

TECHNICAL PROGRESS AS A FACTOR OF ECONOMIC GROWTH

Dejan Gligović

Associate professor Ph.D, Modern business school, Belgrade, Serbia,
dejan.gligovic@mbs.edu.rs; ORCID ID: 0000-0003-2698-7387

Abstract: *Economic growth means an increase in the volume of production and services in a certain time as a result of new investments in production capacities and their more efficient use, as well as new employment and an increase in labor productivity. Technological changes should be understood as the process of improving existing and finding qualitatively new means of production, the process of continuous improvement of existing and finding qualitatively new items of work, finding new sources of energy and improving existing methods of energy use, as well as the continuous process of improving the forms and methods of organization and production management. Technological changes are undoubtedly the most important factor in economic growth. Moreover, it is possible to talk about quality economic growth only if the complex of technological changes is its most important generator. That is why the question of the key mechanism for initiating technological changes is of particular importance in economic theory. Depending on the essence of the answer to it, the type of specific activities that are most expedient to undertake at the level of the national economy or individual companies in order to generate technological development depends a lot.*

Keywords: *economic growth, analysis, technological changes, social product*

JEL classification: *F43, O40*

INTRODUCTION

Analysis of the quality of economic development is a method of examining the quality characteristics of the development process as an economic phenomenon. Economic development represents an economic phenomenon, which consists of a large number of economic processes - some of which are marked by social and political factors that they differ from each other. In this sense, the concept of the quality of economic development is defined as a set of common features that distinguishes the corresponding economic process from other processes. Hence, the essential characteristics of the quality of the development process are: homogeneity (similarity) and comprehensiveness (in the sense that the category of quality is closely related (identical) to the essence of a certain phenomenon).

The analysis of the quality of economic development cannot be separated from its quantitative component, that is, the size with which some defined feature of the (economic) process is measured, such as, for example: labor, capital, income. However, due to the characteristics of economic processes, there is no unified opinion as to whether all quantitative elements are measurable and mutually comparable. This especially applies to the complex of categories of individual economy, such as: utility, consumer preferences and the like. In this sense, the analysis of the quality of economic development is based on the methodology of structural analysis in which, on the basis of empirical material and previous inductive conclusions, hypotheses, deductions, reductions and verifications, an attempt is made to determine the essence of certain economic processes and their mutual dependencies.

Current economic theory extends the position according to which the decisive material impact on economic development has a complex of technological changes, which is denoted by the common denominator as technical progress. Technical progress, due to its extreme complexity, belongs to a category that cannot be directly measured or compared. The size itself is determined as a derived economic category that is determined as a residual from a qualitative-quantitative analysis of the role of capital and labor in production and economic development. Economic development means greater and more effective involvement of the economy of a country in the international economy (Ivić, 2015)

Economic growth represents the expansion of GDP, that is, an increase in the production of a country. It occurs when the production frontier of a country moves up. A close concept is the value of gross domestic product per capita, which determines the standard of living of a country. There is a general agreement on the desirability of economic growth, but opinions differ significantly on how it can be achieved. The question of the relative importance of factors that influence the height of growth is the central point around which theoretical concepts have been developed that indicate the factors that stimulate economic growth. Economic growth is a complex and long-term process, which can be observed from a quantitative and qualitative aspect. Both sides of economic growth are equally important and closely interconnected. The quantitative side of economic growth is most often reduced to the pace of production increase, that is, the intensity of growth expressed through the corresponding growth rate, which is motivated by the availability of data and the simplicity of analysis. However, this indicator is flawed and does not properly reflect the quantitative dimension of growth. In addition to the pace of growth, its stability over time, i.e., resistance to various shocks and uncertainty. Together, those two components - the intensity of growth and its stability, fully and comprehensively characterize the quantitative side of economic growth, and are denoted by the term growth dynamics (Gligorić Matić, 2022)

LITERATURE OVERVIEW

Economic growth, as a value quantification of the development of any economy, depends primarily on the availability and efficiency of the application of production factors (Vasiljević, 1996). It is known that the production function indicates that a higher potential product can only be realized by a higher investment of production factors. Four components affect the physical possibilities of economic expansion, i.e. economic growth, namely (Zdravković, 2010):

1. Increasing the quantity and quality of human resources (labor),
2. Increasing the quantity and quality of natural resources (land),
3. Increasing the supply of capital goods (capital)
4. Improving technology.

The advantage in analyzing the influence of these factors is the possibility of their exact quantification and, based on that, determining the contribution of each of the four mentioned factors in economic growth, as well as forecasting future development and formulating macroeconomic policy measures. With the increase in the level of economic development, the efficiency of the application of production factors becomes the main generator of development potential. In this way, the human factor (entrepreneurship - organization - knowledge) is a key factor in economic development. In order to show the change in the population rate, it is important to point out that during the 19th century, the average population growth rate was below 1%, and that during the first 70 years of the 20th century, it was around 2%. After that, the population growth rate declines, with the growth rate forecast to be 0 in 2100. 1% (Ortiz-Ospina, 2016). The main problem in considering the impact of this factor on economic growth is the impossibility of value expression, and therefore not the exact determination of the basic relationships that determine the overall development potential. According to the classical interpretation, the total social product (P) depends on the volume of employment (L) and average labor productivity (pr) in the observed year (t), that is:

Formula 1.

$$P_t = L_t \cdot p_{rt}$$

Source : Romer, 2006

The number of employees in the economy and their productivity is determined by the amount of available means for work (basic production funds, denoted as K). Hence, the social product depends on the size of the basic production funds and their average efficiency of use in the observed year (ek), which can be expressed by the relation:

Formula 2.

$$P = e_k \cdot K$$

Source : Romer, 2006

The coefficient of efficiency of basic funds arranged in this way $(e_k = \frac{P}{K})$ shows how much social product is realized per one accounting unit of basic funds. Extensive economic growth is associated with economies in the initial stages of development, which have large labor force reserves, low per capita social product, scarce accumulation and a modest volume of production funds. The transition of the economy into several stages of development means a reduction in the participation of employment growth in the creation of development potential. However, in very high stages of economic development, due to the decline in the participation of the primary and secondary sectors in production and employment, as well as the very low growth of

productivity in the tertiary sector, the impact of employment on the growth of the social product strengthens again, and economic growth takes on extensive characteristics. Differences in average growth rates between countries have made significant differences in the average living standards of the population of those countries. The standard of living in industrialized countries is reaching a higher level (Romer, 2006).

After a strong first half of the year, the EU economy has now entered a much more challenging phase. Shocks caused by Russia's war of aggression against Ukraine are dampening global demand and increasing global inflationary pressures. The EU is among the most exposed advanced economies, due to its geographical proximity to the war and its heavy reliance on gas imports from Russia. The energy crisis affects the purchasing power of households and affects production. Economic sentiment has dropped significantly. As a result, while growth in 2022 is forecast to be better than previously forecast, the outlook for 2023 is significantly weaker for growth and higher for inflation compared to the European Commission's summer interim forecast. In conditions of increased uncertainty, high pressure on energy prices, erosion of household purchasing power, weaker external environment and strict financing conditions, it is expected that the EU, the Eurozone and most of the member states will enter into recession in the last quarter of the year.

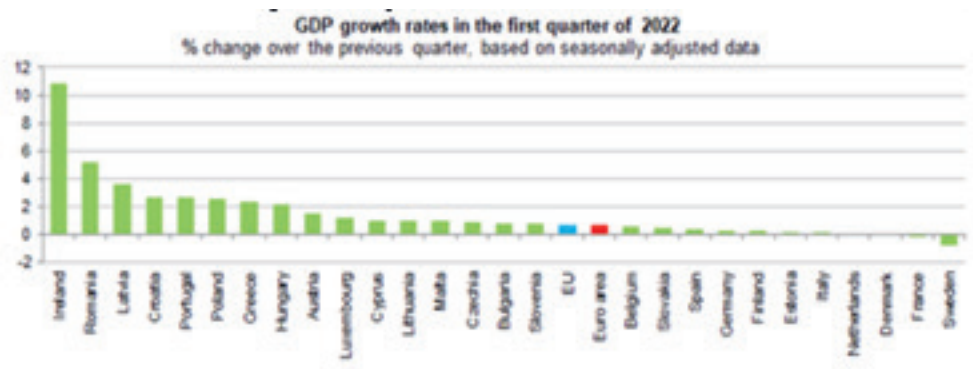
GDP within the Eurozone grew by an average of 0.6% in the first three months of 2022 and employment rose by 0.5%, according to statistics published by Eurostat, the EU statistics agency.

Across the bloc, GDP grew by 0.7% compared to the previous quarter. At the end of last year, growth was considerably slower. GDP grew just 0.2% in the Eurozone and 0.5% across the whole EU.

GDP growth was driven by a strong Irish economic performance. Compared to the end of last year, Irish GDP rebounded by a staggering 10.8%. Other nations, such as Romania (+5.2%) and Latvia (+3.6%) also weighed positively on the average.

The next graph (Graph No. 1) shows the GDP growth rate of the countries in the Eurozone for the year 2022.

Graph 1. GDP growth rates of the Eurozone in 2022.



Source: The Brussels Times Magazine, July, 2022.

Some slight contractions in GDP were observed in Sweden (-0.8%), France (-0.2%), and Denmark (-0.1%). In Belgium, GDP growth was behind the EU and Eurozone averages at 0.5%.

The dynamics behind GDP growth have radically altered since last year. The European energy crisis, made worse by Russia's conflict of Ukraine, has raised inflation and heavily hit consumer spending.

In 2023, however, the aggregate government deficit has increased (to 3.6% in the EU and 3.7% in the eurozone) as economic activity weakens, interest expenses rise and governments extend or introduce new discretionary measures to mitigate the impact of high energy prices. Their planned retirement in 2023 and continued growth should reduce pressure on public coffers thereafter. As a result, the deficit is projected at 3.2% of GDP in the EU and 3.3% in the Eurozone in 2024.

The concept of the quality of economic development is closely related to technical progress, which is treated as a key factor in economic development. Technical progress means the process of:

1. Improving existing and finding qualitatively new tools for work and subjects of work,
2. Finding new and improving existing methods of energy use,
3. Improvements in the forms and methods of organization and management of production and overall operations, as well as
4. Their diffusion from the most advanced to less advanced branches and enterprises.

The basic social, economic and technical effects of applying the results of technical progress are: a) high level of automation of work and intellectual processes; b) rapid progress in the production and introduction of new materials; c) reduction of specific energy consumption and reduction of application of atomic energy; d) the introduction of new forms of transport and communications enable a greater degree of internationalization of the production process and a significant reduction in the importance of the disposal of natural resources in economic development; e) great progress in the control of biological resources; f) qualitative changes in structure, organization and management in all areas of human activities; g) turning information into a key factor of production and economic development; h) major changes in the internal and external structure of employment; i) changes in technology and methods of action on nature in order to neutralize negative environmental effects and waste.

Factors affecting the improvement and economic valorization of technical progress, in order of priority:

1. Socio-economic relations,
2. Structure and degree of organization of the economy
3. The size of the market in which the basic economic segments operate,
4. Organization of research and development,
5. Material possibilities,
6. Level of education and upbringing, as well as
7. Non-economic factors, which in certain partial areas, can have absolute priority.

Numerous studies have shown that technical progress, as a determinant of growth, is incomparably more significant than a simple increase in the amount of avail-

able production factors (Mosurović Ružičić, 2021). The extremely large influence of the results of technical progress on the creation of a development stimulus caused science and technology to become the basic means of domination (the so-called technological colonialism).

The application of new technologies as an economic phenomenon has certain common characteristics, which we list according to their importance for the evaluation of the overall economic efficiency of economic development. The highest level of technology is economically the most expedient because it has the lowest costs per unit of goods and enables the highest growth of total production. However, equating the highest technology with the highest economic efficiency is methodologically not entirely correct, because empirical findings show that certain deviations are possible in the short and medium term. Thus, in the conditions of underdeveloped countries, the main limiting factors for the application of modern technology are cited as: lack of accumulation, first of all, of foreign exchange funds for the purchase of foreign equipment, the small number of qualified labor force, etc. For (post) socialist countries and developing countries that provided significant financial resources through the export of raw materials, the appearance of companies equipped with the most modern technology, which had a devastating effect on the development performance of their economies, is characteristic. However, on the other hand, examples of newly industrialized countries in the Pacific region negate these assumptions.

The mass application of new technologies improves the organic composition of capital because the value of the means of production in relation to labor increases. And this setting should be accepted only conditionally, considering that some types of technology can be introduced with the same, even with a lower organic composition of capital. Namely, technical progress relatively reduces the price of labor resources, that is, the technical composition grows faster than the value one. This means that the natural relationship between the means of labor and the labor force changes faster in favor of the means of labor than is expressed in terms of value. The development of technology is directly related to the increase in social well-being and affects the satisfaction of people's constantly growing needs (Dimitrijević, 2012)

In the conditions of intensive technical progress, the growth of basic funds is faster than that of revolving funds. On the other hand, the effect of moral consumption also increases, which all results in a significant increase in the transferred value (amortization) in relation to the newly created value. Changes in the organic composition of capital also affect the (average) capital ratio, i.e., the value of the basic assets that should be invested in the unit of social product production changes.

METHODOLOGY

Qualitative methodology is the conceptual determination and description of basic elements within the observed problem, using descriptive analysis. By using foreign and available domestic literature that tackles this issue, applying methods of analysis and synthesis, the basic assumptions and models of economic growth will be defined, as well as possible directions of economic policy action, with the aim of increasing economic activity. Also, the method of comparison will be used, both on the theoretical level (comparing the positions of different economic schools on issues related to economic growth). By applying induction methods, starting from the premise of the

effects of individual measures on an individual country, an effort will be made to reach broader conclusions about the observed problem. In addition to the inductive method, the deduction method will be used, in order to examine the correctness of the formulated broader conclusions by applying them to individual national economies.

DISCUSSION

The neoclassical growth model showed that the long-term rate of economic growth depends on the rate of technological change. However, it did not provide an explanation of the determinants of technology. According to that model, differences in growth rates are the result of differences in the accumulation of physical and human capital in the transition phase. To improve such a model, the possibility that different countries have different rates of technical progress and therefore different rates of long-term growth was analyzed. Endogenous growth theory, in this way, focused on explaining the economic forces that influence technical progress. Technical progress occurs as companies or individual inventors, seeking to maximize profits, search for new and better inventions. The ability to make a profit is what makes a company want to innovate. Improvements in technology and economic growth are endogenous results. This theory was developed by Romer (1986, 1990). The condition for the existence of endogenous growth boils down to the fact that the marginal product of capital stops falling. Alfred Marshall hypothesized that the realized aggregate outcome can be significantly different from the sum of effects seen by individuals.

While each individual has diminishing marginal returns on investment in his own factor of production, it can easily happen that with the inclusion of all others, effective productivity does not decrease at all, but remains the same. This type of positive externality is also called Marshallian externality. Externalities can also have negative effects, in the event that the behavior of one person causes costs for everyone else. Innovations and knowledge are a clear example of positive externalities. The property of knowledge is that it is a public good. Public goods have two properties (Erken, Donseelaar, & Thurik, 2018). First, there is no possibility of exclusion, that is, the consumer of a public good cannot physically or legally prevent anyone from consuming that public good with him. Secondly, there is no rivalry in consumption, that is, the consumption of some does not reduce the possibility of consuming it, and enjoying it for others. Societies encourage this engine of growth by establishing property rights to ideas, providing judicial protection, and thus, encouraging innovative activities.

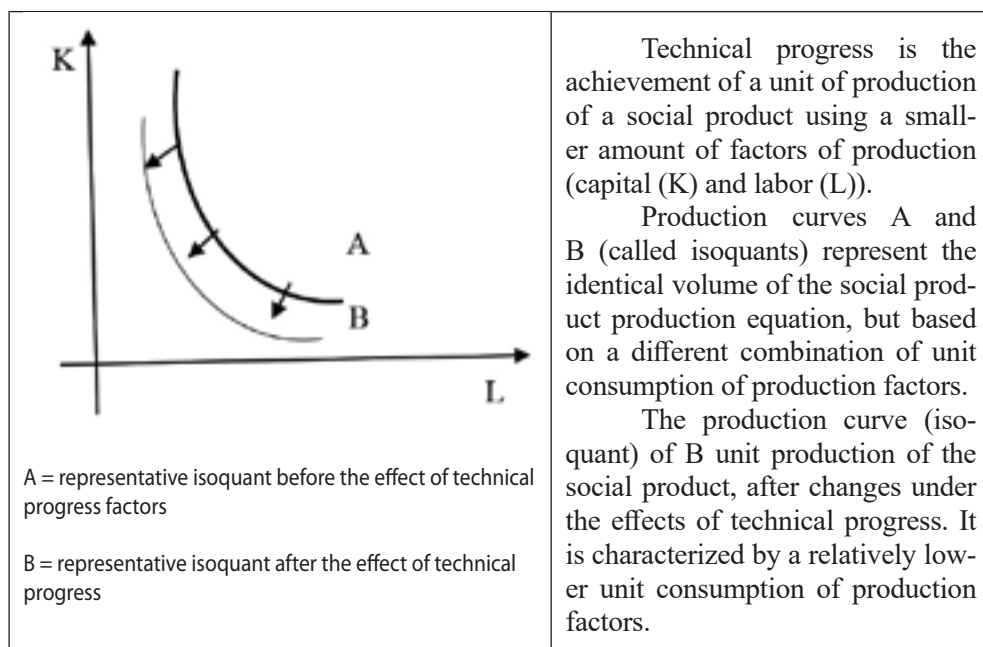
Economic growth in the Western Hemisphere (developed economies) is based on a continuous change in parameter values, i.e. a gradual increase in the participation of the research sector. Qualitatively, the hemi endogenic model does not differ significantly from the basic Solow model, if investments grow gradually. The difference is that the hemiendogenic model implies an initially low participation of the research sector, but its growth has a very strong and long-term impact on economic growth. A constant and low rate of growth in the share of research causes long-term effects on the growth of the economy in the long term (Tomić, 2012). However, this model indicates that economic growth does not last forever.

The hemi endogenic model assumes that the growth of the gross domestic product per capita can be ensured in the coming years by doubling the share of the research and development sector every hundred years, but at some point the growth will stop,

and that at the moment when the income per capita is at a high level (Schmidt, 1997). The idea of the cessation of growth is known in economic theory from the time of the classical economic school.

The application of new technologies makes sense, from an economic point of view, only if the increase in the volume of the social product can be achieved with the same volume of consumption of the factors of production (capital (K) and labor (L)), i.e. if the same volume of the social product can be achieved by reducing the consumption of the factors of production. Technical progress or knowledge is achieved through invention, creation of new knowledge and through innovation, that is, by incorporating new knowledge into current production techniques. Technical progress it includes not only innovative production techniques, but also new managerial methods and new forms business organizations.

Graph 1. Technical progress and economies of scale



Source: Author's presentation

Once discovered and implemented, new knowledge soon becomes available entrepreneurs and businesses at a relatively low price. Technological progress thus spreads to the whole economy. Recently, technical progress has exploded especially in the field of information technology: electronic computers, wireless communication, the Internet, mobile phones, etc. Significant technological progress has also been achieved in the field of innovation in medicine and biotechnology (Grant, 2017).

Measuring the level and speed of diffusion of the results of technical progress does not have a single methodology for now, because not a single modern and tested method has shown satisfactory results. The best synthetic indicator for measuring technical progress, in an international comparison, is considered to be the indicator of global productivity.

However, aggregate partial indicators can also be used, among which the following stand out:

- Growth rate and level of productivity;
- Speed and degree of diffusion of new modern technologies;
- Electricity consumption per employee and in total;
- Degree of chemicalization of production processes;
- Development of scientific research infrastructure and its allocation;
- Number of applied for and registered patents. (Simeunović, 2015) A global idea of technical progress can also be obtained indirectly, by analyzing the intensity and structure of investments, the technological equipment of work, the age structure and the level of automation of installed equipment, i.e. import and export prices, regional export destinations, the participation of individual activities in total production and employment.

CONCLUSION

Technological changes are undoubtedly the most important factor in economic growth. Moreover, about quality it is possible to talk about economic growth only if the complex of technological changes is his the most important generator. That is why the question of the key is of particular importance in economic theory the mechanism of initiating technological changes. Depending on the essence of the answer to it the type of specific activities that are most expedient to undertake at the level of the national economy or individual companies in order to generate technological development depends a lot. Two key explanations for the origin of technological changes are: a) technological changes by supply, that is, technological changes made possible by the autonomous development of science and research and development activities, and b) technological changes conditioned by demand. The first explanation can be found under the name of science and technology push theory of technological changes, and the second direction under the name of demand pull theory of technological changes, i.e. technological changes that drive the needs, i.e. demand.

In the economic literature, there has long been a tendency to oppose the aforementioned two theories of generation of technological changes. However, an acceptable explanation of the underlying generators of technological change must include both supply-side and demand-side factors. In this sense, a number of researchers rightly note that neither of the mentioned two interpretations taken autonomously explains the logic of generating technological development to a satisfactory degree, but taken together they are valid as a solid basis in determining the basic generators of modern technological changes.

LITERATURE

- Dimitrijević, B. (2012). Kako ekonomisati vremenom – ključni problem ekonomije. *Poslovna ekonomija*, Vol. 6., pp. 489–505.
- Erken, H., Donselaar, P., & Thurik, R. (2018). Total factor productivity and the role of entrepreneurship. *Journal Technol Transf*, pp.1493–1521.
- Gligorić Matić, M. . (2022). Mjerenje i analiza dinamike privrednog rasta u evropskim zemljama. *Ekonomski horizonti*, Vol. 24.
- Grant, C. (2017). *he Contribution of Education to Economic Growth. K4D Helpdesk Report.*

- Brighton, UK.: Institute of Development Studies.
- Ivić, M. (2015). Economic Growth and Development, Journal of Process Management. *New Technologies International Vol. 3, No.1*, pp. 55-62.
- Mosurović Ružičić, M. F. (2021). Istraživanje i razvoj u modelima, Ekonomskog rasta i strukturnih promena. *Poslovna ekonomija, Vol. 2*, pp. 55-72.
- Ortiz-Ospina, E. R. (2016). *World Population Growth*. OurWorldInData.org.
- Romer, D. (2006). *Advanced Macroeconomics*. New York: McGraw-Hill.
- Schmidt, G. (1997). Dynamic analysis of a Solow-Romer model of endogenous economic growth. *Working paper no.68*, pp. 10-17.
- Simeunović, B. (2015). *Razvoj modela za merenje performansi procesa*. Beograd: FON.
- Tomić, D. (2012). Relationship between technological progress and economic growth; Historical overview. *Quality. Innovation. Future* (pp. pp.1290-1299). Maribor: Univerza v Mariboru -Fakulteta za organizacijske vede, Maribor.
- Vasiljević, V. (1996). *Naučni i tehnološki progres – Osnovne koncepcije i metodi merenja*. Beograd.: Ekonomski fakultet,.
- Zdravković, D. &. (2010). *Osnovi ekonomije*. Kruševac: FIM.

