ pieces tires} / 10 \text{ employees} + 10 \text{ Kg rubber} = ??? \quad (4)$$

It would not be an exaggeration to claim that it is not feasible to measure the total input productivity (V) in terms of quantities.

$$V = \text{Çıktı Miktarı} / \text{Çalışan Sayısı} + \text{Tüm Diğer Girdiler} = ??? \quad (5)$$

There is more to it. Let us re-consider output per employee analysis in quantities and take a look at the output of two competitive firms in auto industry. Assume that one worker at Mercedes plant produces 5 cars while at Ford plant one worker produces 7 cars a day. Is the worker at Ford automobile plant more productive than the worker at Mercedes plant?

Certainly, not. It would be irrational and misleading to make such a comparison. For a sound comparative analysis the output of both firms has to be the same, e.g., homogeneous, and employ the same technology. This is a case encountered in Neoclassical economic analysis.

In short, quantitative analysis of productivity with two or more inputs of production is not of much value, while partial analysis with regard to one input only can give us some useful insights.

Value analysis of "productivity"

Measuring productivity in terms of value is not free of problems, either. But, it

seems to be less cumbersome, more reliable and less complex method ⁷ to use. In measuring the productivity, a specified value criterion, say value-added (**VA**= wage + profit) can be used. Using **VA** criterion, the productivity analysis can be divided into 5 broad sub-categories:

1. $V = VA/TM$ = Wage + profit / Total production cost
2. $KV = VA/L$ = Wage + profit / Per employee
3. $KV = VA/t$ = Wage + profit / Unit time employed
4. $KV = VA/W$ = Wage + profit / Total wage bill
5. $KV = VA/OC$ = Wage + profit / Non-wage input costs

TM, denotes total production costs; **L**, employees; **t**, unit time employed; **W**, (**L*w**) total wage bill; and **OC**, non-wage input costs.

"Productivity growth" (economic growth)

Productivity growth is a dynamic concept indicating an increase in the products supplied, implying economic growth. It is a rather vital fact of economic life. For, it does not only improve the competitive strength of producing firm, but also increases the total value-added, thus the economic welfare.

The study of the causes of productivity growth is rather important. But, since a thorough study has already been done in another article (Gürak,2004-b), only a brief reference shall be made, here.

Productivity growth in terms of values can be analyzed in two sub-categories: value-added (**VA**) and quantities (**Q**).

- 1- Quantitative growth: or
- 2- Value growth.

A quantitative growth indicates a variation in the relations between quantities used in production and the quantities supplied. The remarks made on quantitative "productivity" analysis are also valid for quantitative "productivity growth" analysis. In other words, measurement of productivity growth with regard to two or more inputs would not produce healthy and reliable results. Measurement with regard to one input only, especially with regard to employees or the unit time employed would be feasible, but the outcome is bound to be dubious, especially with regard to "new" products and "production methods".

Productivity growth analysis in terms of values is, certainly, not free of disputes, but it is more likely to produce more reliable results in comparison to

⁷ From here onwards, productivity analysis shall be only in terms of "value", unless otherwise stated.

quantitative analysis. Therefore, in the rest of this work, productivity growth will be considered only in terms of produced value-added (**VA**). Since labor(-er) is regarded as the only production factor capable of adding value, it would be rational to measure productivity in terms of value-added (**VA/L**) or total income (**TR/L**) with regard to employed worker, or with regard to wage cost (**VA/LWC** or **TR/LWC**), respectively. In this work the latter method (**VA/LWC**) will be preferred. For this way, it would also be possible to study the fluctuations in income distribution along with productivity growth.

Is "value" criterion a perfect choice?

Certainly, it is not a perfect criterion free of all shortcomings. For instance, assume that the national currency of a country varies in value due to some reason, *cet. par.* In terms of value criterion, it would seem like that the productivity in this particular country has varied, although there does not need to be any variations in production relations within the country. This situation reflects one of the shortcomings of value criterion. But it seems, nevertheless, less cumbersome than the quantitative analysis.

In this work, it is assumed that producing firms employ their resources at optimum efficiency level in an economy free of inflation or devaluation risks. In other words, there is optimum micro-economic efficiency in production. The crucial distinction is; the system is characterized by "**technological productivity growth**" caused by "**new technologies**" or, synonymously, by "**technological innovations**". And we shall study how this process affects "**production costs**", "**price**", "**profitability**", as well as "**income distribution**".

Relations between mental labor - technological innovations and growth

That the mental labor of human beings endowed with creative abilities is the incessant source of value-creation as well as the only productive input capable of adding value, has already been discussed in other works (Gürak, 2000-a; and 2004-b). Now, we shall focus on the discussion of some key concepts like education/training-skill- experience- qualified labor(-er) and creative mental labor.

The labor(-er) employed in production can be divided into two categories:

- 1- Labor(-er) with quality (human capital); and
- 2- Labor(-er) without quality (no human capital).

Labor(-er) with quality (human capital) concept refers to the set of knowledge acquired through formal (at schools) and informal education/training, personal

skills, abilities as well as experience of laborer (worker). Thus, a **qualified laborer** or, alternatively, **laborer with human capital** is the person who possesses such features to certain extent; and the **qualified labor-force** or, alternatively, **labor-force with human capital** refers to the sum of laborers with such endowments. In other words, **qualified labor (work)** is the "service" supplied by qualified laborers.

The prevailing state of general, scientific and technological knowledge is determined by the knowledge accumulated in past and present contributions to it. To measure the extent of present knowledge and qualifications of a society or labor-force, various methods can be used. For instance, total or average time spent on education/training could be a yardstick, but not a perfect one. For it is practically impossible to measure properly the quality of education/training, or the teaching/learning abilities of teachers/students, respectively. Nor a proper comparison would be feasible.

In addition, for the proper measurement and comparison of "experiences" of different individuals, there is no method available. For the degree and quality of experience is not determined by education/training but personal abilities and years of work. Thus, measuring an analytical concept like experience with mathematical or statistical tools is unlikely to produce sound results.

Technology was defined as the knowledge created by mental labor to modify and to control the environment we live in (Gürak;2004-b). Accordingly, the qualifications (education/training + skills + experience) possessed by laborers play a vital role both in creation of new technologies and efficient application of all technologies in use.

The critical question in relation is; what is the role played by "unqualified" laborers?

With reference to the definition of **qualified labor(-er)**, the term **unqualified labor(-er)** should refer to "uneducated/untrained-unskilled and inexperienced" laborer, which is practically and scientifically out of the question. Entirely unqualified laborer can only exist in the artificial economic models, not in reality. In contemporary societies, every individual possesses relatively more or less qualifications acquired through formal/informal education/training, skills and experience. A rational and realistic theoretical economic model and analysis should mention differences in qualifications. For, there exists no laborer without some degree of qualifications. Some laborers may not have the proper qualifications for a specific job, but that is a different matter. A more proper distinction would be rather as "**qualified-less qualified**" or "**qualified-**

insufficiently qualified. Therefore, the distinction of labor(-ers) in orthodox doctrines as labor (L) and human capital (H) is artificial and irrational impeding proper economic analysis.

The technological⁸ and general economic development level of a country is closely related to the total qualifications of its labor-force. In other words, the higher the total qualifications, the higher, it is expected, the country's overall development level⁹. Not only new technology-producing creative minds but also technology-using minds are rather essential.

However, technology-using qualifications are not alone sufficient to secure **long-run** economic growth. For instance, assume a nation that possesses sufficient number of qualified laborers in every branch of industry and employ them efficiently in production process of "given" goods using the "given" technologies. But, some day, the markets for the "given" products are bound to saturate. In order to sustain growth in the long-run, **new technologies producing new products/production methods will have to be introduced.** And to produce new technologies, **qualified labor with creative abilities** is required. Thus, **creative mental labor** comes fore as the most important source of long-run economic growth.

Transfer of technology

Developing countries (LDCs) do not necessarily need technology-producing creative mental labor in order to realize economic growth. In other words, the presence of creative minds producing new technologies is not imperative, at least for short- and medium-term growth. For quite a large number of "**new technologies for LDCs**" already exists in developed countries (DCs). What the LDCs need more is qualified labor-force capable of using the existing technologies efficiently, given the proper global markets for technology transfer. Re-inventing the already invented technologies available in DCs is not only highly costly and risky, but also irrational. Therefore, it would be more rational if the LDCs devoted their scarce resources more to labor qualifications aimed at increasing the efficiency, than producing entirely new technologies, in general. In specific cases, the rational policy choice should vary from country to country depending on the specific country conditions. But, unfortunately, the global technology markets are far from perfect, designed primarily to protect

8 Assuming the absence of imperfections in technology markets, and that the institutional and cultural infrastructure is at contemporary standards.

9 The former Soviet and East European countries are exceptions for they are, in a way, still in a transition period to globally efficient market economic system, and still have some shortcomings in their institutional and cultural infrastructure.

and promote the DC firms' interests, rather than promoting growth in DCs, global competition and welfare. Restrictive clauses and especially "**transfer pricing**" mechanism, accompanying the technology transfer process contain many features against the interests of LDCs and against the promotion of global competition. In order to increase the benefits of LDCs from technology transfer, the prevailing market imperfections have to be corrected and a new system has to be introduced promoting global competitiveness, which would make the world economically a better place to live (see Gürak, 1990).

The limit of growth

Assume a nation with some "given" technologies but producing no technological innovations where production is at optimum productivity level, that is all human, physical and financial resources are employed at maximum efficiency level. In that nation, the output as well as welfare would be at highest achievable level. The growth rate of economy would depend on the population growth rate, only. Yet, in reality, economic growth is a dynamic and continuous process independent of population growth rate. It is a function of "productive knowledge".

The most significant distinction of human beings from other species has been the production of knowledge. Since the Industrial Revolution in Britain, the supply and accumulation of knowledge has increased rapidly. And with the impressive developments in sectors like electronics, computers and semi-conductors, not only supply but also dissemination and exchange of information/knowledge began to increase rapidly. The growing pool of productive knowledge (new technologies) increased the demand for laborers with higher qualifications in order to employ new technologies efficiently. It is nowadays imperative to have access to highly qualified labor-force not only to maintain the high living standards in DCs, but also for the LDCs to catch-up or close the gap with DCs. Learning new knowledge in our age has become both for societies and for firms a "**permanent**" process.

"Productive knowledge" is not the only factor influencing growth. Other major factors are:

- 1- "Fair" global and domestic competition conditions.
- 2- Appropriate institutional, political and cultural infrastructure.
- 3- Technological development level.
- 4- Financial resources.
- 5- Natural resources.

Excluding nature and laborer, the rest is not capable of producing any value by itself, making no direct contribution to growth process, except for assisting indirectly. And labor is the only input of production capable of "adding-value" to

available products. Assume a total destruction of all man-made physical products by an earthquake or war. Given the natural resources, everything can be reproduced by knowledgeable laborers.

A significant portion of man-made physical items were destroyed both in Japan and Germany during the WW II. But both countries recovered rapidly and have taken their places among the most developed and industrialized nations in world. For, both had access to "technologies" and "qualified labor force" required for successful reconstruction of everything destroyed. Some countries like Turkey, which had access to neither the necessary technologies nor the qualified labor force, on the other hand, although they did not participate at war and not suffered any physical destruction, are still struggling to catch-up and close the development gap. South Korea, which had a lower per capita income than Turkey in 1950s and 1960s, has nowadays not only closed the gap but also surpassed by a good margin. In 1997, per capita industrial sector value-added was 2,486 \$, while it was only 646 \$ in Turkey (UNIDO). The difference in the qualifications of labor-forces in both countries explains why it is so.

Efficiency and technological-productivity growth

Because of competition, while striving after higher profits, producers constantly seek for new opportunities to reduce costs and/or to introduce new products. These competitive attempts to increase productivity also contribute to the growth of welfare and shall be studied below under two subcategories "micro" and "macro" productivity growth in terms of values.

Growth-1: Efficiency (micro-productivity) increase

Productivity increase does not take place only through introduction of new technologies. Improvements in efficient use of available resources with given technology can also lead to productivity increases. Therefore, it is imperative to draw a distinct line between these productivity increases of different nature. Increases in productivity with "given" technologies shall be referred to as "micro productivity", or synonymously, as **efficiency growth** applicable only for **short-term growth** (see Tablo:1)

The principle determinants of efficiency growth are given in Table:2. Although no new technologies are introduced, efficiency growth contributes to increase in produced value-added (**VA**), rate of profit (**r**) and the share of profit in **VA**, while causing the share of wage (**w**) in **VA** to fall, cet. par.

Table: 1 Causes of growth in efficiency (micro-productivity) and technological- (macro) productivity

<p>Macro (technological-) productivity growth</p> <ul style="list-style-type: none"> a. New method of production; or b. New product and production method 	<p>Long-term</p>	<p>New technology</p>
<p>Micro productivity (efficiency) growth</p> <ul style="list-style-type: none"> 1- Human resource efficiency 2- Financial efficiency 2- Technical efficiency 	<p>Short-term</p>	<p>"Given" technology</p>

Table: 2 Relations between efficiency (micro-productivity) and growth, value-added (VA) and profitability (r)

New technology	Cause of efficiency (micro-productivity) growth	VA/K	VA/L	r	π/VA	w/VA
No	Restructuring production	↑	↑	↑	↑	↓
No	Increasing capacity utilization	↑	↑	↑	↑	↓
No	Multiple shift-work	↑	↑	↑	↑	↓
No	Reallocating the resources	↑	↑	↑	↑	↓
No	Improved general education	↑	↑	↑	↑	↓
No	Learning on-the-job & experience	↑	↑	↑	↑	↓
No	Improved safety & sanitary	↑	↑	↑	↑	↓
No	Democracy at plant-site	↑	↑	↑	↑	↓

Limits of efficiency (micro-productivity) growth

Assume that a firm produces good-X, and all resources, human, physical and financial, are employed at optimum level, that is maximum technical efficiency prevails and profits are maximized while costs are minimized. What are the options for firms if they desire to increase their profits?

1. **Horizontal growth:** One of the options is to find **new markets** for their products. In order to meet the potential demand for "given" goods from new markets, the producer may have to make "expansive" investments". As long as demand grows, the income and thus total profits of firm will continue to increase, cet. par. However, given the product, there is always an upper limit for demand. As the market for given product begin to saturate, the strength of demand shall begin to decline and eventually halt. After that point, the output could only aim to meet the demand caused by depreciation and population growth, given the purchasing-power. The impact of population growth on output growth can only be marginal. Thus, the growth process without "new products" is sooner or later bound to come to an end, as the pessimistic theories predict.
2. **Wage cut:** Another option of a firm to increase profits is to reduce the wages paid to employees, cet. par. Thus, the share of wages in value-added will drop and share of profits increase, while the total value-added

remains unchanged. This option may prove beneficial for the wage-reducing firm, but would, quite likely, produce opposite results for the economy, if all firms introduced wage-cuts at the same time. It would reduce the total demand and the value-added produced, implying negative growth. Therefore, what is beneficial for one firm does not necessarily have to be beneficial for all firms or the economy.

3. **Reducing costs of production:** Given technology and the optimum efficiency level in production, the only possibility to reduce costs seems to be paying less for the purchased inputs of production. But, the suppliers of inputs of production would naturally be rather reluctant to sell for lower prices, which would imply reduced profits for them, *cet. par.*

According to the cases discussed above, in the absence of technological progress, there is an inevitable limit to growth with "given" products. Assuming less than optimum efficiency in production process, there is some scope to increase the supply of value-added, that is growth. But, as the markets approach saturation point, the strength of demand is bound to decline and eventually stop. Therefore, it is imperative to introduce technological innovations to sustain long-run economic growth.

Growth-2: Technological productivity growth

Compared to efficiency (micro-productivity) growth, technological growth contains a distinguished and crucial difference, e.g., "**new technologies**" or, synonymously, "**technological innovations**". It implies that now the economy is subject to changes in terms of "new" products and/or to unit cost reducing production methods of "given" products. Technological productivity growth, which is the engine of long-run economic growth, can be divided into two groups (see Table:3):

Table: 3 Technological (macro) productivity growth.

a- Given product but new production method	Long-run	New technology
b- New product/new production method		

a-) "Given" product but new production process

Given the product, the most rational and effective behavior of firms to improve competitive strength and profits is to employ new unit cost reducing production method. To serve this purpose, the new technology should facilitate production with one of the following features:

1. The same amount of **VA**, but less inputs/labor.
2. The same amount and value of inputs, but more **VA**.
3. The growth rate of **VA** is greater than the growth rate of value of inputs.
4. The rate of decline in the value of inputs is greater than the rate of decline in **VA**.

A related problem expected to arise is the strength of demand. As the product is assumed to be given, demand is expected to decline with the saturation of markets, which would cause the profit rate to decline, which, in its term, would cause a decline in the investment rate.

b-) New product / new production method

The distinguished feature of this kind of macro (technological) productivity is the introduction of "new products" usually accompanied by "new production methods". Long-run and sustainable economic growth can only be realized by technological productivity increases. The long-run economic growth rate is normally subject to fluctuations, even to crises. Neither the growth process ceases, nor the profit rate tends to fall to zero in the long-run. Often, the shortage or exhaustion of certain natural resources becomes the major subject of economic debates. But, nevertheless, the economic growth process continues. Moreover, in contrast to approximately 3,000 hours worked annually 50-60 years ago, an employee works about 1,500-2,000 hours nowadays and produce much better quality and more variety products. The only reason for these developments is incessant **technological productivity growth** that is the supply of new technologies, or, to be more specific, incessant supply of **new products and/or new production methods**.

New products require new investments, which naturally generate new demands. As a result, the initial profit rate tends to be higher than the average rate prevailing in markets with given products/technologies. This is a natural process. Otherwise, the firms would not have incentives to take risks to utilize new

technologies. As a result of new technologies, not only the profit rate tends to rise, but also the options for consumers increase.¹⁰

In summary, the reason for the long-run profit rate not to fall to zero and sustained economic growth is **technological productivity growth**. Invention and application of new technologies is an irreversible and uninterrupted process of economic life in progressive societies. Incessant technological productivity growth does not only serve the interests of producers but also of individuals. As a result of technological productivity growth, employees work less hours, produce much more and better quality products. In addition, the real income per capita increases, facilitating more consumption and improved living standards. In spite of some setbacks and objections, people in general, welcome such developments.

Why do firms need technological productivity growth?

Three major reasons can be outlined to explain why the profit-maximizing firms in competition seek for technological productivity growth introducing "new products" or production methods".

1. To be ahead in competition.
2. To maximize long-run profits.
3. Not to lag behind competitors.

The main goal of every commercial firm in competitive environment is first to survive competition and then maximize the profit rate and long-run profits in long-run. In short-run, the commercial firm may increase profits by reducing some production costs through some non-technological measures. But, in the long-run, the only way to keep profits from falling to zero is to introduce new products and production methods that is technological productivity growth.

- a) **Competitive advantage:** By reducing the unit costs of a "given" product by introducing a new production method, the firm would gain cost advantage against competitors. That could imply either higher profit rate if the price remains unchanged, or price advantage if the cost reduction is reflected in reduced price. If entirely new products are introduced by new technology, the firm is expected to enjoy higher than average profit rate and access to new markets.

¹⁰ A new product can be an entirely new one or a modified one of a given product with new features. For instance, although the service supplied by mobile phones is the same as traditional phones, the former is considered as a "new product", due to some improvements. Accordingly, LCD or plasma TV sets are also considered as "new products".

- b) **Monopoly advantage:** The owner of the new knowledge to produce **new product/production process** normally applies for a patent, which facilitates to enjoy monopolistic advantages until the others catch-up. Meanwhile the **expected** profit rate of technology owner is, quite likely, above the average market profit rate. In the absence of such expectations, the producer may not have sufficient incentives to finance the risky R&D process to introduce new products..
- c) **Defensive strategy:** Assume that the competitor(s) of a firm acquire cost advantage or aim to gain a larger share of the market by introducing new technologies. If the firm in question does not take the necessary counter measures, it would risk losing everything. In order to survive the competition, it has to catch-up with others either by inventing a competitive technology or by transferring it through a patent/license agreement. The cost of ignorance is withering away from the market for good.

What should be the characteristic features of a contemporary firm to be and maintain a competitive edge in global markets in the long-run? In view of the above statements, one can draw the following conclusions:

- i. Have access to a labor-force endowed with required qualifications to **create** and to **use efficiently** the new technologies, along with appropriate technological infrastructure.
- ii. If the required technology is transferred, not created by internal resources, then the firm should have the appropriate capabilities to **adapt** and **further develop** the new technology.
- iii. Employees of the firm should get continuous intra-firm professional training to keep pace with the most recent developments. Decision-makers of the firm should be open to all kind opinions and promote participation in decision-making.
- iv. Optimum technical or economic efficiency should be one of the major priorities of the firm.
- v. Short- and long-run expectations and goals of the firm should be both, rational and realistic with regard to global facts and developments.
- vi. The firm must have appropriate dynamics to take the necessary risks and steps at right time and place.

Technological innovations and consumers

From the point of consumers, technological productivity growth, in general, provides to major utilities:

1. Cost-reducing technological innovations of "given" products, may reduce the sale price of products, which would lead to increased consumption, *cet. par.*
2. "Entirely new" or "improved quality" products are introduced at the service of consumers.

In both cases, the consumers benefit from technological productivity growth.

Employment and technological productivity growth

Technological innovations usually display two different impacts on employment:

1. Causing job-losses, thus reducing employment.
2. Creating new jobs, thus contributing to employment.

In retrospect, one can frequently encounter cases where people meet new technologies with suspicion, or even display hostile resistance to change. The underlying reason of this behavior is the fear to lose jobs, in other words, loses income. However, again in retrospect, one can observe that while, on one side, causing job-losses, the new technologies provide, on the other side, new employment opportunities in many "new fields". Which is more beneficial for the mankind: keeping the available jobs with "given" technologies or promoting new technologies and new employment opportunities? Historical developments have already answered this question: the "new" wins over the "old".

Reflections of technological productivity growth

In the following parts, the purpose will be to display in simple models how technological productivity growth affects price, value-added, wage-profit ratio and functional income distribution.

"Given" product - "new" production process

All initial production figures used are selected randomly. Since the sole purpose is to analyze the consequences of a technological innovation, the selection of random figures is unimportant.

Initial values:

$$w_t = 100 \text{ TL}$$

$$L_t = 500 \text{ workers}$$

$$LWC_t = w_t * L_t = 100 * 500 = 50,000 \text{ TL}$$

$$OC_t = FC_t + VC_t = 40,000 + 40,000 = 80,000 \text{ TL}$$

$$TC_t = LWC_t + OC_t = 130,000 \text{ TL}$$

TC denotes total costs, **OC** total costs excluding wages, **FC** fixed-costs like rent-capital goods, **VC** variable costs excluding wages such as raw-materials, energy, etc., and **t** the time. On the income side, (**TR**) denotes the total revenue.

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

$$q_t = 10,000 \text{ pieces}$$

$$TR_t = p_t (15) * q_t (10,000) = 150,000 \text{ TL}$$

p denotes price and **q** the quantity produced. The hypothetical size of profit (**π**), rate of profit (**r**) and value-added (**VA**) will emerge as follows:

$$\pi_t = TR_t - TC_t = 20,000 \text{ TL}$$

$$VA_t = \pi_t + LWC_t = 20,000 + 50,000 = 70,000 \text{ TL}$$

$$r_t = \pi_t / TC_t = 20,000 / 130,000 = \sim \% 15$$

$$\pi_t / VA_t = \sim \% 28 \quad (\text{share of profit in VA})$$

$$LWC_t / VA_t = \sim \% 71 \quad (\text{share of wages in VA})$$

Case-1 Labor(-er) saving technological innovation

Assume that after the introduction of new technology the firm continues to use the same quantities of inputs as before. But the number of employees is reduced from 500 to 300, cet. par. The new technology will alter the rate of profit and shares of income in **VA** of wage and profit, assuming that quantity supplied, price, wage-rate and non-wage input costs remain the same.

$$LWC_{t+1} = w_{t+1} * L_{t+1} = 100 * 300 = 30,000 \text{ TL}$$

$$OC_{t+1} = FC_{t+1} + VC_{t+1} = 80,000 \text{ TL}$$

$$TC_{t+1} = LWC_{t+1} + OC_{t+1} = 110,000 \text{ TL}$$

$$\pi_{t+1} = TR_{t+1} - TC_{t+1} = 40,000 \text{ TL}$$

$$VA_{t+1} = \pi_{t+1} + LWC_{t+1} = 40,000 + 30,000 = 70,000 \text{ TL}$$

and;

$$r_{t+1} = \pi_{t+1} / TC_{t+1} = \sim \% 36$$

$$\pi_{t+1} / VA_{t+1} = \sim \% 57 \quad (\text{share of profit in VA})$$

$$LWC_{t+1} / VA_{t+1} = \sim \% 43 \quad (\text{share of wages in VA})$$

Although the total **VA** produced is unchanged (150,000 TL), share of profit in **VA** (**r** /**VA**) increased from 28 percent to 57 percent. And, although the real wage level remained the same as before, the share of wages in **VA** dropped as a consequence of labor(-er) saving technological innovation.

Another interesting development is the decline in **VA** produced. The reason for this outcome is the reduction in the number of employees, which caused a decline in the total **VA** ($LWC=\pi$) produced.

By assumption, price was given and remained unchanged. As a result of new cost reducing technological innovation, the firm faces with three options:

1. Keeping the price in tact and increase total profits.
2. Increase its competitive strength by reducing price, while keeping the profit rate constant.
3. A combination of options 1 and 2.

If the firm prefers to reduce the end price of product, it will gain competitive advantage but at the cost of losing some profits.

Case-2 Input-saving (excluding laborer) technological innovation

Let us assume that, after the introduction of new technology, the same quantity of output is produced with less amount of inputs but the same amount of labor(-er), say $VC_{t+1}=20,000$. Some variables will change, while others remain the same. Those remaining the same are:

$$\begin{aligned}
 w_t &= 100 \text{ TL} \\
 L_t &= 500 \text{ laborers} \\
 p &= 15 \text{ TL} \\
 q &= 10,000 \text{ pieces} \\
 LWC_t &= w_t * L_t = 100*500 = 50,000 \text{ TL}
 \end{aligned}$$

And the new values of some variables:

$$\begin{aligned}
 OC_{t+1} &= FC_{t+1} + VC_{t+1} = 40,000 + 20,000 &= 60,000 \text{ TL} \\
 TC_{t+1} &= LWC_{t+1} + OC_{t+1} = 50,000 + 60,000 &= 110,000 \text{ TL} \\
 \pi_{t+1} &= TR_{t+1} - TC_{t+1} = 150,000 - 110,000 &= 40,000 \text{ TL} \\
 VA_{t+1} &= \pi_{t+1} + LWC_{t+1} = 40,000+50,000 &= 90,000 \text{ TL} \\
 r_{t+1} &= \pi_{t+1} / TC_{t+1} = 40,000 / 110,000 = &\sim \% 36 \\
 \pi_{t+1} / VA_{t+1} &= &\sim \% 44 \quad (\text{share of profit in VA}) \\
 LWC_{t+1} / VA_{t+1} &= &\sim \% 55 \quad (\text{share of wages in VA})
 \end{aligned}$$

As displayed above, after the introduction of new input-saving technology the rate of profit increases from 15 percent to 36 percent, share of profit in **VA** from 28 percent to 44.4 percent, while share of wages in **VA** drop from 71 percent to 55.5 percent, cet. par.

Since, by assumption, there is no change in quantity demanded, there is no reason to reduce the price. However, the firm might desire to use the cost advantage in competition to expand its markets. In this case, the price will have to fall. Assume that initially the rate of profit remains the same ($r = \% 15$) and price is subject to fluctuation. Reducing the price from 15 TL to 12.7 TL would not cause any inconvenience to the firm. But, at any price between 15 TL and 12.7 TL would imply loss of potential profits, cet. par. Any amount of fall in price below 15 TL would also imply decline in the potential share of profits in **VA**.

$$\begin{aligned}
 P_{t+1} &= 12.7 \text{ TL} \\
 TR_{t+1} &= p_{t+1} (12.7) * q_{t+1} (10,000) = 127,000 \text{ TL} \\
 \pi_{t+1} &= TR_{t+1} - TC_{t+1} = 127,000 - 110,000 = 17,000 \text{ TL} \\
 VA_{t+1} &= \pi_{t+1} + LWC_{t+1} = 17,000 + 50,000 = 67,000 \text{ TL} \\
 r_{t+1} &= \pi_{t+1} / TC_{t+1} = 17,000 / 110,000 = \sim \% 15 \\
 \pi_{t+1} / VA_{t+1} &= 17,000 / 67,000 = \sim \% 25 \text{ (share of profit in VA)} \\
 LWC_{t+1} / VA_{t+1} &= 50,000 / 67,000 = \sim \% 75 \text{ (share of wages in VA)}
 \end{aligned}$$

Case-3 Output increasing technological innovation

Now assume that all inputs of production, including the employees, remains the same while output increases by 20 percent from 10,000 to 12,000 due to new production process. Once again, some variables will change while others remain unchanged. First the constants:

$$\begin{aligned}
 w_t &= 100 \text{ TL} \\
 L_t &= 500 \text{ employees} \\
 LWC_t &= w_t * L_t = 100 * 500 = 50,000 \text{ TL} \\
 p &= 15 \text{ TL} \\
 OC_t &= FC_t + VC_t = 40,000 + 40,000 = 80,000 \text{ TL} \\
 TC_t &= LWC_t + OC_t = 130,000 \text{ TL}
 \end{aligned}$$

And the changed new values:

$$\begin{aligned}
 q_{t+1} &= 12,000 \text{ pcs} \\
 TR_{t+1} &= p_{t+1} (15) * q_{t+1} (12,000) = 180,000 \text{ TL} \\
 \pi_{t+1} &= TR_{t+1} - TC_{t+1} = 180,000 - 130,000 = 50,000 \text{ TL} \\
 VA_{t+1} &= \pi_{t+1} + LWC_{t+1} = 50,000 + 50,000 = 100,000 \text{ TL} \\
 r_{t+1} &= \pi_{t+1} / TC_{t+1} = 50,000 / 130,000 = \sim \% 38 \\
 \pi_{t+1} / VA_{t+1} &= \% 50 \quad \text{(share of profit in VA)} \\
 LWC_{t+1} / VA_{t+1} &= \% 50 \quad \text{(share of wages in VA)}
 \end{aligned}$$

The new technology causes the initial profit rate of 15 percent to rise to about 38 percent, the share of profit in **VA** from 25 to 50 percent, while the share of

real wage in **VA** drops from 75 percent to 50 percent, though it remained unchanged. Note that though the real wage does not change, its share drops, implying improved distribution of functional income in favor of the profits due to new technology.

Assume that the firm decides to reduce the price of product from 15 TL to 13 TL to gain competitive price advantage. This move would cause the profits to fall below the potential amount, but make the firm more competitive.

$$\begin{aligned}
 P_{t+1} &= 13 \text{ TL} \\
 TR_{t+1} &= p_{t+1} (13) * q_{t+1} (12,000) &= 156,000 \text{ TL} \\
 \pi_{t+1} &= TR_{t+1} - TC_{t+1} = 156,000 - 130,000 &= 26,000 \text{ TL} \\
 VA_{t+1} &= \pi_{t+1} + LWC_{t+1} = 26,000 + 50,000 &= 76,000 \text{ TL} \\
 r_{t+1} &= \pi_{t+1} / TC_{t+1} = 26,000 / 130,000 = &\% 20 \\
 \pi_{t+1} / VA_{t+1} &= 26,000 / 76,000 = \sim \% 34 &\text{ (share of profit in VA)} \\
 LWC_{t+1} / VA_{t+1} &= 50,000 / 76,000 = \sim \% 65 &\text{ (share of wages in VA)}
 \end{aligned}$$

In the case presented above, in spite of the price fall to 13 TL, the rate of profit is higher than in the "initial" case. In addition, the firm is in a better position in terms of share of income. The new technology has not only strengthened the competitive position of firm, but also raised both, the profit rate and share of profits in total revenue, in comparison to "initial" case..

Case-4 Labor- and input-saving technological innovation

In actual economies, new technologies do not save "only" laborer or inputs, as discussed in the previous samples. "Given" the product, the new technology often saves both, laborer and inputs and occasionally even the output as well. Such developments cause the profit rate to rise, which is the main goal of every firm in the long-run. As a result, though the real wage rate does not change as in the previous samples, the share of profits in **VA** increases and the functional income is re-distributed in favor of the profits, *cet. par.*

Assume that the initial values are valid and new technology allows the firm to produce the same amount of output with less inputs and employees.

$$\begin{aligned}
 w_{t+1} &= 100 \text{ TL} \\
 L_{t+1} &= 400 \text{ employees} \\
 p_{t+1} &= 15 \text{ TL / pcs} \\
 q_{t+1} &= 10,000 \text{ units} \\
 LWC_{t+1} &= w_t * L_t = 40,000 \text{ TL} \\
 FC_{t+1} &= 30,000 \text{ TL} \\
 VC_{t+1} &= 30,000 \text{ TL}
 \end{aligned}$$

$$\begin{aligned}
OC_{t+1} &= FC_{t+1} + VC_{t+1} = 60,000 \text{ TL} \\
TR_{t+1} &= p_t * q_t = 15 * 10000 = 150,000 \text{ TL} \\
TC_{t+1} &= OC_{t+1} + LWC_{t+1} = 60,000 + 40,000 = 100,000 \text{ TL} \\
\pi_{t+1} &= TR_{t+1} - TC_{t+1} = 150,000 - 100,000 = \mathbf{50,000 \text{ TL}} \\
r_{t+1} &= \pi_{t+1} / TC_{t+1} = 50,000 / 100,000 = \mathbf{\% 50} \\
VA_{t+1} &= LWC_{t+1} + \pi_{t+1} = 40,000 + 50,000 = \mathbf{90,000 \text{ TL}} \\
VA_{t+1} / L_{t+1} &= 90,000 / 400 = \mathbf{225 \text{ TL / per employee}} \\
\pi_{t+1} / VA_{t+1} &= 50,000 / 90,000 = \sim \mathbf{\% 55} \quad (\text{share of profit in VA}) \\
LWC_{t+1} / VA_{t+1} &= 40,000 / 90,000 = \sim \mathbf{\% 44} \quad (\text{share of wages in VA})
\end{aligned}$$

In consequence, as the costs of inputs and wages are reduced due to new technology, total profits (π_{t+1}) and profit rate (r_{t+1}) increases along with the share of profits in VA. Functional income is again re-distributed in favor of the profits while the real wage rate remains the same.

New product-New production process

So far, we analyzed cases where a "given product" was produced by "new production processes". Yet, we know that productivity growth due application of new process technologies for "given products" has only a limited impact on the economic growth. For, no matter how much the production costs and/or price declines due to new process technology, the markets are bound to saturate sooner or later, which would bring the growth process to an end.

The actual cause of long-run productivity and economic growth is technological innovations introducing "new products", which are, in general, accompanied by "new production processes". Incessant supplies of new products are the cause of ever rising living standards. Due to such innovations, both the quality and the quantity of products placed at the service of end-users increases along with the individual and total wealth. In the absent of such innovations the marginal utility of the "given products" would tend to decline in time accompanied by declining profit rates. Eventually the economies would reach the well-known "equilibrium" point of Neoclassical doctrine at some future date and further growth would be subject to population growth rate only. New investments would cease and the living standards would remain unchanged. But this is not case in reality simply because of **new products/production processes**, which are the products of **mental labor**.

Let us take a closer look at how "new products/new production processes" affect the productivity change in terms of "aggregate value added" (AVA). Assume that in an economy five different products ($q_1, q_2, q_3, q_4,$ and q_5) are being produced. Q denotes the quantity of total output, Y the value of total output and p the price of products.

$$q_1 = 3,000, q_2 = 14,000, q_3 = 5,000, q_4 = 7,000, q_5 = 6,000 \text{ pieces}$$

$$p = 10 \text{ TL}$$

$$Q_t = \sum q_i = \mathbf{35,000 \text{ pieces}} \quad i = 1, \dots, 5$$

$$Y_t = Q_1 * p = 35,000 * 10 = \mathbf{350,000 \text{ TL}}$$

Further assume that two "new products" are introduced following a technological innovations, say digital TV, q_6 and solar energy drive car, q_7 . Total supply of new products is 5,000 pieces and the average price 10 TL, cet. par. Both, Q and Y will naturally change.

$$q_6 = 2,000 \text{ pieces, and } q_7 = 3,000 \text{ pieces}$$

$$Q_{t+1} = \sum q_i = 35,000 + 5,000 = \mathbf{40,000 \text{ pieces.}} \quad i = 1, \dots, 7$$

$$Y_{t+1} = Q_2 * p = 350,000 + 5,000 * 10 = \mathbf{400,000 \text{ TL}}$$

Thus, the contribution of new products to total wealth in terms of value will be $\Delta Y = \mathbf{50,000 \text{ TL}}$. Meanwhile, total quantity supplied (Q) increases from 35,000 pieces to 40,000 and the total value-added (Y) from 350,000 TL to 400,000 TL.

The related and rather important questions are: How to determine the prices of new products? What would be the new profit-rate?

Since the products are **new ones**, there will be no chance to make a price comparison. But, since the owner of the new product will have monopoly rights due to patent ownership, the "**expected**" profit rate would, quite likely, be above the market average rate. This expectation is rather important for the further development and introduction of new products.

New product/new production process and functional income distribution

By assumption, the wage rate of an employee remained unchanged until the next round of wage-negotiations, while new technologies were being employed. Using simple mathematical symbols¹¹ the likely impact of technological innovation in short-run would be as indicated below, cet. par.:

$$w_{t+1} = w_t$$

But,

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

$$r_{t+1} > r_t$$

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

¹¹ w = wage; VA = value-added; t = time; r = profit rate; π = amount of profit

$$\pi_{t+1} / VA_{t+1} > \pi_t / VA_t$$

$$w_{t+1} / VA_{t+1} < w_t / VA_t$$

As observed above, the total value-added or total income increases with the employment of new technology, and the functional income changes in favor of the profits although there has been no decline in real wage-rate. In other words, every technological productivity growth implies re-distribution of functional income in favor of capital-owner, cet. par.

Wage rise

Deteriorated functional income distribution for wage-earners, in spite of constant real wage-level, as a consequence of technological productivity growth continues, normally, until the next round of wage-negotiations. The outcome of negotiations is uncertain and depends on the bargaining-power of both parties. Assume that, after the employment of new technology, the new values of certain variables emerge as follows:

$$w_t = 100 \text{ TL}$$

$$L_t = 500$$

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

$$q_t = 10,000 \text{ pieces}$$

$$LWC_t = w_t * L_t = 100 * 500 = 50,000 \text{ TL}$$

$$OC_{t+1} = FC_{t+1} + VC_{t+1} = 80,000 \text{ TL}$$

$$TC_t = LWC_t + OC_t = 130,000 \text{ TL}$$

$$TR_t = 15 * 10,000 = 150,000 \text{ TL}$$

$$\pi_t = TR_t - TC_t = 20,000 \text{ TL}$$

$$r_t = \pi_t / TC_t = \sim \% 15$$

$$VA_t = \pi_t + LWC_t = 20,000 + 50,000 = 70,000 \text{ TL}$$

$$\pi_t / VA_t = \sim \% 28.5$$

$$LWC_t / VA_t = \sim \% 71.4$$

And further assume that after negotiations the wage-level increases by 20 percent.

$$\Delta w = 20$$

New wage level;

$$w_{t+1} = 120 \text{ TL}$$

Naturally, both labor costs and total costs will rise.

$$LWC_{t+1} = w_{t+1} * L_{t+1} = 120*500 = 60,000 \text{ TL}$$

$$TC_{t+1} = LWC_{t+1} + OC_{t+1} = 140,000 \text{ TL}$$

And,

$$\pi_{t+1} = TR_{t+1} - TC_{t+1} = 10,000 \text{ TL}$$

$$r_{t+1} = \pi_{t+1} / TC_{t+1} = \sim \% 7$$

$$VA_{t+1} = \pi_{t+1} + LWC_{t+1} = 10,000+60,000 = 70,000 \text{ TL}$$

$$\pi_{t+1} / VA_{t+1} = \sim \% 14$$

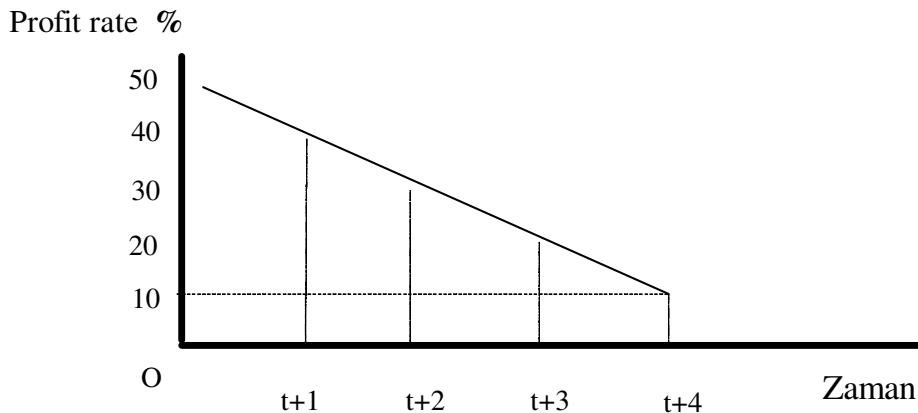
$$LWC_{t+1} / VA_{t+1} = \sim \% 85$$

As a result of wage-rise, though the total value-added remains unchanged (70,000 TL), the share of profit in total value-added declines from 15 percent to 7 percent, while the share of wages increases from 71.4 percent to about 85 percent. The shares of wage-rate and profit-rate affect each other in the opposite directions.

New product, "monopoly" and profit rate

Assume that Company-X, using its mental endowments and accumulated knowledge, develops a new medicine against cancer and acquires the patent for exclusive use of it. Due to patent ownership, Company-X enjoys a rather privileged monopoly position in the market against competitors. In the initial stage of new product demand would quite likely by far exceed the supply and being a monopoly, Company-X would set the price as high as market can bear. Accordingly, the profit-rate would quite likely be above the market average rate, say by 50 percent. But in time, the competitors would develop similar products and as the supply increases, competition will force the price and the profit-rate to decline. Assume that, given time, the profit-rate falls to the market average-rate, say 10 percent. This hypothetical trend of profit-rate is illustrated on Figure-1, which indicates that at time-period ($t+4$) the profit-rate declines to average market profit-rate. In the absence of competition, Company-X would set the price as high as possible and extract above average profit-rate, as long as demand lasted.

Figure-1 Competition and changing trend of profit-rate



Technological productivity growth and price

"New product" - "new production process"

Let us assume that the new technology is a new process technology enabling a decline in the production cost of a "given" product. For instance, say that the new process technology reduces the cost of refrigerator production from 100 TL to 90 TL per piece. This situation would give the producer three options regarding the price:

1- Continue to sell at the same price as before, while increasing the profit-rate:

2- Reduce the end-price to gain competitive edge against the competitors, cet. par.: Or,

3- A combination of 1 and 2.

If first option is preferred, the price will remain unchanged, but the value-added created per unit-time employed and profit-rate would increase. If second option is preferred, both the price and the "potential" profit-rate would have to decline, while total revenue is likely to increase, cet. par. Third option would provide a combination of two outcomes.

A producer in a fair competitive environment with access to a new process technology enabling reduction in unit costs is quite likely to prefer the second option and reduce the end-price. This would be a rather rational behavior paving the way to a larger market share of the market and eventually to elimination of competition in the long-run, cet. par. The price reduction due to new process

technology would also be in the favor of end-users, which would imply a positive "income effect" on their income.

"New" product/process and "new" price

Studying the long-run trends in economic development, we observe that the real price-level does not show continues tendency to decline. The main reason for this is the incessant introduction of "new products/processes", which does not only cause the profit-rate to rise above the average but also requires setting new prices for new products. The profit-rate of new product was expected to be higher than average because of monopoly position and excessive demand. As long as monopoly privileges through exclusive patent right prevails, monopoly profits may continue. But, in time, the competitors are expected to catch-up, increase the supply and force the price/profit level to fall.

Studies on long-run price indexes have to take into consideration that there are incessant introduction of new products/processes accompanied by "new prices". For instance, mobile phones supply, in practice, the same kind of service as the traditional house phones. But, nevertheless, they are no longer the same, because they contain rather different features. Therefore, more expensive mobile phones than traditional ones do not imply that the "general phone price level" has gone up. It would be a great error to apply one price index for all phones, for all phones are not the same quality. The same conditions apply for the car industry as well. 2004 year car model of a company is usually not the same in 2005 or in 2006 with respect to its features and price. Because of the differences in quality, a price comparison would be not only irrational but also erroneous. Due to the above mentioned reasons, there seems to be no price index available to measure the long-run price-level properly.

Other factors influencing price level

Imperfect competition

If there was a perfectly competitive market, as the orthodox doctrines claim, a cost reducing technological innovation of a "given product" would automatically cause the price of product to fall, *cet. par.* Actually, some prices tend to decline from time to time as a result of cost-reducing technological innovations and competitive environment. For instance, in spite of various kinds of qualitative improvements, the prices of computers have, in general, fallen sharply in last decades. But, there are also some factors making a price-reduction undesirable for producers. The main factor is "imperfect competitive market conditions". If the market is dominated by a few "oligopolistik" companies or by a "monopolistic" seller, cost-reducing technological innovations may not reduce the expected

results. The single seller may decide or a few sellers might agree on a non-price competition strategy, which would be in favor of growing profit-rate per unit output, but against the interests of end-users.

Wage-negotiations

Another factor, which might prevent a plausible price-reduction, might be the wage-increase demands of labor unions. It is not an infrequently encountered incidence that the company management meets the wage-increase demands with positive approach in order to prevent any possible conflict, which might cause trouble in supply. The higher the expectations of management, the greater might be the tendency to accept wage-increase demands. Otherwise, a conflict with the union may cause serious losses of markets and profits to competitors. Especially in cases of monopoly or oligopolistik competition, the management might be more inclined to have a positive approach to wage-rise, because they can easily manipulate the end-price, thus their profits, *cet. par.*

With respect to general price level, a wage-increase in a sector would imply, in a way, a general level price-reduction, that is an increase in income, *cet. par.* But this development might lead to deterioration in real incomes of wage-earners in other sectors, if the wage-rise leads to a general price-level increase, *cet. par.*

Service sector

The wage-increase demands of labor unions does not only influence the price level in related sector where new technologies lead to cost-reduction, but also the wage and price levels in other sectors, though there may not be any technological innovations, thus productivity growth. For instance, a wage-rise in an industrial sector due to technological productivity growth may cause, indirectly, wage-increases in other sectors, such as service or public sector, which display, owing to their internal dynamics, relatively less productivity growth. Public sector services may prove to be a proper example. Although the productivity growth seems to be rather insignificant, if not non-existent, this does not stop the public servants to demand wage increases. As a result, though the economy may experience decline in price in certain sectors due to technological productivity growth, the general price-level may display a rather different trend, *cet. par.*

Debt-interest payments

Another reason making the decline in general-price level an unattractive option is the total debts and interest payments of producers. If the price-level falls in a sector due to a technological innovation, this might put the producers, who borrowed to undertake production, to an awkward financial position. For the price-decline would imply reduced real profits and increased financial production

costs with regard to amount borrowed and interests to be paid. Therefore, price-falls are not always desirable from the point of borrowers, *cet. par.*

Institutional / cultural infrastructure

Factors like bad governance of national economy, inappropriate interventions, and inadequate institutional and/or cultural infrastructure can also influence the general price level.

Service sector and productivity growth

So far, special attention was paid to use the term "**product**" to refer to the supply of producers, which covered both, physical/tangible/storable commodities and non-physical/tangible/storable services. The ordinary economic textbooks are sometimes indifferent to what they really mean and often imply both, commodities and services, with regard to production and exchange. Yet, if proper attention is paid one notes clearly that traditional economic theories of price formation, production, exchange, growth and trade are, in principle, about "commodities", not services. This fact implies, surprisingly, that the service-sector activities, which make up the largest share of GDP in modern societies, are ignored or overlooked in the economic models.

Actually, for the sake of proper economic analysis making separate analysis in industrial and service sectors regarding value/price, growth, trade, etc., would be more appropriate and rational. But, unfortunately, this fact seems to have been overlooked since the time of Classical economists. In fact, service sector activities were often consciously ignored, among others by Marx, being regarded as "unproductive" or "parasite" activities. Only industrial or agricultural economic activities were regarded as "productive". The Neoclassical doctrines were, and still seem to be, in the same tradition. In other words, models of traditional economic doctrines deal, in principle, with production and exchange relations of physical/tangible/storable items that are "commodities", ignoring service sector activities.

Yet, in modern societies, the largest portion of employment and output is in the service sectors, which was once regarded as "unproductive". The share of the so called blue-collar industrial or agricultural employment is constantly decreasing, though not the per-capita value-added by them. As time passed, the relative portion of the Marxian proletariat has decreased, while that of **cogniteria** increased (Toffler; 1992:p.90).

Is it feasible to measure productivity growth in service sector as in manufacturing or agriculture? Can one employ the same criteria in analysis?

It is hardly feasible, if not impossible, to measure the productivity change in service sectors. There are simply no physical/tangible/storable things to measure. Qualitative improvements in services supplied due to technological progress make measurement problem even more cumbersome. For instance, how can one properly measure the quality and quantity of the services supplied by a teacher? Or, to set another example, a medical doctor has, nowadays, access to incomparably more tools of various qualities than 20 years ago. But, how can we compare the productivity difference of doctors now and 20 years ago? Should we use a quantitative method? Or would a value-added criterion serve the purpose better? Which method could possibly produce more appropriate results with regard to what students learn?

If one attempted to measure productivity growth or compare productivities at any cost, the least cumbersome and most appropriate method seems to be the one based on value-added created per unit-time employed, though it is a far from perfect method.

Conclusion

The main source of long-run economic growth, thus of ever rising standards of living, is technological progresses, which are a product of mental labor. Owing to technological progresses the long-run average profit-rate does not show a tendency to fall below the critical limits for continued new investments. Technological innovations do not only reduce production costs, but also introduce "new" products and processes, which are crucial for long-run growth trends.

The critical sort-term impacts of technological productivity growth, e.g., new technologies, are as follows, cet. par.:

- a) Real wage rate remains unchanged while **VA** increases.
- b) The relative share of real wage in **VA** declines.
- c) The relative share of profits in **VA** increases.
- d) As a consequence income distribution changes in favor of profits.
- e) Income distribution trend is closely associated with real wage trend.

Functional income distribution changes in favor of profits, because the wage-rate is assumed to be constant in the sort-run until the next round of wage negotiations. But, in the course of time, as a consequence of positive changes due to technological productivity growth, demand and pressure for wage-rise increases to take a larger piece of economic pie produced. The final outcome depends on the bargaining power of two parties and on specific economic conditions.

"In the long-run", both individual and total wealth and standards of living tend to increase due to technological productivity growth. In other words, **incessant technological progresses appear as the source of long-run and sustained economic growth.**

Developed countries, which are quite well aware of the crucial role played by technological innovations, put great emphasis on education/training and R&D facilities. But, the situation in other countries lagging behind, like Turkey, Peru, Gambia, Vietnam, etc., is rather different. These countries do not necessarily need to make new inventions/innovations to secure growth, at least for a quite long period. Because, if the "available" technologies developed and owned, through patent agreements, by industrialized country producers can be transferred to developing countries through appropriate channels, they could make the same impact as new technologies do in developed parts of the world. Therefore, to benefit from technological innovations, developing country producers do not have to follow the highly costly and risky R&D process as developed country producers did. The basic pre-requirements for a successful transfer are access to, first of all, a labor force with appropriate qualities along with political-institutional and cultural infrastructure, at least "**in theory**".

But, unfortunately, the global markets for technology transfer are far from perfect (Gürak; 2003). Although the adaptive capacity of recipient country is rather important, that is not enough for a successful technology transfer. There is an urgent need to formulate new codes of global technology transfer in favor of the global competitiveness and, more importantly, in favor of the less developed countries.

Developing country decision-makers should also put great emphasis on increasing the qualities of their labor-force in order to make efficient use of available technologies and to successful adaptation/further development of new technologies to be transferred.

While studying long-run economic growth, technological progress and global economic relations, it seems rather important to attribute careful attention and to take the necessary precautions on the following critical aspects:

1. The characteristic features of global technology markets such as promotion of R&D, **ownership**, etc.
2. The process of technology transfer and the global technology market imperfections (Gürak, 2003). And,
3. Global distribution of global **VA** produced.

To summarize;

- **Technological productivity growth** is the source of long-run economic growth.
- The source of technological productivity growth is **technological innovations**.
- And the source of all technological innovations is **mental labor**.

Efficient use of technologies requires **labor-force** with necessary qualitative endowments. And the long-run growth of economies requires labor(-er?) with **creative mental capabilities**.

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