

## THE IMPACT OF TECHNOLOGY ON THE STRUCTURE OF EMPLOYMENT AT THE PRESENT STAGE

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**Introduction.** In the modern world, technology, as one of the most significant factors of human development, has a significant impact on various spheres of life. Throughout history, technology has been the basis for improving living standards and has been the main determinant of changes in the human community. Modern technologies are also changing the economy and are the basis for economic prosperity. At the same time, technological progress is characterized by increasing dynamism, which raises certain concerns and controversies about future transformations in society and the economy caused by new technologies. Modern technologies are capable of implementing transformations that previously seemed impossible. In today's globalized world, new trends emerging in developed countries are rapidly spreading across countries and continents.

One of the spheres affected by technology is human labor. The current state of the labor market is characterized by the influence of many factors, but the most dynamic of them are technology and innovation. In the last few centuries alone, technology has completely changed the labor market, creating new activities and reducing employment in old ones. However, the future impact of technology on the labor market is one of the most debated issues in the modern world. Economists are trying to investigate the possible consequences of this impact, but its presence is obvious. Analyzing the impact of technology on the labor market is one of the priority areas of research in the modern world.

**Analysis of recent research and publications.** Technologies and their impact on the labor market have been studied by many scholars at different times, including economists such as P. Schulte, D. Autor, W. Arthur, F. Bonciu, M. Borrus, H. Saudi, M. Boskin, and others. International organizations such as the UN, the World Bank, the OECD and the ILO also pay considerable attention to the problem.

In view of the rapid development of technology in recent decades, there is a need for constant monitoring and analysis of processes related to technological change, which actualizes the subject of the research.

**Objectives of the article.** The purpose of the research is to analyze the impact of the level of technological development of the country on the structure of employment in the main sectors of the economy. In this research, it is important to identify the main directions of technology's impact on the labor market, to find out the structure of employment in countries with different levels of technological development, and to outline the main prospects for transformations in the labor market.

**The main material of the study.** Technology as a concept can be defined as "the practical application of knowledge in a particular field" [1]. The role of technology in the economic development of countries is significant, and the state of the economy as a whole and its components in particular depends on the level of technology development. Despite differences in research methods, economists recognize the close relationship between knowledge development, technological progress, and long-term growth in labor productivity and

GDP [2; 3]. Technology helps to reduce labor intensity and increase labor productivity, which improves social welfare and promotes economic development [4]. According to research, more than 85% of employment growth over the past 80 years is attributed to the development of technology [5].

The technological development of countries is influenced by economic, social and political factors, as well as the level of economic openness, and the quality of education and infrastructure [6].

Technology is characterized by a number of quantitative and qualitative measures. Indicators of the level of technology development in a country can include such measures as research and development expenditures (as a percentage of GDP), charges for the use of intellectual property, and the share of high technology exports in total exports. Research and development expenditures show how interested a country is in creating innovations. The higher the R&D expenditures, the more innovations will be created in the country. Charges for the use of intellectual property show the level of involvement of modern technologies in the country. The share of high technology exports shows how efficiently the technologies created in the country are used and how successful they are, since only a truly competitive technological product can enter the international market.

Among the indicators that characterize the level of technological development, it is also worth highlighting the Global Innovation Index (GII), which is calculated by the World Intellectual Property Organization and estimates the effectiveness of innovation in approximately 132 economies, emphasizing the strengths and weaknesses of innovation in these countries. The index includes about 80 indicators, including assessments of the policy environment, education, infrastructure, and knowledge creation in each economy [7]. The various indicators offered by the GII help to track the performance and compare the development of economies belonging to the same region or income group. Accordingly, based on the latest available ranking for 2022, it is possible to conclude which countries are more technologically advanced.

To identify trends in the impact of technology on the structure of employment, it is first worth analyzing the impact of technological progress on the labor market in the past.

Scientists often mention that we live in the era of Industry 4.0 [8]. This means that the fourth industrial revolution in human history is already underway. In order to determine its impact on the labor market, it is advisable to consider the peculiarities of the impact of the first three industrial revolutions.

The First Industrial Revolution took place in the late eighteenth and early nineteenth centuries [9]. It began in Great Britain but spread to all developed countries. The impetus for the first industrial revolution was the invention of the steam engine. During this industrial revolution, the question was raised not only about the impact of technology on human labor in terms of reducing the physical effort of workers and incomparable increase in productivity and production, but also in terms of the risk of eliminating human labor and dismissal of workers due to their replacement by mechanical equipment. The First Industrial Revolution eliminated some low-value-added jobs in both agriculture and manufacturing, but increased their number in other industries [1].

The Second Industrial Revolution took place in the late nineteenth and early twentieth centuries [9]. It was characterized by a change in energy sources, namely the transition from coal to oil, the invention of electricity, the electric motor, the telephone, and the conveyor belt. This made it possible to significantly increase labor productivity. The chemical and steel industries also developed at that time. Thus, although during the Second Industrial Revolution labor productivity increased in most industries, which certainly led to some job losses, at the same time, other sectors of the economy (including chemical and steel industries) developed, which increased the need for workers in these areas [10]. There was a flow of labor, but not a reduction in the need for it. The Great Depression, which had nothing to do with technological progress and had completely different causes, had incomparably more devastating consequences for workers.

The Third Industrial Revolution began in 1970 and is also called the digital revolution. Its main features were the development of electronics and information and communication technologies, as well as production automation. These factors again significantly increased labor productivity [1]. During the third industrial revolution, the share of the service sector in developed countries increased significantly. The decline in employment in agriculture and industry due to the automation of processes and the use of machinery (and the resulting increase in labor productivity) contributed to the flow of labor to the service sector.

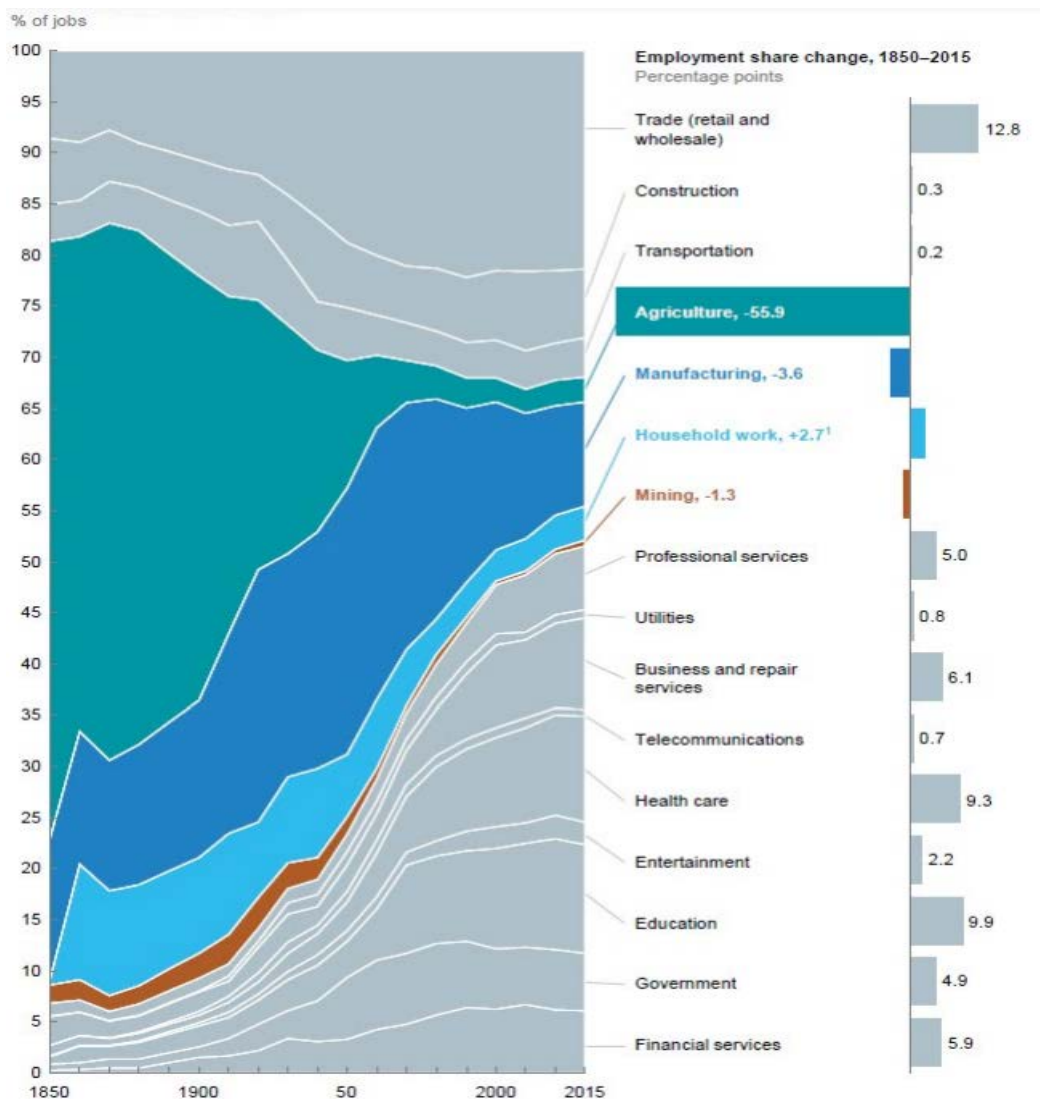
Thus, technological progress has contributed to structural changes in the labor market. Although technological development led to a decrease in employment in some areas where machines began to perform this work, at the same time, the need for workers in other areas increased. The important aspect is that such transformations not only increased labor productivity, but also made work easier for workers. As a result, both the economy and society progressed. It is also worth noting that as technology changed the way work was done,

the number of jobs created exceeded the number of jobs eliminated [11]. The combination of important innovations, as well as improvements in production methods and infrastructure development, increased both overall factor productivity and GDP per capita, which is one of the main indicators of living standards, during the nineteenth and twentieth centuries. Technology and innovation have also been associated with a net increase in total employment [10]. Since the beginning of the twenty-first century, information and communication technologies (ICTs) have further increased productivity, and new technologies, including automation, advanced robotics, and artificial intelligence, are opening up new opportunities for future productivity gains.

In terms of the structure of employment, the four technological revolutions resulted in a decline in the share of employment, first in agriculture and later in industry. Instead, there has been an increase in the share of people employed in the service sector. This trend can be seen in the structure of employment in the labor market of a technologically advanced country such as the United States (ranked 2nd in the Global Innovation Index – 2022) for the period 1850–2015 (Figure 1).

Over the period monitored, employment in agriculture experienced the largest decline (by 56%), and employment in industry fell by 3.6%. Instead, the share of people employed in trade (by 12%), educational and health services (by 9.9% and 9.3%), financial services (by 5.9%), and other services increased (Figure 1).

Figure 1 illustrates the impact of technological progress on the structure of the labor market. We can see an increase in the share of people employed in industry and a decline in the share of people employed in agriculture in the early twentieth century, when the Second Industrial Revolution took place. Instead, the share of those em-



**Figure 1. Structure of employment in the US labor market over the past 150 years**

Source: [10]

ployed in the service sector began to grow rapidly in the middle of the twentieth century, when the Third Industrial Revolution began, while the share of those employed in agriculture, mining, and to a lesser extent in other types of industry declined. Recent trends have been a decline in the share of people employed in industry, and over the past 5 years, in some types of services (e.g., educational and financial), while the share of people employed in other services (health care and repair) has been growing. In general, between 1870 and 2018, employment in the agricultural sector in the United States decreased from almost 50% of the labor force to less than 2%. Instead, the healthcare, software, and service sectors have become the main sources of employment [12]. According to forecasts, the demand for labor in the field of science will grow by 23% by 2030 [13].

Recently, artificial intelligence (AI) has become the main determinant of changes in the labor market. According to recent researches, AI will lead to job cuts in manufacturing [14], agriculture [15], and some services, as well as the creation of new jobs in other services.

To assess the impact of the level of technological development on the structure of the labor market, it is advisable to analyze the employment structure of the 10 countries with the highest Global Innovation Index (GII) scores in 2022 (developed OECD countries) and compare the results with the employment structure of the 10 countries ranked as the worst performers (developing countries). The list of countries is shown in Table 1.

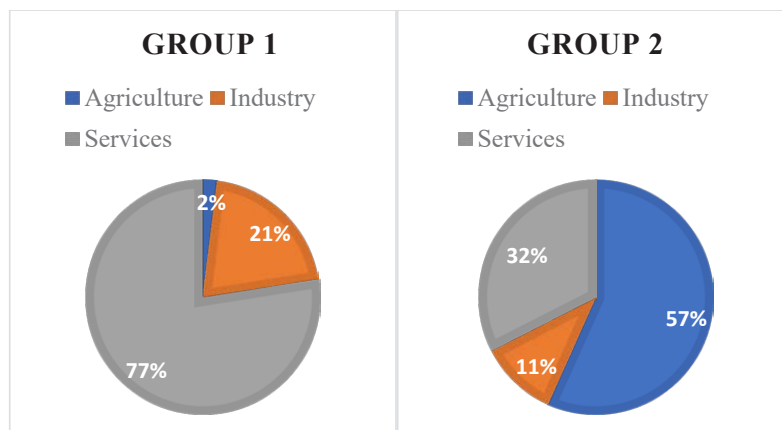
Table 1

**List of countries analyzed and their position in GII-2022**

Group 1	Position in GII-2022	Group 2	Position in GII-2022
Switzerland	1	Burkina Faso	119
USA	2	Cameroon	120
Sweden	3	Togo	121
Great Britain	4	Mozambique	122
Netherlands	5	Benin	123
Republic of Korea	6	Niger	124
Germany	8	Mali	125
Finland	9	Angola	126
Denmark	10	Yemen	127
France	12	Guinea	128

*Source: [7]*

Figure 2 shows the results of comparing the weighted average (taking into account the size of the labor force) structure of the labor market in the groups of countries analyzed. The analysis was based on the World Bank's data on the share of people employed in each sector of the economy (modeled ILO estimate) and the total labor force. In calculating the average for each of the two groups of countries, the weight of each country was proportional to the share of its labor force in the group.



**Figure 2. Comparison of the employment structure in the 10 most and least technologically advanced countries according to the GII – 2022**

*Source: calculated by the authors based on data from [16]*

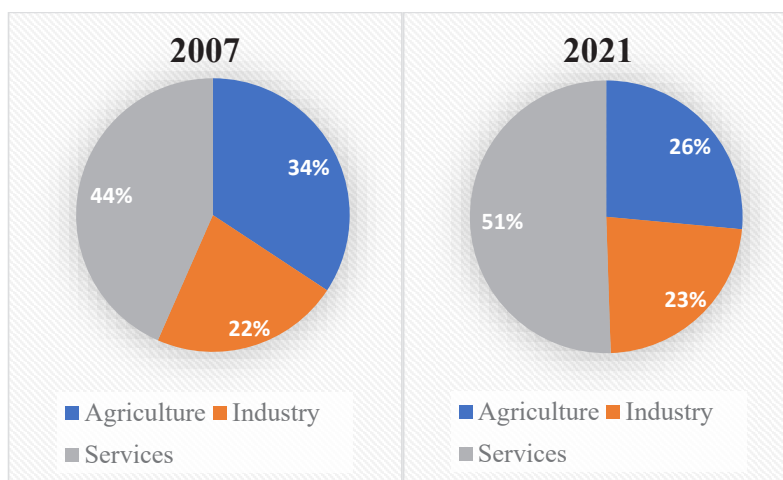
Thus, in developed countries, the share of people employed in agriculture is much smaller (2% vs. 57%), but a much larger share of the population is employed in the service sector (77% vs. 32%). The smallest difference is observed in the share of people employed in industry (21% vs. 11%). Comparing the results of the analysis with theoretical information and Figure 1, we can conclude that in the least technologically advanced countries, the structure of the labor market is in roughly the same state as it was in developed countries more than 100 years ago, before the Second Industrial Revolution. Most of the population is employed in agriculture.

Such a large difference in the structure of employment is primarily explained by the difference in technological and economic development of the countries. Labor markets in developed countries are characterized by a sufficient supply of well-trained human resources to create the required number of new highly skilled jobs. If necessary, such countries can and do attract specialists from less developed countries. These countries usually have effective social policies in place to help workers who are at risk of losing their jobs due to technological progress, improve their skills, upgrade their qualifications, or find another field of activity, as richer countries have sufficient resources to do so. Also, developed countries are characterized by lower birth rates, which also affects the labor supply. The situation in developing countries is different. In these countries, the level of education of the population is often not high, which affects the supply of qualified specialists in the labor market, so employees cannot effectively use modern technologies in their work, increase their productivity, and this increases the risk that they will be replaced by technology in the future [17]. State institutions and their role in such countries are also weaker, which affects the availability of social protection schemes for workers. For the most part, labor-intensive work that does not require a high level of qualification and special skills prevails in developing countries due to the cheapness of labor.

Now it is appropriate to consider the structure of the labor market in the dynamics. For this purpose, 180 countries were selected and the weighted average share of employment in each of the three sectors of the economy was calculated as of 2007 and 2021. The change in the structure of the labor market over 15 years is shown in Figure 3. This change is caused by technological progress, as it is this progress that affects the structure of the labor market on a global scale. Political processes, social policy, and other factors that affect the structure of the labor market may be reflected in country indicators, but not in the global trend.

Thus, technological progress has contributed to an increase in the share of people employed in the service sector from 44% to 51%, a decrease in the share of people employed in agriculture, and a virtually unchanged share of people employed in industry. It is worth noting that the values obtained in 2021 are between those for technologically advanced and relatively backward countries.

To summarize, at the current stage of human development, the employment structure depends on the level of technological development of the country, as the level of technology development affects economic growth, the quality of labor and labor productivity. The more technologically advanced a country is, the greater the proportion of the population employed in the service sector and the smaller the proportion employed in agriculture.



**Figure 3. Changes in the structure of the global labor market from 2007 to 2021**

*Source: calculated by the authors based on data from [16]*

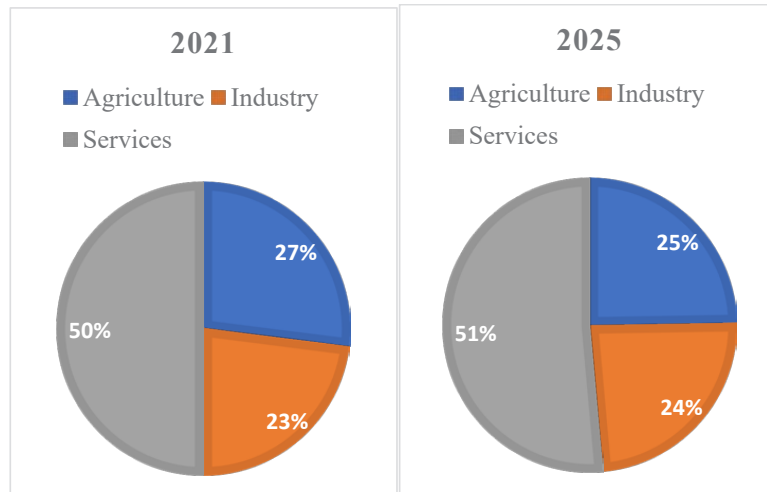


Figure 4. Forecast of the structure of the global labor market in 2025

Source: calculated by the authors based on data from [16]

To make the research more complete, it is advisable to forecast the structure of employment in technologically advanced and less developed countries. This will help identify trends that may be just emerging. Based on the data on the structure of employment in 1991–2021 in the world as a whole, the exponential smoothing algorithm was used to calculate the forecast value of the share of people employed in each of the three sectors of the economy in 2025.

According to the calculated forecast (Figure 4), with a 95% probability, it can be stated that by 2025, employment in services and industry will increase globally, while employment in agriculture will decrease.

Forecasting the structure of the labor market in 2025 was also carried out for the previously identified groups of countries. Comparing the forecasts for the top 10 and bottom 10 countries in the Global Innovation Index 2022 ranking (Figures 5, 6), it is worth noting that the more technologically advanced countries will see a significant decline in industrial employment in the future, while the least technologically advanced countries will see further declines in agricultural employment and growth in industrial employment, which has already occurred in developed countries.

This allows us to conclude that job substitution in industry is a fairly new trend that has not yet reached less technologically advanced countries.

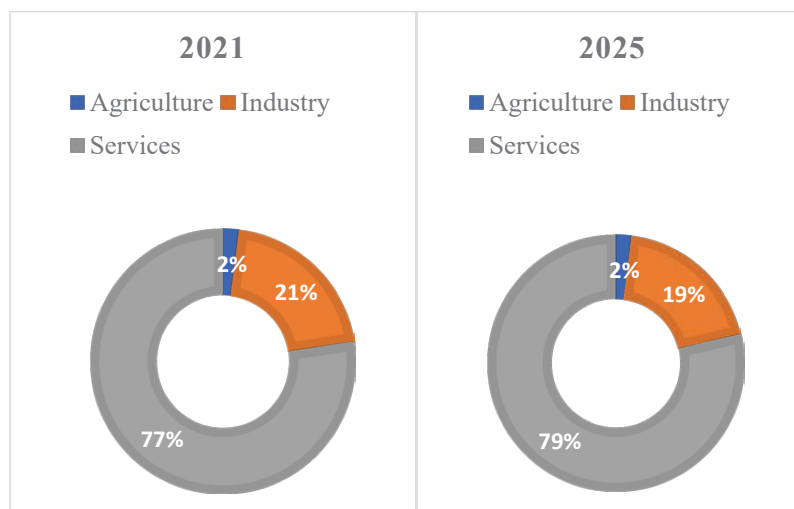
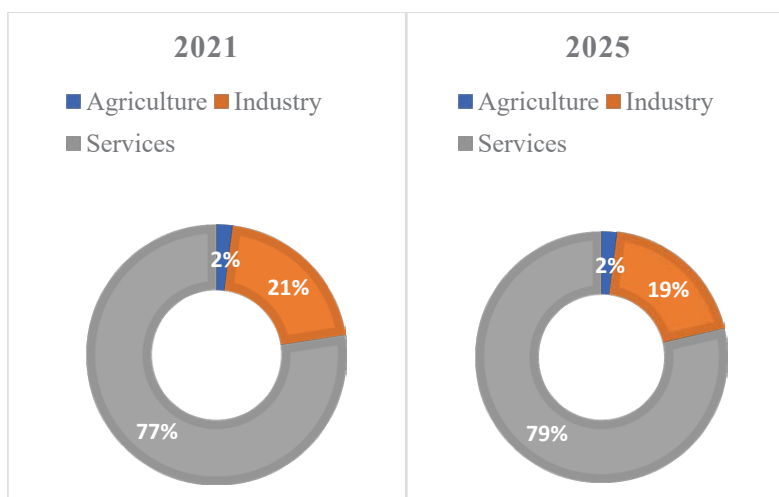


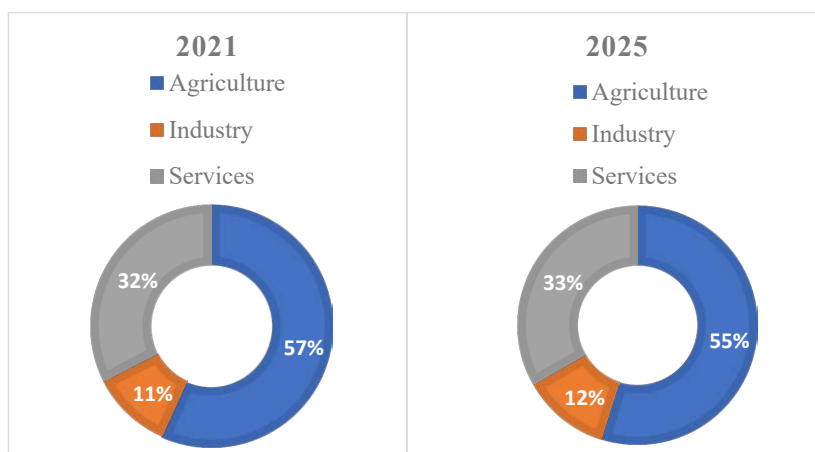
Figure 4. Forecast of the structure of the global labor market in 2025

Source: calculated by the authors based on data from [16]



**Figure 5. Forecast of the labor market structure in 10 countries with the highest GII-2022 (group 1)**

*Source: calculated by the authors based on data from [16]*



**Figure 6. Forecast of the labor market structure in 10 countries with the lowest GII-2022 (group 2)**

*Source: calculated by the authors based on data from [16]*

It is worth noting that in technologically advanced countries, there will not be a significant reduction in the share of people employed in agriculture, as this share is already low at the moment, and most of the work is already done by machines.

Thus, the main consequence of technological progress on the structure of the labor market at the present stage is a reduction in the share of people employed in industry, rather than in agriculture, as it was before. For now, this trend is only evident in technologically advanced countries, where the share of employment in agriculture is already low. There are good reasons to hope that this trend will eventually reach less technologically advanced countries, as they have not yet passed the first stage of transformation (reduction of the share of employment in agriculture).

Comparing changes in the global employment structure with changes in the employment structure by country group, we can see that structural changes on a global scale are closer to changes in less developed countries, namely, growth in industrial employment and a decline in agricultural employment.

**Conclusions.** The impact of technology on the labor market consists in increasing labor productivity and reducing the share of physical and low-skilled labor. Throughout history, technological transformations have led to a shift in labor from physical to intellectual labor, from agriculture to industry, and later to services.

The structure of the labor market in technologically advanced countries differs significantly from that in technologically backward countries. While in developed countries the majority of the population is employed

in the service sector, in developing countries the population is mainly engaged in agriculture. There are also differences in the dynamics of the employment structure: while in technological countries the share of people employed in industry is decreasing and the share of people employed in services is increasing, in less technological countries the share of people employed in agriculture is decreasing, while the share of people employed in industry is increasing. These trends are expected to continue in the future. In general, it can be concluded that technologically backward countries are on the same path as developed countries were decades ago. The trends that prevailed in developed countries in the first half and middle of the twentieth century are now present in a number of developing countries.

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**Lidiya Yemelyanova**, Candidate of Economic Sciences, Associate Professor at the Department of International Economic Analysis and Finance. **Semen Mlynko**, Master's Student, Ivan Franko National University of Lviv. **The impact of technology on the structure of employment at the present stage.**

The article analyzes the impact of technology on the labor market in the past, as well as the current state of the labor market and the prospects for its transformation in the near future. The measures that serve as indicators of the level of technological development are identified. The impact of technology on the labor market is characterized. It is found that technological development increases labor productivity, which leads to economic growth. A comparison of the employment structure in technologically advanced countries and technologically backward countries is made. It is found that the employment structure of these two groups of countries differs significantly, and the trends prevailing in the labor markets of the studied groups of countries are also different. The reasons for these differences are clarified. It has been found that technologically backward countries, which are also developing countries, have different labor market conditions from developed countries, lower labor force qualifications and weaker social policies. It was also found that in developed countries, there is no longer a reduction in employment in agriculture, but employment in industry is declining. Common to the labor markets of both groups of countries is an increase in the share of those employed in the service sector. The current state and prospects of transformations in the global labor market are determined. It has been found that global trends are closer to those of developing countries than to the trends prevailing in the labor markets of developed countries.

**Key words:** technology, productivity, labor market, industrial revolution, service sector.

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У статті проаналізовано вплив технологій на ринок праці в минулому, а також розглянуто сучасний стан ринку праці та перспективи його трансформацій у найближчому майбутньому. Проведено аналіз впливу рівня технологічного розвитку країни на структуру зайнятості в основних секторах економіки. Визначено показники, які слугують індикаторами рівня технологічного розвитку. Охарактеризовано вплив технологій на ринок праці. Виявлено, що технологічний розвиток збільшує продуктивність праці, а це веде до економічного зростання. На прикладі США з'ясовано, що внаслідок трансформацій на ринку праці розвинутих країн в минулому скоротилась частка важкої та низькокваліфікованої праці, натомість зросла частка зайнятих спочатку у промисловості, а з середини ХХ століття – у сфері послуг. Проте в наш час зайнятість у певних видах послуг зростає, у той час як в інших – починає зменшуватись. Проведено порівняння структури зайнятості в технологічно розвинутих країнах та технологічно відсталих. Виявлено, що структура зайнятості цих двох груп країн значно різниться, відмінними є також тренди, що панують на ринках праці цих двох груп країн. З'ясовано причини цих розбіжностей. Виявлено, що технологічно відсталі країни, які є також країнами, що розвиваються, мають відмінні від розвинутих країн умови розвитку ринку праці, нижчу кваліфікацію робочої сили та слабшу соціальну політику держави, спричинену браком фінансових ресурсів у державної влади. Також виявлено, що в розвинутих країнах більше не відбувається скорочення зайнятих у сільському господарстві, натомість скорочується зайнятість у промисловості. У країнах, що розвиваються, продовжується скорочення частки зайнятих у сільському господарстві, натомість зростає частка зайнятих у промисловості. Спільним для ринків праці обох груп країн є збільшення частки зайнятих у сфері послуг. Проаналізовано сучасний стан та перспективи трансформацій на світовому ринку праці. Виявлено, що світові тренди є ближчими до трендів країн, що розвиваються, ніж до трендів, що панують на ринках праці розвинутих країн: існують перспективи подальшого зростання зайнятих як у сфері послуг, так і в промисловості та скорочення зайнятості у сільському господарстві.

**Ключові слова:** технології, продуктивність, ринок праці, промислова революція, сфера послуг.