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THE IMPACT OF TECHNOLOGICAL INNOVATIONS ON EMPLOYMENT IN THE FINANCIAL SECTOR

The object of research is the employment in the financial sector of three countries with different levels of development – the United Kingdom, South Korea, and Ukraine. It is well known that the current stage of the industrial revolution («Industry 4.0») is fundamentally different from previous ones, as it threatens the massive displacement of mental labor. This paper attempts to assess the impact of technological innovations on employment in the financial sector.

Theoretical, statistical, and econometric methods are used in this research. The paper systemizes the various points of view on how the fourth industrial revolution may affect the labor market and attempts to test the validity of existing approaches. An analysis of the relationship between each country's level of technological development (which is measured by the Global innovation index) and the number of employees in the financial sector over the past seven years is conducted. A single-factor model is constructed for each country.

Correlation and regression analysis prove the inverse relationship between the indicators in all countries: the higher the level of innovation, the lower the employment level. The results differ among countries only in terms of the strength of the relationship. The strongest relationship is found in South Korea, although the country is lower in the ranking of innovation potential and achievements compared to the United Kingdom. At the same time, South Korea is known as the world leader in terms of the number of robots per capita. However, the obtained results allow to state that there is a strong correlation between the two indicators in both developed countries.

In Ukraine, there is a clear downward trend of employment in the financial sector, and the values of the Global innovation index are noticeably smaller and quite volatile. Econometric analysis shows that the relationship is also inverse, as in developed countries, but it is weaker. Therefore, the research results confirm the fears of those economists who extend the negative consequences of technological innovations to developing countries.

Keywords: *employment, unemployment, financial sector, global innovation index, fourth industrial revolution.*

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1. Introduction

The problem of the impact of technological progress on employment has been perennial since the first industrial revolution when resistance to the initial primitive mechanization took the form of an aggressive Luddite movement. The second industrial revolution which occurred thanks to the development of assembly line production and the use of electricity, has already led to the mass displacement of hard physical labor. Therefore, technological inventions, while accelerating economic development in every way, also had the undesirable effect of technological unemployment. But beginning with the third industrial revolution, the displacement of labor force by machines has already spread to mental activity [1].

We are living in the times of «Industry 4.0», the recent warnings related to artificial intelligence when anxiety about mass unemployment is gripping more and more white-collar workers – office and service sector workers. Proof of this can already be observed all around – over the past decades, computers have replaced a number of jobs, including the functions of telephone operators, cashiers and accountants.

Recognized researchers of the problem of the fourth industrial revolution and the impact of high technology on the labor market note the global risks posed by new technologies, including a sharp decrease in the chances of employment for a significant number of workers, salary reduction, deepening economic and gender inequality [2–4].

Employees of Oxford University researched the impact of computerization on the US labor market, covering 702 professions, and determined that about 47 % of total jobs will be automated [5]. Their later study, conducted with other scholars, extended the analysis to new countries and regions and allowed them to make a conclusion that a similar situation is observed in developing countries. They estimated that about 85 % of jobs in Ethiopia, 77 % in China, 72 % in Thailand, 69 % in India, 67 % in South Africa, 65 % in Argentina are threatened by automation [6].

A separate group consists of techno-optimists, who believe that the substitution effect created by automation and artificial intelligence counteracts the productivity effect, which increases the need for workers to perform non-standard tasks. This effect is complemented by additional capital accumulation and improvement of existing equipment, which inevitably increases the demand for labor [7].

A similar approach was used in the study [8]. But after analyzing data from 21 OECD countries and tak-

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ing into account the heterogeneity of tasks within each profession, its authors found that the threat from technological progress is significantly less: on average, 9 % of jobs being replaced by automation. At the same time, there is a considerable heterogeneity by country: while in Korea and Estonia the share is 6 %, in Austria and Germany it is 12 % [8]. Such differences between countries reflect general differences in the organization of jobs, the direction of investment, and the education of workers.

Lithuanian researchers using data from 25 European countries for the period of 2000–2012 came to the conclusion that the technological innovations have no effect on unemployment [9]. They explain this unexpected result by the fact that the total unemployment rate is a multifactorial value. The situation in the labor market depends on macroeconomic conditions, legislative norms affecting the investment decisions of firms, institutional restrictions, the composition of households, preferences for leisure, etc., makes it difficult to identify the impact of technologies on the employment rate.

Based on the existing divergence of opinions, it is advisable to check the above assumptions. *The aim of research* is to build its own empirical model and to test the presence and strength of the connection between new technologies and employment. Three countries were chosen as *the object of this research*. The United Kingdom, a developed Western European country, South Korea that holds the world record for the relative number of industrial robots, and Ukraine, which is threatened by the position of an outsider in the fourth industrial revolution [10]. In this case, the scope of the study is narrowed to one type of economic activity, namely financial and insurance, which is often mentioned as having a high risk to automation.

2. Methods of research

The Global Innovation Index (GII) was used to assess the level of innovation [11]. It consists of 82 different indicators divided into two groups: Innovation Input and Innovation Output. And thus, according to the organizers, it allows objective assessment of the development of innovation in differently economically developed countries around the world.

Data on employment in the finance and insurance services sector are drawn from the websites of the statistical services of the respective countries [12–14]. The time series covers the last 7 years because this number is enough for conducting correlation and regression analysis.

The simple linear regression model is chosen as an estimator for the research. The explanatory variable is the level of innovation (The Global Innovation Index); the endogenous variable is employment in the financial services sector.

The functional form of the regression model used in the research is linear. Variable «*x*» is the level of innovation and the variable «y» is the number of employees in the financial services sector:

$$y=a+b*x.$$

Given the assumptions, the relationship between variables should have a negative direction: the higher the level of innovation, the lower the employment, so the parameter $b<0$.

The correlation coefficient is used to measure the strength of the relationship between these variables.

3. Research results and discussion

The United Kingdom is consistently ranked at a high level in Global Innovation Index [11]. According to OECD research only 10 % of employees in the country are at high risk of disappearing [8]. PwC analysts concluded that up to 30 % of the UK jobs could be automated by the early 2030s. It is lower than the US (38 %) or Germany (35 %), but higher than Japan (21 %) [15].

The risk of job automation in the financial and insurance sector is 61 % in the US and 32 % in the UK. Researchers explain this gap by the fact that the level of education and skills of workers in this sector is much higher in the UK than in the US: City of London professionals work in international markets, and American – mainly in the domestic retail market [15]. However, the situation may worsen due to Brexit.

Statistic data of the UK economy are given in Table 1.

Table 1

The level of innovation and employment in the financial sector of the UK economy, 2013–2019

Year	2013	2014	2015	2016	2017	2018	2019
Number of employees in the financial services sector in the UK (thsd)	1,172	1,182	1,279	1,196	1,241	1,373	1,276
Global Innovation Index, GII	61.25	62.37	62.42	61.93	60.89	60.13	61.30

Note: formed by the author based on data from [11, 12]

Fig. 1 is given for a visual assessment of the relationship between employment and level of innovation and for further analysis.

Until 2016, it is possible to see similar trends that illustrate the direct relationship, but in the period 2016–2018, employment is growing, and in 2018–2019 it is possible to see a decline. The Global Innovation Index illustrates the opposite trend at this time. It indicates an inverse relationship.

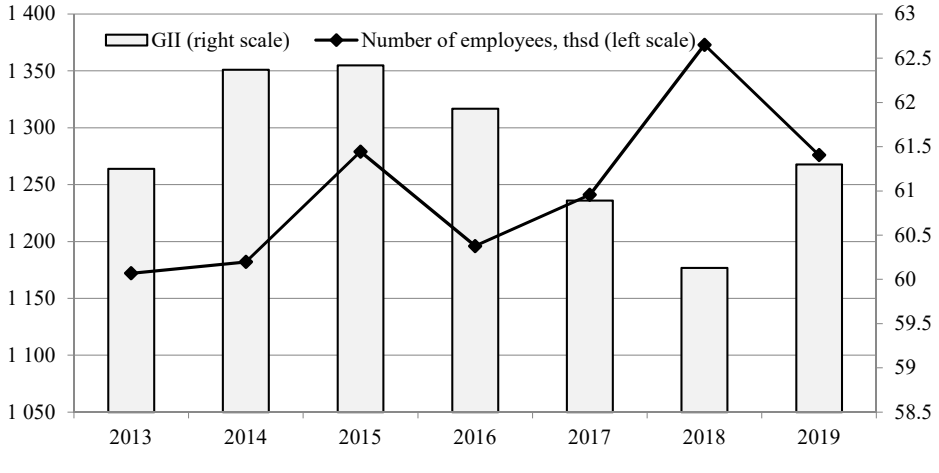

Fig. 1. Dynamics of indicators of the UK, 2013–2019

As for the dynamics, it is ambiguous. In both indicators it is possible to see the alternation of falls and rises. However, in 2019, employment in the UK services sector is slightly lower than in 2015. The range of variation of the innovation index is 60.13–62.42. It is complicated to predict further changes, as the indicators do not show a clear trend.

Calculated parameters: a=4,298.31, b=–46.67.

The regression equation has the form:

$$y=4{,}298.31-49.67x,$$

$b<0$, hence the relationship has a negative direction. With a growth in the level of innovation of the UK economy at 1 unit, the level of employment decreases at 49.67 thousand people.

$a>0$, hence the level of innovation changes more rapidly, than employment.

a has an economic significance since the equation y=4,298.31+0 makes sense because the level of employment can be positive if the innovation index falls to 0.

The strength of the relationship is measured by the Pearson correlation coefficient. After performing the necessary calculations, let's obtain the next result:

$$\eta=-0.7954.$$

The obtained coefficient belongs to the interval [0.7–0.9], therefore there is a strong relationship.

In the face of the global challenges of the twenty-first century South Korea has established itself as a country with high innovation potential. Small in area, it was not able to gain a prominent position on the world stage with its own resources, so the path of technological and scientific development was chosen. The lack of natural resources has been compensated by the development of human capital, so today Korea is known for having one of the highest levels of a skilled and professional workforce. The country is characterized by intensive investment in the field of education, science and technology [16].

According to OECD research the share of automatable jobs in Korea is only 6 % [8]. But the decline of employment has already been observed in the finance and insurance services sector of the economy [17]. This can be proved by the example of data in Table 2.

Table 2

The level of innovation and employment in the financial sector of the South Korean economy, 2013–2019

Year	2013	2014	2015	2016	2017	2018	2019
Number of employees in the financial services sector in South Korea (thsd)	862	819	760	776	758	804	761
Global Innovation Index, GII	53.9	53.31	55.27	56.26	57.15	57.70	56.63

Note: formed by the authors based on data from [11, 13]

Fig. 2 shows the statistical data.

The highest number of employees can be seen in 2013 and 2014, and the innovation index is currently the lowest. In the next years the gradual increase in GII was accompanied by fluctuations in the number of employees. There were some periods where the inverse relationship was apparent and some periods – with the direct relationship where the growth of innovation index has been accompanied by the growth of employment. However, in 2017 and 2019 when employment was the lowest, the index was almost the highest.

In total, in 7 years, the financial services sector has lost about 100 thousand employees. Employment dynamics illustrate a declining trend, while GII dynamics are fuzzy. By 2019, further growth could be predicted, but the level of the indicator suddenly decreased. In general, the index ranges from 53.31 to 57.70.

Next, the parameters for the linear regression equation are calculated, they look like this: a=1,605.71, b=–14.61.

The regression equation:

$$y=1605.71-14.61x,$$

$b<0$, that is, it illustrates the inverse relationship. Employment will decrease by 14.61 thousand if innovation increases by 1 unit.

$a>0$, hence GII is changing faster than employment.

a also has an economic significance since the equation y=1,605.71+0 makes sense. If the GII falls to 0, employment can be positive.

The Pearson correlation coefficient was used for further research. It was calculated that:

$$\eta=-0.8689.$$

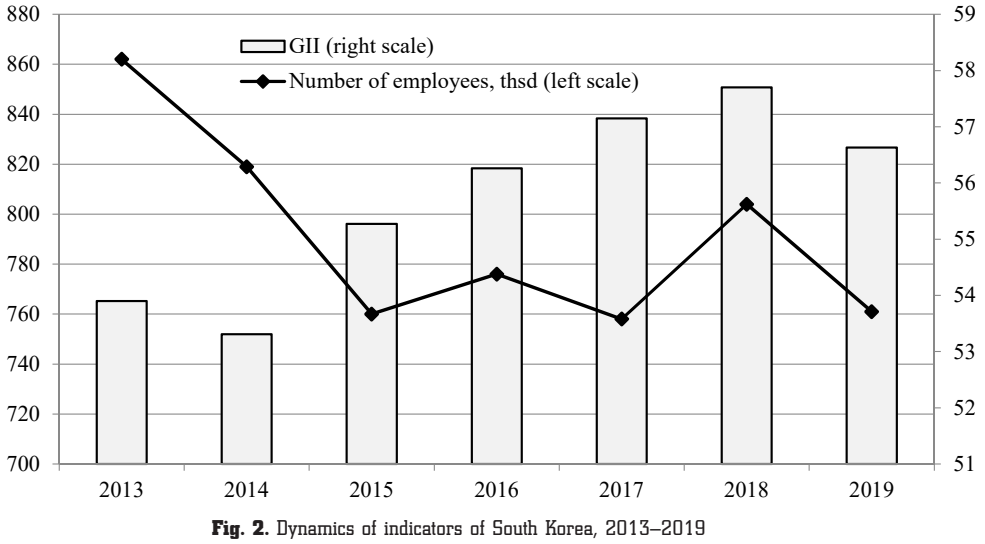

Fig. 2. Dynamics of indicators of South Korea, 2013–2019

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The indicator belongs to the interval [0.7–0.9], which illustrates the strong relationship.

In Ukraine, employment by sector is uneven in absolute terms, but the share of the decline in employment in the financial sector is the largest – 30.9 % in 2019, compared to 2013. However, this can be attributed to the policy of the National Bank of Ukraine to reduce the number of banking institutions. The reform of 2014–2019 contributed to the stabilization and strengthening of the financial sector through the clean-up of toxic and insolvent banks.

Thus, it is possible to observe a decline in employment in the selected sector, although it may depend not so much on technology as on reforms. Table 3 shows the dynamics of employment in finance and GII.

Table 3

The level of innovation and employment in the financial sector of the Ukrainian economy, 2013–2019

Year	2013	2014	2015	2016	2017	2018	2019
Number of employees in the financial services sector in Ukraine (thsd)	306.2	286.8	243.6	225.6	215.9	214.0	211.6
Global Innovation Index, GII	35.78	36.26	36.45	35.72	37.62	38.52	37.40

Note: formed by the authors based on data from [11, 14]

Fig. 3 is drawn for a more visual comparison of data.

In Fig. 3 there is a clear tendency to reduce the number of employees in the financial sector, while GII is quite volatile. However, in 2018 employment was low, while the index was the highest. If to study the direction of the relationship, in the periods 2013–2015 and 2016–2018 GII has an upward trend, and employment, as noted, decreased. This indicates a negative direction. It is worth noting that in 2019 in Ukraine employment in the financial sector not only decreased, but also decreased the level of innovation. This indicates the instability of positions.

The level of innovation of Ukraine lags far behind the countries analyzed above and ranges from 35.72 to 38.52. For comparison, the level of innovation of the United Kingdom fluctuates around 60 units, and South Korea – about 55 units.

Calculated parameters: a=1,237.07, b=–26.72.

So, the regression equation has the form:

$$y=1137.85-24.29x,$$

$b<0$, hence the relationship has a negative direction. With the growth of the GII at 1 unit, employment in the financial services sector decreases at 24.29 thousand people.

$a>0$, GII again changes more rapidly, than employment.

a also has economic significance, similarly to other countries.

Due to the heterogeneous fluctuations of the Global Innovation Index in Ukraine, it is impossible to divide adequately the indicators into intervals, so then the normal correlation coefficient is applied. It is calculated that:

$$y=-0.6666.$$

The indicator belongs to the interval [0.5–0.7], which illustrates the moderate relationship.

4. Conclusions

The results of this research provide an opportunity to draw the following conclusions.

1. Inverse relationship between the indicators has been confirmed. Three negative correlation coefficients have been obtained, which prove that as the level of innovation increases, the number of employees decreases. Since the financial services sector has been studied, it can be argued that threats exist not only for routine work but also for mental work.

2. The strength of the relationship between the level of innovation and number of employees varies by country. So, South Korea has the strongest relationship, although the country does not rank first in the Global Innovation Index. This means that the country is already in the process of robotization and the introduction of high technology and employment decline is not limited to the financial sector.

3. The United Kingdom illustrates a slightly weaker relationship than South Korea, but also a stronger one. According to the Global Innovation Index, the country has a stable position at the beginning of the ranking, well ahead of Korea, which indicates its readiness for technological change and the use of technology at this stage of development.

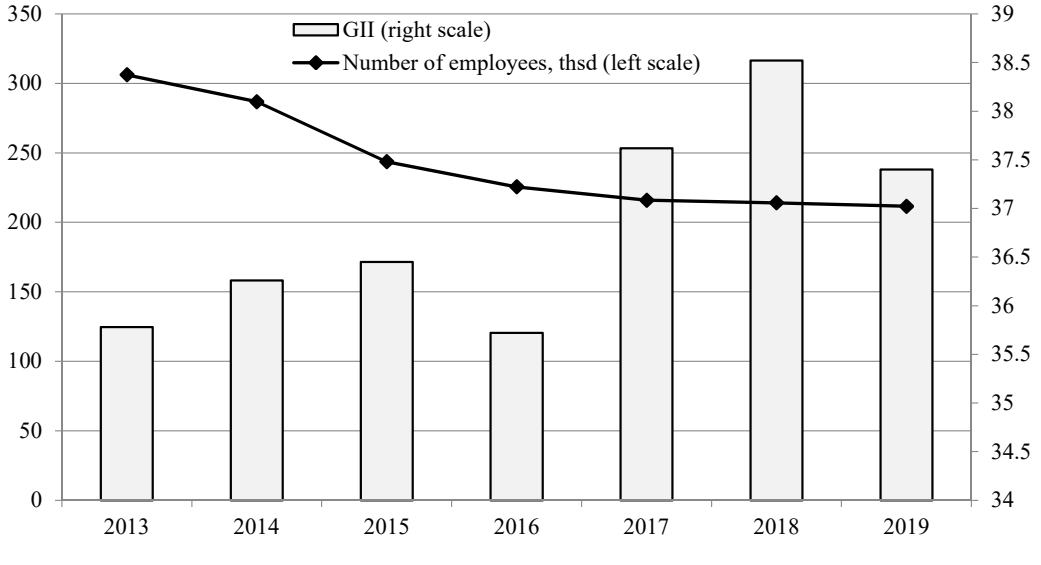

Fig. 3. Dynamics of indicators of Ukraine, 2013–2019

4. In Ukraine, an inverse relationship between innovation and employment has also been found. Its strength is much weaker than in other countries but is moderate. It means that certain technologies are being introduced into the financial services sector, but they are replacing primitive labor. It is too early to talk about the threats of mass automation.

The data obtained during the study are presented in Table 4.

Table 4

The results of empirical research

Country	Correlations	The strength of the relationship	Supposition
The United Kingdom	–0.7954	Strong	Global robotics, mass unemployment
South Korea	–0.8689	Strong	
Ukraine	–0.6666	Moderate	The impact of robotics only on certain professions

Note: formed by the authors

Based on these results and going back to existing approaches in economics, it is possible to assume the correctness of the predictions of techno-pessimists [5, 6], who extend their conclusions not only to developed countries but also to developing countries. Prospects for further researches may be related to an in-depth analysis of the impact of innovations not only on the level of employment but also on its structure.

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