IS INDUSTRY 4.0 A REVOLUTIONARY OR EVOLUTIONARY CHANGE? ANALYSIS OF CHOSEN ECONOMIC INDICATORS FOR SLOVAK AND CZECH ECONOMY

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Abstract: *Since Industry 4.0 has emerged, it has provoked discussions among managers, politicians, educators, workers, and the wide public. Involvement of new technologies into production process, but also rapid development of information and communication technologies, is associated with this concept. These tendencies are a source of concern for workers in the labor market, as Industry 4.0 initiative is seen as a revolutionary change in the production process instead of an evolutionary economic development, especially with positive impact on labor productivity. This concept of Industry 4.0 is used for the analysis of selected economic indicators in the conditions of Slovak and Czech economy from 1995 to 2018, for the analysis of development in all sectors together, but also in individual sectors separately. The results confirm the assumption of a rather evolutionary approach to the economic development, which, after the period of economic transformation, indicates continual investments in technological equipment with new technologies as well, rising productivity and wages, accompanied by increase in number of workers and decrease in hours worked per employee, than a revolutionary change due to implementation of Industry 4.0 initiative. However, the results also point to different developments across sectors.*

Keywords: *Industry 4.0, Gross Fixed Capital Formation, Labor Productivity, Wages*

JEL Classification: O11, E24

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1 Introduction

The topic of Industry 4.0 relates to the idea of dramatic changes in the ways of production, especially those connected with the use of new technologies, affecting labor market as well. Changes in the competencies of future workers expected, such as the ability of workers to operate these new technologies and thus to continue to engage in the production activities of enterprises, also create expectation of changes in the vocational education and training (Mason & Vanark, 1994; Pecina & Sládek, 2017; Gashenko et al., 2020). If these pressures on the need to have the necessary competencies of workers are not respected, in the context of Industry 4.0 concept, dismissal of such workers, and at the same time shortage of workers with the appropriate competencies, are assumed. The change in structures of jobs is also expected, further underlining these trends. The public debate accelerated by social media contributes to creating the fear of lots of jobs vanishing.

These ideas are based on the conviction that changes connected with Industry 4.0 are radical. But if we look back in history, there were changes in production caused by industrialization (Settsu & Takashima, 2020; Hasino & Otsuka, 2020) and they were also connected with the same kind of fears. From emotional point of view, the fear of losing individual competitive position of each of us as workers due to the implementation of new technologies and the need of new competencies is understandable at individual level. But there should be some-kind of global perspective which could make us relax and provide us with suitable understanding that all the changes caused by the implementation of Industry 4.0 would have positive effect on our lives. As manifested by the previous industrial revolutions, the future positive effects are much bigger than contemporary negative expectations of scared workers.

Although it is true that there are changes affecting production and employees due to Industry 4.0, these changes are not radical nor endangering the position of workers in many companies in variety of economic sectors. Based on economic data, the opinion will be presented that economic development in Slovakia and Czech Republic is an evolutionary change with a possible positive impact on workers rather than a revolutionary change connected with Industry 4.0 initiative. We are supposed to prepare for changes inevitably coming and bringing a more productive and effective future to companies, workers, and consumers. But it seems, that changes inevitably coming would not occur as fast as they were assumed, and we will have enough time to adapt

to the evolutionary changes connected with the implementation of Industry 4.0.

2 Development of industrial revolutions

People constantly procured wide range of goods to meet their needs. Since human needs can be described as unlimited and, on the other hand, resources for creating goods to satisfy human needs are limited, the production of these goods must be organized in an efficient way. In this sense, we can talk about a long-lasting trend of increasing productivity, which manifested itself, among other things, in the division of labor and specialization. The increasing pressure on production growth thus necessarily led to the use of any opportunity to increase production efficiency, including knowledge and new production technologies.

In the 18th century production technologies based on the use of the power of water and steam were implemented in the production process. Thus, we can date the first industrial revolution to 1784, which we could call Industry 1.0. Within this wave of production development, there is an extensive development of production facilities using production technologies and significantly increasing the volume of production, while replacing the manual work of workers with the activities performed by machines.

A period of one hundred years had passed and the developments in the field of technology and at the same time in the field of organization and management of manufacturing companies reached the point that we call the second industrial revolution, or Industry 2.0. This is associated with the extensive division of labor and specialization in connection with the development of mass production and assembly lines, which occurred around 1870. These approaches to production further increased labor productivity and led to further increase in production. Once again, we can identify a potential threat in the form of replacement of workers by machines. In addition to the division of labor and specialization, in the sense of Taylor's scientific management principles or establishment of assembly lines according to Henry Ford approach, there is also dehumanization of workers used as no more than another production source. On the other hand, the increasing productivity and falling production costs lead to increase in the volume of production and reduction of this production price, which allow both, greater satisfaction of customers' needs and a rising number of

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companies creating opportunities for more workers to be employed.

The third industrial revolution, or Industry 3.0, dates to 1969, and relates to the involvement of electronics and information technology into the production process. Although electricity continues to be a significant resource for mechanical machines in manufacturing, electronics and information technology further increase productivity as computing capacity and potential for the use of information technology in the production process growth (Lazanyi & Lambovska, 2020).

These three industrial revolutions mentioned so far can be characterized as spontaneous, and their designation as industrial revolutions comes only subsequently, with the recognition of their effects on production processes and the economy. In this sense, there was a change in approach to the industrial revolutions in 2011, when the fourth industrial revolution, Industry 4.0, was announced as a man-made activity using technological progress to boost production.

Industry 4.0 is thus based on a rapid development of information and communication technologies, digital technologies, development of globalization and availability of big data, robotics, artificial intelligence, and other areas. In this context, initiative to adapt to these trends is also much more prominent, by consciously influencing the training of future workers (Zhong et al., 2017; Kowalikova, Polak & Rakowski, 2020; Silva et al., 2020). This is also due to assumptions about changes in the structure of occupational types, i.e., the assumption of the demise of many occupations and the emergence of new, hitherto unknown types of occupations (Flores, Xu & Lu, 2020). In this sense the concept of Education 4.0 emerged. In the area of impacts on society, the concept of Society 4.0 or even Society 5.0 is also part of the discussion.

Although only a few years have passed since the announcement of Industry 4.0, several negative areas have emerged in the discussion of its concept and impact on the society. One of them is the already mentioned concern about the impact on the labor market, as well as in the field of education. However, the criticism of Industry 4.0 also lies in the excessive focus on productivity and increasing efficiency of the production process, regardless of environmental pollution and extensive use of resources. The relationship resulting from mechanization, which puts workers in the role of insignificant machine manipulators, creates requirements for appropriate qualifications of workers rather than use of human potential, is also criticized (Xu et al., 2021).

That is why Industry 5.0 initiative emerges, which regulates the approach to the fourth industrial revolution, in which the relationship between worker and machine is seen as cooperation (Demir, Döven & Sezen, 2019; Nahavandi, 2019). It emphasizes the position of workers as a source of innovation and inspiration and puts machines in the role of helpers capable of developing human potential. Emphasis is placed on the specification of production respecting individual customer requirements and on a wider use of renewable resources and circular economy (European Commission, 2022).

3 Methodology

The main idea of the analysis is to characterize the development of chosen economic indexes to show the development of economic processes in the Czech Republic and Slovakia in sectors according to NACE breakdown. The indexes were chosen in such way that they can illustrate the labor productivity (Szirmal, 2015; Vonyo & Klien, 2019) and other economic indexes (Brahama, Tripathi & Sahay, 2021; Xu, Xu & Li, 2018), which can relate to industrial revolutions and can indicate the impact and benefits of Industry 4.0 initiative.

According to the analysis of chosen economic indexes, the aim of the article is to answer the question if the changes in economies of Slovakia and the Czech Republic, analyzed at the level of individual sectors according to NACE breakdown, indicate the impact of Industry 4.0 initiative as a revolutionary change or evolutionary development. In other words, it intends to identify if there are significant changes – leap changes – in the results of the analysis of chosen economic indicators enabling us to confirm the significant impact of Industry 4.0 initiative in Slovakia or the Czech Republic. Besides, the results of conducted analysis should bring hard data to the emotional discussion of the impacts of Industry 4.0 initiative on workers and workers' conditions which are nowadays rather emotional and full of worries and fears of losing jobs or having difficulties to adapt to the new, changed production conditions by workers.

For the analysis, the data from Eurostat database were used. The data were analyzed in the time-period from 1995 till 2018, which is the longest range available with complete datasets. Such a long-term period was chosen both, to identify the long-term changes in both economies and at the same time to identify whether effects of Industry 4.0 occur in these economies or in any

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sector of these economies. As there were, and in the Czech Republic still is, different currencies, the Euro was chosen as a summarizing currency for the whole time-period. The selected data were (with abbreviation in brackets):

- (O) output,
- (CoE) compensation on employees,
- (CoFC) consumption of fixed capital,
- (GFCF) gross fixed capital formation,
- (HTE) hours worked by employees within total employment,
- (PTE) number of employees within total employment as volume of persons.

Those data were analyzed for the whole national economy and in each sector type according to NACE classification as follows (with abbreviation in brackets):

- (All) total – all NACE activities,
- (A) agriculture, forestry, and fishing,
- (B-E) industry except construction,
- (F) construction,
- (G-I) wholesale and retail trade, transport, accommodation, and food service activities,
- (J) information and communication,
- (K) financial and insurance activities,
- (L) real estate activities,
- (M-N) professional, scientific, and technical activities; administrative and support service activities,
- (O-Q) public administration, defense, education, human health, and social work activities,
- (R-U) arts, entertainment and recreation, other service activities; activities of household and extra-territorial organizations and bodies.

From the ratios the most important for the influence of the Industry 4.0 are the following (computation of ratios from economic variables in brackets):

- (CoE/O) personal costs,
- (CoFC/O) fixed costs,
- (O/PTE) workers productivity,
- (CoE/PTE) workers wage,
- (HTE/PTE) annual hours worked per employee.

In the graph there are mutual comparison of the selected variables and ratios presented to illustrate the development of whole economy (all sectors) and for each sector for both countries, the Czech Republic and Slovakia.

4 Data and analysis

The economic situation and development of the selected indicators for the entire Slovak and Czech economy, i.e., for all sectors of individual economies, are characterized as input to the analysis. This approach assumes, that if there are strong tendencies manifested in the fear of many people in connection with job loss and the possibility of future employment, the data for all sectors should show a significant change in the trends of the observed economic indicators.

Thus, in Figure 1 and 2, there are mutual relationships between chosen indicators for the Slovak and Czech economy presented. The results are presented in such a way that it is possible to identify the relationship between the analyzed variables and to monitor the development of this relationship in the period 1995 to 2018 at the same time.

The relationship between capital equipment and the volume of workers is presented, where the capital equipment is represented by gross fixed capital formation and the volume of workers is represented by thousands of persons employed recalculated for total full-time employment. If the influence of Industry 4.0 should manifest itself in the data in accordance with the fear of losing jobs due to the replacement of workers by machines, there should be a decrease in the volume of workers as the volume of gross fixed capital formation increases. But there are no such trends in the Czech economy nor the Slovak

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economy. The relationship is directly proportional and moderately strong (R^2 = 0.74 for Slovakia; R^2 = 0.43 for Czech Republic) according to the analyzed data. It is possible to identify only a gradual increase in employment, with the rising number of workers especially after the year 2000, while increasing the amount of fixed assets. This can be interpreted as a successful transformation of both economies and their gradual economic development connected with increase in production. The increase in investment in technological equipment of enterprises can be identified in both economies, however, accompanied by the need for larger number of workers, especially at the end of the analyzed time-period.

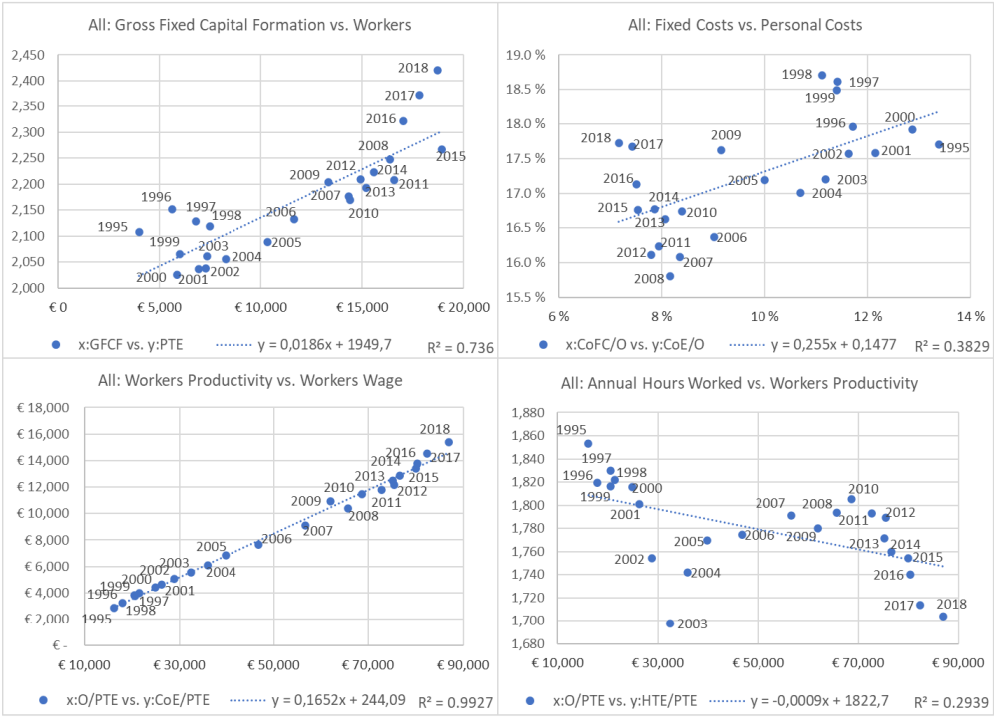
Subsequently, a similar view is also provided by the analysis of relationship between fixed costs and personal costs calculated as share of output of Czech and Slovak economy. As in the previous case, there is directly proportional relationship between both ratios, indicating the overall economic development of both countries rather than the impact of Industry 4.0. In this case, the increase in productivity in both areas, in the use of technology and in the field of human resources, can be identified, as both cost ratios decrease over the analyzed time-period.

Neither of these two relationships indicates the expected impact of Industry 4.0 activities, so the data do not suggest substitution of manual labor by manufacturing technologies. Regarding the evolution of the analyzed variables in time, respectively the ratios related to capital equipment and human work, it is possible to identify increase in the total number of employees in both economies and at the same time increase in capital equipment. In addition, the growth of capital equipment is accompanied by decline in the share of fixed costs in the economy's output compared to the 90s. The data also do not indicate significant leap that could be associated with Industry 4.0 initiative. If a more significant systemic change in the data structure can be identified, then this change is more related to the period of economic boom from 2000 to 2008, i.e., in the period between two economic crises. It therefore rather indicates a reaction of economies to the standard economic cycle.

The assumption of ongoing economic development in both countries is also supported by the third analyzed relationship, which captures the relationship between labor productivity and workers' wages. This relationship is significantly the strongest (R^2 = 0.99 for Slovakia; R^2 = 0.99 for Czech Republic) from all analyzed relationships. In addition, there is a noticeable

time sequence of mutual increase of both variables, which in previous cases shows fluctuation. As already mentioned, this part of the analyzed relationships also points to increasing labor productivity, which, in addition, is associated with wage growth. Therefore, it can be assumed, that there is no inadequate use of human labor in connection with the growth of labor productivity. In other words, workers are not penalized by increasing their productivity in terms of their wages, even if the increase in productivity is partly achieved by incorporating new technologies into the production process. Thus, there are no negative effects of industrialization and productivity growth for workers.

Figure 1: Analysis of the selected indicators for all sectors in Slovakia



Source: author's calculations.

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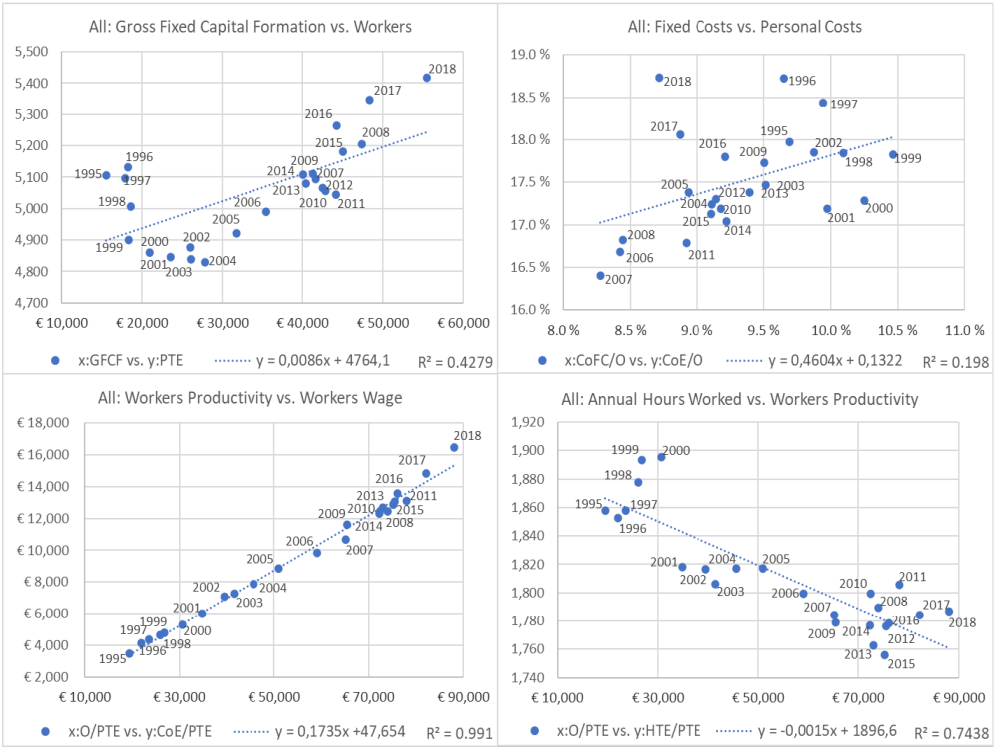
Figure 2: Analysis of the selected indicators for all sectors in the Czech Republic



Source: author's calculations.

The last analyzed relationship reflects the impact on hours worked per employee. There is a negative relationship between labor productivity and hours worked per employee. Here, clear logic is shown, the growing volume of the capital equipment and at the same time the increasing productivity of labor is reflected in the improvement of working conditions of employees. The mentioned trend is also reflected in wider discussions on the general reduction of working hours and is related to the development of society that prefers leisure time, which can be used for personal and personality development. It is thus possible to obtain more motivated and more satisfied employees, which is clearly positive effect for both, workers and employers.

The last analyzed part also shows development when there was more significant decrease in the number of hours worked in the 90s. If we supplement this observation with information about the number of employees in the 90s, we

will get an illustration of the effects of transformation of economies, which is associated with a decline in employment and the number of hours worked by employees. Thus, there is probably a tendency towards the standard use of workers in developed economies. Subsequently, we see stagnation in the number of hours worked in both economies in the first decade of millennium. Again, after taking the growing number of workers into consideration, it is possible to identify the next stage of development of both economies, which is most likely affected by the situation on the labor market, where there are enough workers with the potential to participate in the production process and at the same time it is the period of economic prosperity between the two economic crises. In the last decade after 2008, the number of hours worked decreased again, especially in Slovakia. This is again related to the situation on the labor market, where the effects of falling unemployment rate are evident. In this sense, the involvement of new technologies into the production process is not a revolutionary approach, but rather a necessity to maintain and further increase the economic output of individual companies and the whole economy. The conditions for the development of labor productivity using new technologies are simply created appropriately. It is an inevitable consequence of the labor market conditions and overall economic cycle rather than some actions motivated by Industry 4.0 initiative.

Although the analysis of selected relationships in relation to Industry 4.0 for the whole economy of both countries does not indicate significant changes caused primarily by Industry 4.0 implementation, the situation may differ in individual sectors, because the analysis of all sectors together may not show partial tendencies connected to Industry 4.0 that can be identified only on the level of individual sectors. Thus, the results of the analysis of the abovementioned relationships between selected indicators for Slovakia are presented in Table 1 and for the Czech Republic in Table 2.

If we follow the same logic, based on the analysis so far, i.e., the effort to identify specific sectors in which the assumption of the potential replacement of human labor by mechanization due to Industry 4.0 is met, we are looking for sectors in which there is inversely proportional relationship between capital equipment and volume of workers, or between fixed and personal costs, or this relationship is statistically insignificant. In case of such sectors, concerns about the negative consequences associated with the Industry 4.0 initiative can be assumed to be at least partially justified.

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Table 1: Analysis of selected indicators for sector breakdown of Slovak economy

SLOVAKIA

	Gross Fixed Capital Formation			Number of Workers			Gross Fixed Capital Formation vs. Workers	
	min.	max.	average	min.	max.	average	y:PTE vs. x:GFCF	R^2
A:	107	800	431	71	202	104	y = -0.1608x + 173.14 (-)	0.6179
B-E:	1,435	6,983	4,347	512	642	568	y = -0.0121x + 620.79 (-)	0.3387
F:	25	448	221	120	187	155	y = 0.1289x + 129.62	0.6273
G-I:	583	3,774	1,937	409	633	541	y = 0.0634x + 417.77	0.7625
J:	272	1,562	715	40	71	50	y = 0.0104x + 42.631	0.0900 (!)
K:	117	440	241	29	47	39	y = 0.0113x + 36.187	0.0382 (!)
L:	99	3,794	1,677	17	29	21	y = 0.0032x + 15.432	0.7919
M-N:	105	1,315	484	109	253	173	y = 0.0866x + 130.91	0.5573
O-Q:	394	3,052	1,498	441	479	456	y = 0.0010x + 454.10	0.0073 (!)
R-U:	49	334	144	51	76	61	y = 0.0600x + 52.805	0.5860
	Fixed Costs			**Personal Costs**			**Fixed Costs vs. Personal Costs**	
	min.	max.	average	min.	max.	average	y:CoE/O vs. x:CoFC/O	R^2
A:	9.3 %	18.2 %	11.2 %	13.8 %	27.9 %	20.4 %	y = 1.5937x + 0.0249	0.3439
B-E:	5.6 %	10.5 %	7.4 %	8.9 %	13.7 %	10.9 %	y = 0.7043x + 0.0563	0.4382
F:	1.2 %	12.1 %	2.5 %	10.1 %	18.6 %	12.9 %	y = 0.7902x + 0.1097	0.5918
G-I:	5.3 %	10.0 %	6.8 %	17.6 %	25.7 %	22.0 %	y = -0.8694x + 0.2791 (-)	0.1475
J:	11.4 %	41.7 %	20.5 %	17.0 %	23.0 %	19.4 %	y = -0.0911x + 0.2123 (-)	0.1535
K:	4.8 %	26.6 %	10.6 %	16.2 %	29.2 %	22.4 %	y = 0.3859x + 0.1829	0.4677
L:	24.3 %	42.8 %	32.7 %	2.5 %	3.9 %	3.2 %	y = -0.0365x + 0.0435 (-)	0.2425
M-N:	2.3 %	12.1 %	4.5 %	17.6 %	24.6 %	21.3 %	y = 0.1144x + 0.2074	0.0144 (!)
O-Q:	9.3 %	27.9 %	18.8 %	40.9 %	52.7 %	46.9 %	y = -0.4998x + 0.5627 (-)	0.7869
R-U:	3.1 %	15.5 %	5.7 %	14.3 %	27.8 %	19.0 %	y = 0.5297x + 0.1603	0.2228
	Annual Hours Worked			**Labor Productivity**			**Annual Hours Worked vs. Productivity**	
	min.	max.	average	min.	max.	average	y: HTE/PTE vs. x:O/PTE	R^2
A:	1.796	2,038	1,894	7,801	62,265	33,225	y = -0.0008x + 1,920.9 (-)	0.0920 (!)
B-E:	1,675	1,778	1,739	23,431	159,321	90,435	y = 0.00002x + 1,736.7	0.0023 (!)
F:	1,786	2,038	1,922	16,310	90,562	51,687	y = 0.0015x + 1,845.3	0.3765
G-I:	1,728	1,886	1,819	14,278	53,106	33,772	y = -0.0015x + 1,870.1 (-)	0.1823
J:	1,752	1,918	1,854	17,428	105,154	69,489	y = -0.00007x + 1,858.8 (-)	0.0029 (!)
K:	1,687	1,821	1,758	25,894	107,160	71,142	y = -0.0004x + 1,786.9 (-)	0.1307
L:	1,639	1,861	1,770	123,904	439,668	269,567	y = -0.0004x + 1,882.0 (-)	0.4502
M-N:	1,742	1,981	1,881	12,070	69,220	36,713	y = -0.0025x + 1,970.9 (-)	0.5625
O-Q:	1,558	1,831	1,660	7,337	35,419	20,490	y = -0.0075x + 1,814.3 (-)	0.7030
R-U:	1,654	1,908	1,785	10,137	64,886	36,924	y = -0.0022x + 1,864.4 (-)	0.2561

Note: (-) means that the relationship is inversly proportionate; (!) means that realtionship is weak

Source: author's calculations.

In all analyzed individual sectors in both countries, as in the previous analysis, there was very close and statistically very significant direct relationship between labor productivity and workers' wages. Thus, there is no situation where the increase in labor productivity would not be accompanied by the increase in workers' wages, caused, for example, by replacement of workers

by new technologies in the production process in any individual sector. This is also the reason, why the results are not included in Table 1 or Table 2. The development of the relationship of those two economic indicators in each individual sector are very same as presented in Figure 1 and Figure 2, for whole economies. For workers this can be seen as a positive impact of increasing productivity due to industrialization.

Table 2: Analysis of selected indicators for sector breakdown of Czech economy

CZECH REPUBLIC								
	Gross Fixed Capital Formation			Number of Workers			Gross Fixed Capital Formation vs. Workers	
	min.	max.	average	min.	max.	average	y:PTE vs. x:GFCF	R^2
A:	404	1,653	941	159	269	192	y = -0.0641x + 252.59 (-)	0.4656
B-E:	6,308	15,864	10,566	1,379	1,617	1,496	y = -0.0043x + 1541.4 (-)	0.0453 (!)
F:	486	1,704	1,062	402	523	439	y = -0.0361x + 476.93 (-)	0.2553
G-I:	2,331	9,185	5,692	1,130	1,285	1,199	y = 0.0182x + 1094.8	0.4988
J:	553	3,971	1,965	80	154	114	y = 0.0269x + 61.335	0.7869
K:	428	2,274	973	71	97	88	y = 0.0074x + 80.710	0.2478
L:	1,585	11,625	6,548	55	103	83	y = 0.0050x + 50.461	0.9110
M-N:	766	3,378	1,812	320	479	392	y = 0.0550x + 292.06	0.9309
O-Q:	1,115	6,592	3,770	861	978	895	y = 0.0104x + 855.37	0.3328
R-U:	180	827	574	126	194	160	y = 0.0844x + 111.17	0.6500
	Fixed Costs			**Personal Costs**			**Fixed Costs vs. Personal Costs**	
	min.	max.	average	min.	max.	average	y:CoE/O vs. x:CoFC/O	R^2
A:	8.3 %	10.6 %	9.2 %	14.9 %	21.6 %	18.5 %	y = 0.4730x + 0.1415	0.0209 (!)
B-E:	5.9 %	8.1 %	6.8 %	11.9 %	15.0 %	13.1 %	y = 1.1521x + 0.0520	0.6516
F:	2.5 %	4.2 %	3.2 %	11.0 %	17.7 %	13.2 %	y = -1.6585x + 0.1853 (-)	0.2553
G-I:	8.4 %	10.1 %	9.2 %	19.3 %	22.3 %	21.0 %	y = -0.1225x + 0.2217 (-)	0.0075 (!)
J:	11.9 %	18.1 %	14.8 %	15.6 %	23.3 %	18.9 %	y = 0.7391x + 0.0800	0.2449
K:	8.4 %	12.2 %	9.7 %	16.9 %	23.2 %	19.9 %	y = 1.2653x + 0.0763	0.6930
L:	18.0 %	27.7 %	21.8 %	2.6 %	3.3 %	3.0 %	y = -0.0114x + 0.0320 (-)	0.0296 (!)
M-N:	6.2 %	10.0 %	8.3 %	16.4 %	19.9 %	18.0 %	y = -0.0284x + 0.1826 (-)	0.0006 (!)
O-Q:	15.6 %	21.5 %	18.8 %	39.9 %	51.0 %	44.0 %	y = -1.5052x + 0.7220 (-)	0.7941
R-U:	6.7 %	9.1 %	7.9 %	15.1 %	24.4 %	19.1 %	y = 2.5193x - 0.0070	0.5508
	Annual Hours Worked			**Labor Productivity**			**Annual Hours Worked vs. Productivity**	
	min.	max.	average	min.	max.	average	y: HTE/PTE vs. x:O/PTE	R^2
A:	1.913	2.044	1.969	15.361	63.839	38.536	y = -0.0006x + 1,993.6 (-)	0.1283
B-E:	1.694	1.832	1.752	26.299	131,040	80,883	y = -0.0008x + 1,813.6 (-)	0.5840
F:	1,887	2,061	1,966	19,241	83,927	53,647	y = -0.0022x + 2,081.7 (-)	0.7071
G-I:	1,809	1,984	1,886	14,505	62,592	37,976	y = -0.0031x + 2,003.5 (-)	0.7998
J:	1,743	1,921	1,835	32,792	122,749	86,101	y = -0.0014x + 1,958.8 (-)	0.7239
K:	1,662	1,827	1,743	38,595	145,321	95,144	y = -0.0009x + 1,832.9 (-)	0.5686
L:	1,810	2,063	1,961	83,555	312,555	188,978	y = -0.0007x + 2,090.7 (-)	0.4699
M-N:	1,678	1,886	1,788	17,754	70,740	45,332	y = -0.0031x + 1,930.5 (-)	0.8201
O-Q:	1,667	1,770	1,709	10,317	42,216	26,696	y = -0.0011x + 1,737.7 (-)	0.1434
R-U:	1,693	1,895	1,810	15,746	63,839	32,366	y = -0.0032x + 1,912.5 (-)	0.3783

Note: (-) means that the relationship is inversly proportionate; (!) means that realtionship is weak

Source: author's calculations.

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In most sectors in both countries, a directly proportional and statistically significant relationship between gross fixed capital formation and the number of workers can be identified. Therefore, the conclusions drawn in the initial analysis of overall economies of both countries apply to these sectors, so that the data do not indicate the suspicion of substitution of human labor by technologies because of Industry 4.0 initiative. On the other hand, there are sectors for which the data suggest a potential impact of Industry 4.0 initiatives, with the increase in capital equipment and decrease in the number of employees. In these cases, it may be the impact of Industry 4.0 connected with the threat to workers' jobs due to increasing industrialization in the sector. Such sectors with negatively proportional and statistically significant relationship (R^2 = 0.62 for Slovakia; R^2 = 0.47 for the Czech Republic) are agriculture sectors in both countries. There is a significant decrease in the number of workers in the 90s and subsequent stabilization in the following period. It seems, the change has its connection with the transition process in both economies and the decline of importance of agriculture sector within the economies of both countries. But there is also increasing amount of capital equipment without adequate increase in the number of workers after 2011 indicating possible influence of Industry 4.0 activities. The negatively proportional relationship is also identified for industry sector in both countries, although in the Czech Republic this relationship is not statistically significant (R^2 = 0.05 for the Czech Republic; R^2 = 0.34 for Slovakia). In both countries there is a similar development in industry sectors, where there is a significantly negatively proportional relationship till 2010, followed by a sharp increase in the number of workers almost without an increase in capital equipment. In Slovakia, it is also the information and communications sector, financial and insurance sector, and public services sector which do not have a statistically significant proportional relationship.

The relationship between fixed costs and personal costs analyzed for individual sectors of both economies shows significant differences between individual sectors. This also explains the low level of statistical significance of this relationship analyzed at the level of overall economy and ambiguous development of the relationship over time. However, in accordance with the analytical approach chosen for the research, in the case of influence of Industry 4.0 on individual sectors with negative impact on the position of workers, the relationship between fixed and personal costs should be statistically significant and inversely proportional. This would suggest that

increasing capital equipment is associated with increase of connected costs as a share of output over time, and simultaneously decrease in the share of personal costs. Thus, although the conclusions of previous analyses suggest that the involvement of more capital equipment in production does not lead to reduction in the number of workers, these workers are penalized in the form of lower valuation of their work performance.

In Slovakia, it is possible to identify sectors (wholesale and retail trade; information and communication; real estate activities; public administration) in which a negatively proportional and statistically significant relationship is manifested. Similarly, in the Czech Republic, a negatively proportional relationship is identified for public administration sector. However, these relationships have time evolution, when the share of fixed costs in the production output decreases and personnel costs in the output increase. Therefore, there is no expected increase in cost burden due to the increase in capital equipment and thus the threat to the position of employees over time. In connection with the development of the situation on the labor market, it can also be assumed that the increase in personnel costs is related to the possibility of increasing number of workers in the given sectors.

In construction sector in the Czech Republic as the only sector, the conditions formulated in the initial assumption of approach to the relationship between fixed and personnel costs and their development over time are met. Especially in the 90s, the share of personnel costs decreased sharply, with a current growth of fixed costs, which in the first decade of the millennium was replaced by opposite trend, only to return to an inversely proportional relationship after 2011. The fulfillment of the conditions formulated for negative effects of Industry 4.0, which appear in public discussions, is therefore mainly caused by sharp changes in construction industry in the 90s, i.e., long before the very concept of Industry 4.0 appeared. On the other hand, construction is the sector with the long-term lowest share of fixed costs in output and can historically be considered labor-intensive, in addition to relatively low skills requirements for workers. For these reasons, almost any technical investment can manifest itself in a way with a potentially negative interpretation. In addition, the construction industry in the Czech Republic was one of the sectors where the increase in the volume of capital equipment took place with simultaneous reduction in the number of employees.

In other sectors with an inversely proportional relationship between fixed and

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personal costs, it can be characterized as a statistically insignificant or only slightly statistically significant. The direct proportional relationship in the sectors indicate mutual development of importance of labor and technology and need to finance them due to rising costs. These results thus indicate that the assumption of occurrence of the phenomena valid for the analysis of the relationships between all sectors and in individual sectors can be considered justified. In this sense, the conclusions regarding the costs of new technologies in relation to personal costs are thus ambiguous. In some industries, both fixed and personal costs are falling. However, in other sectors, such as retail and transport, real estate, and public services for both countries, and information and communication for Slovakia, and construction sector for the Czech Republic, there are negatively proportional relationships. Very interesting is the sector of public administration, health, and education. There is a decrease in fixed costs and increase in personal costs, and the personal costs are the highest among all sectors for all time. The sector is specific due to the dominant position of the state, and its influence both in the field of investment in technology and personal costs, due to regular increasing in salaries of civil servants. At the same time, digitization and other technological enhancements in the public sector have been discussed for a long time.

The last relationship analyzed, as in the case of the analysis of overall economies, is the relationship between productivity and the number of hours worked by one worker. The analyzed relationship between labor productivity and hours worked per employee shows an inversely proportional and statistically significant relationship in almost all sectors in both countries. There are exceptions especially in Slovakia, where there are sectors with a directly proportional relationship (industry; construction) or a statistically insignificant relationship (agriculture; industry; information and communication). Particularly, in the Slovak construction sector, where due to the increase of hours worked till 2010, the relationship is directly proportional and statistically significant. In Slovakia, three stages of the development of the relationship between labor productivity and hours worked can be identified in all sectors: In the 90s, there was a decrease in hours worked, then by 2010 stagnation or slight growth accompanied by an increase in labor productivity occurs, and a subsequent often sharp decline in hours worked comes, even without a proper change in labor productivity. In the Czech Republic, only the significant increase of labor productivity in the period of 2000–2010 can be identified for all sectors.

5 Discussion of results

The results of the analysis suggest that both countries have been increasing in the volume of production – the increase of output. Also, the increasing production volume is enabling enterprises to use more financial sources for investments. The increase of consumption of fixed capital, compensation on employees connected with wages and in labor productivity can also be identified. This process of increasing various economic indicators is also connected with the decrease of time spent at work. Although same distinctive changes among selected indexes can be identified, the whole development seems to be rather a fluent evolutionary change than a radical revolutionary leap.

According to the comparison of the situation of analyzed economic indicators in the year 2018 in the Czech Republic and Slovakia it seems that both countries have quite similar economical settings nowadays in the analyzed areas. However, there are differences in the development of the analyzed ratios during the time-period. This can be due to long mutual history and sociocultural background, but different starting positions back in 90ties (Janecek, 1993), as both countries separated from each other in 1993.

The article is not aimed at denying the influence of many initiatives and actions motivated by Industry 4.0, taken by private or public sector. The thoughts and approaches according to Industry 4.0 initiative in both countries encourage and boost the economic development and positive effects on individual economic subjects, individual sectors, and the whole economies. But according to the presented results, there are no radical changes in the development of chosen economic indicators connected with Industry 4.0 initiative. Thus, in accordance with the aim of the article, there should be no irrational worries or fears of workers about being supplemented by machines or not being able to adapt to new competencies requirements in the future due to Industry 4.0 implementation in the production process.

This analysis builds on previous analyses (Záthurecký & Marinič, 2019; Marinič & Pecina, 2021), and confirms that even if technological changes occur, the volume of fixed assets increases or fixed costs increase, there is no replacement of human labor by machines, and a positive effect on employees can be identified as a result. The logical link between the analyzed variables can be identified, when there is a technological development and investment

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in the new technologies, which creates space for job creation even within the increasing pressure of competition, not only on the domestic market but also on the international market. The increase in investment in technology also creates space for growth in labor productivity and enables continuous increase in wages and salaries. This creates positive effects in relation to employees, specifically in higher employment, and reduces hours worked per employee. These are very positive effects for workers and customers as well.

The results of the analysis thus correspond with other studies that identify a significant contribution of technological development, informatization, and digitization, as a source or expression of Industry 4.0, in the field of labor productivity (Kurt, 2019; Trenovski et al., 2020). Another study, examining different selected economic indicators over the same time, points to the development of GDP in connection with the share of university-educated workers. It is concluded that Industry 4.0 initiative in Slovakia raises greater need to increase educational potential of employees, even with the expected future increase in staff qualification requirements, unlike developed countries like Germany or Japan, where the share of university-educated workers have been rising for several years now (Habánik et al., 2021).

The development of both analyzed economies and further technological investments creates an opportunity to maintain prosperity and a high level of production and consumption, despite ageing population and in a more ecological economy (Rutkowska & Sulich, 2020). The growth of GDP and labor productivity as the benefits of Industry 4.0, and identification of the area of industrial production as an area with huge potential for development has also been identified for the Slovak economy (Grenčíková, Kordoš & Berkovič, 2020a).

Although Industry 4.0 does not lead to radical changes in the economy, but rather to a smooth transition to more efficient production methods and higher productivity, and employees do not have to worry about being substituted by technology, there remains another area where concerns about Industry 4.0 may arise. That area is education in the form of preparation for future occupations and changes in educational content and forms of teaching in future, especially in the field of vocational education (Pecina & Sládek, 2017). It will be necessary to develop new competencies of future employees, related to digitization and other technologically developed areas (Grenčiková et al., 2021). However, it will be necessary to develop competencies not only in connection with

technology, but also in the field of creativity, emotional intelligence, critical thinking, and interpersonal relationships (Beke, 2020; Beke et al. 2020), both, focusing on employees and focusing on managers and future entrepreneurs (Gódány et al., 2021).

These challenges are completely in accordance with the requirements of Industry 4.0 for the workers with suitable competencies. But according to the analysis conducted, it seems there will be much more time to adapt the education process of future workers or provide suitable education support to the present workers then it could be assumed due to the expectation of radical changes connected with Industry 4.0 initiatives.

The study conducted in Slovak companies shows that there are changes in the structure of profession, described as revolutionary and in connection with the necessary competencies of employees, but the situation is very variable depending on the size of the enterprise (Grenčíková, Kordoš & Berkovič, 2020b). The results of a survey among Czech companies, which identifies the need for education in connection with the introduction of new technologies into production in many companies are presented in another study (Vacek et al., 2020). It emphasizes the standard approach, which created concerns that changes in job positions would be drastic and difficult to adapt to, and at the same time stated that many Czech companies were already working to improve the qualifications of their employees, albeit mostly externally. But these trends in the approach to workers' further education are not surprising because there are common tendencies in the society for life-long and life-wide education.

The analysis of individual industries points to different developments in individual industries and different degrees of current and potential impact of Industry 4.0 in the future. The results of the analysis suggest a similar conclusion as the study, which also confirms that they are not radical changes that threaten employees, but rather a gradual development with a positive potential impact on employees (Asdollahi-Yazdi et al., 2020).

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6 Conclusion

Although Industry 4.0 has only appeared in academic terminology since 2011, the article covers the period 1995 to 2018. This approach is chosen mainly due to the focus of the analysis on the key question of whether Industry 4.0 in the Slovak and Czech economies is a revolutionary change or rather an evolutionary economic development.

In this sense, the analysis of selected indicators relating to all sectors of the Slovak and Czech economy has been performed. These indicators are arranged in logically interconnected relationships, which should point to the existence of the leap in their development over time, in the event of a revolutionary change because of Industry 4.0 initiative implementation.

However, at the level of analysis of all sectors, such phenomenon does not occur, which rather points to an evolutionary development in the conditions of both analyzed economies since the transformation in the 90s and their gradual transformation into developed economies. There is an increase in labor productivity, decrease in the share of fixed and personnel costs and a reduction in hours worked per employee. These trends are reflected in all-sectors analysis as well.

The situation is slightly different when individual sectors are analyzed separately. Here, the trends in the analysis of all sectors are no longer so obvious. There is either a denial of the identified relationships, in the sense of a change from a directly proportional relationship to an inversely proportional relationship and vice versa or a decrease in the statistical significance of the relationships themselves. It turns out that what applies to the whole economy may not and does not apply to individual sectors. The situation in individual sectors varies and it can be assumed that although the sectors are undergoing a gradual evolutionary economic development in connection with the influence of Industry 4.0, in some sectors the impact is milder and in others it is significantly greater.

The presented results of the analysis show that although there are impacts of ideas of Industry 4.0 initiative and there is also a support of Industry 4.0 implementation from various public institutions, the changes according to the chosen indicators rather represent an evolutionary development than a revolutionary change. Thus, the results of the analysis stand against the

emotional worries and fears of both workers and the public about workers being supplemented by machines or technology leading to losing job opportunities due to the insufficient ability to adapt to changes of working conditions or develop the needed competencies. In this context it seems there will be much more time to adapt than it was assumed in the case of expected radical changes connected with the implementation of Industry 4.0 initiative.

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