

Industry 4.0 – Analysis of the Industry Sectors in Czech Republic and Slovakia

Peter Marinič¹

¹ Masaryk University, Faculty of Education/Department of Physics, Chemistry and Vocational Education, Poříčí 623/7, Brno, 603 00 Czech Republic

marinic@ped.muni.cz

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Abstract. Industry 4.0 has become very popular topic in recent years for a lot of people, especially economists, technicians but also teachers. All of them are trying to find out how to implement the ideas of Industry 4.0 in their field, how to develop them and what impact the Industry 4.0 would have. A lot of them are worried about radical changes connected with the implementation is ideas of Industry 4.0, as they understand the Industry 4.0 initiative as revolutionary rather than evolutionary change. In the article, there are data from Eurostat for the NACE sectors breakdown from Czech Republic and Slovakia presented as the background for the main idea of not radical change caused by Industry 4.0. The development of chosen economical indexes for the time-period of 1995 till 2018 are analyzed to illustrate the development of the position of human labor and using the machinery in different kinds of sector types. As the aim of the article is to show, that the fear of radical changes connected with the Industry 4.0 initiatives, are not based on hard data and are more emotionally motivated.

Keywords: Industry 4.0, Labor Productivity, Wages

JEL classification: *O11, E24*

1 Introduction

The topic of Industry 4.0 relates to the idea of dramatic changes in ways of production, especially connected with the use of new technologies and changes in the labor market. The changes in competencies of future workers, which will be expected workers should have to be able to participate in production as employees, also create the expectation of changes in the vocational education and training [1, 2, 3]. There is also public debate accelerated by social media, which creates the fear of lots of jobs vanishing.

These ideas are based on the conviction that changes connected with the Industry 4.0 are radical. But if we look in the history, there were changes in production caused by industrialization [4, 5] and they were also connected with the same kind of fears. The emotional point of view, the fear of losing the individual competitive position of each

of us as a worker due to implementation of new technologies and need of new competencies is understandable at individual level. But there should be some-kind of global perspective which could make us calm and provide us with the suitable understanding that all the changes of implementation of Industry 4.0 would have positive effect on our lives.

Although it is true, that there are changes effecting production and employees due to Industry 4.0, but these changes are not radical nor endangering the position of workers in many companies in variety of economic sectors. Based on economic data, there will be presented the opinion that the Industry 4.0 is evolutionary change with possible positive impact on workers rather than revolutionary change. The idea is to prepare for changes inevitably coming and bringing the more productive and effective future to companies, workers, and consumers.

2 Methodology

The main idea of the article is to point out the development of chosen economical indexes to show the development of industrialization process in the Czech Republic and Slovakia in the sectors according to NACE breakdown. The indexes were chosen in such way that they can illustrate the labor productivity [6, 7] and other connected economic indexes [8, 9].

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. In the fact that there were, and in the Czech Republic still is, different currencies, the Euro was chosen as the 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,
- 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, Czech Republic, and Slovakia.

3 Data and analysis

As first step of the analysis the economy of Slovakia and Czech Republic are analyzed and presented in figure 1 and 2. The relationship between capital equipment and the volume of workers is presented, where capital equipment is represented by gross fixed capital formation and volume of workers is represented by thousands of persons employed recalculated for total full-time employment. This should capture the impact of Industry 4.0 and with the increase in technological investments there should be decrease in number of workers due to the replacement of manual work by machines. But there are no such trends in Czech economy nor Slovak economy.

Subsequently, similar view is also provided by the analysis of relationship between fixed costs and personal costs calculated as a share of output of Czech and Slovak economy. As in the previous case, there is a proportional increase in both ratios, indicating the overall economic development of both countries rather than the impact of Industry 4.0.

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. In addition, there is a noticeable time sequence of mutual increase of both variables, which in previous cases shows considerable fluctuation.

The last analyzed relationship reflects the impact to the hours worked per employee. There is negative relationship between the labor productivity and hours worked per employee. Here, a clear logic is shown, connecting the growing volume of capital equipment and at the same time the increasing productivity of labor, which is reflected in the improvement of working conditions of employees. The mentioned trend is also reflected in the 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.

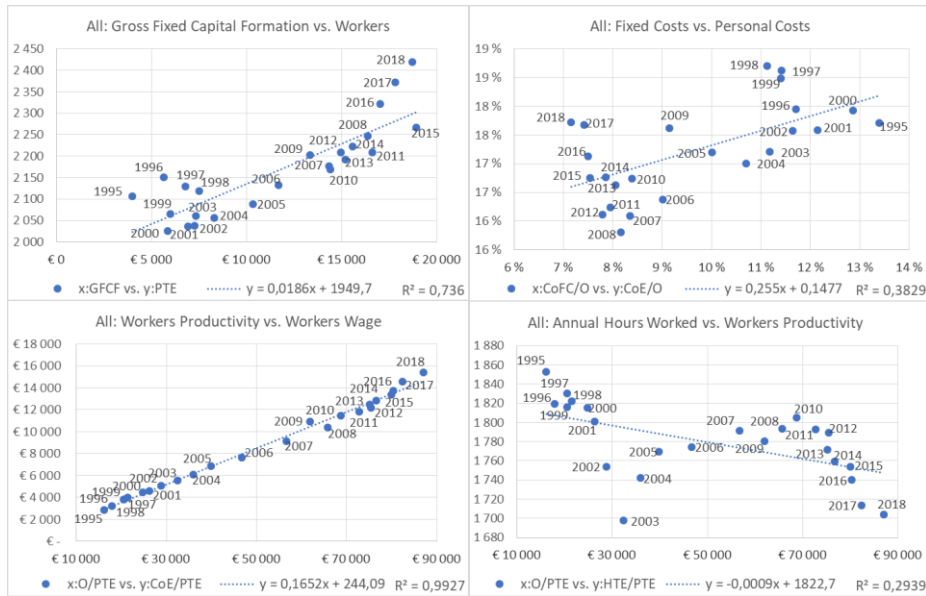


Fig. 12. Analysis of the selected indicators for all sectors in Slovakia.

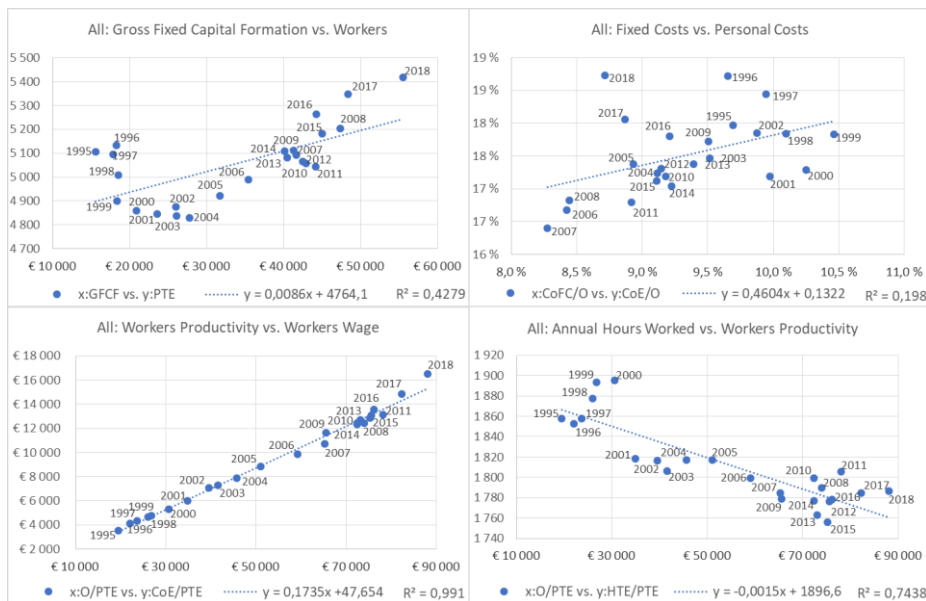


Fig. 2. Analysis of the selected indicators for all sectors in the Czech Republic.

Although the analysis of selected relationships in relation to Industry 4.0 for the whole economy of both countries does not indicate significant changes and rather points to positive effects on workers, the situation may differ in individual sectors. 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.

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

Also, the analyzed relationship between the labor productivity and hours worked per employee shows an inversely proportional and statistically significant relationship almost in all sectors in both countries. There are exceptions especially in Slovakia, where there are sectors with directly proportional relationship or statistically not significant relationship. For example, in Slovak construction sector, where due to increase of hours worked till 2010, the relationship is directly proportional and statistically significant.

Table 1. Analysis of selected indicators for sector breakdown of Slovak economy
SLOVAKIA

	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	$y = -0.0008x + 1,920.5 (-)$	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	$y = -0.00007x + 1,858 (-)$	0.0029 (!)
K:	1,687	1,821	1,758	25,894	107,160	71,142	$y = -0.0004x + 1,786.5 (-)$	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	$y = -0.0025x + 1,970.5 (-)$	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
	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
	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

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

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

CZECH REPUBLIC								
	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
	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
	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

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

In Slovakia, three stages of development of the relationship between labor productivity and hours worked can be identified in all sectors: In 90s, there was decrease in hours worked, then by 2010 stagnation or slight growth accompanied by an increase in labor productivity occurs, and subsequent often sharp decline in hours worked, even without a proper change in labor productivity, comes. In the Czech Republic, only the significant increase of labor productivity in period of 2000-2010 can be identified.

In most sectors, a directly proportional and statistically significant relationship between gross fixed capital formation and number of workers can be identified. However, in the case of both countries, an inversely proportionate and statistically significant relationship between these variables in the agriculture sector can be identified. 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. The negative connection is

also evident in the industry sector, even though the period of more significant inversely proportionate relationship in the 90s is replaced, especially in the Czech Republic, by a transition to directly proportional relationship. In the Czech Republic there is inversely proportional relationship also in construction sector.

Last analyzed and interesting area identified is the relationship between fix costs and personal costs. The direct proportional relationship in sectors indicate the mutual development of the importance of labor and technology, and the need to finance them due to rising costs. In other sectors with inversely proportional relationship, it can be characterized as statistically insignificant or only weakly statistically significant. The exception is the sector of public administration, health, and education. There is 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 dominant position of the state, and its influence both in the field of investment in technology and on personal costs, due to the regular increasing in salaries of civil servants.

4 Conclusion

The aim of the article was to identify changes in relatively long time-period – 24 years from 1995 to 2018. According to the analysis and results it seems that the analyzed countries are developing in their production possibilities – increase of output. Also, the increase of production possibilities is enabling the enterprises to use more financial sources for the investments. Increase of the consumption of fixed capital, compensation on employees connected with wages, and in labor productivity can be identified. This process of increasing the various economic indexes is also connected with the decrease of time spent in the work. Although some distinctive changes among selected indexes can be identified, the whole development is rather fluent change than jump revolution.

According to comparison of the situation of analyzed indexes in the year 2018 in the Czech Republic and Slovakia it seems that both countries has quite similar economical settings nowadays in analyzed areas. But there are differences in the development of the analyzed ratios during the time-period. This can be due to different starting positions back in 90ties [10], as both countries separate from each other in 1993, and before then there were mutual currency, government, enterprises, and other socio-cultural connections.

This analysis builds on previous analyzes [11, 12], 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 as a result positive effect on employees can be identified. The logical link between the analyzed variables can be identify, when there is a technological development and investment to the new technologies, which creates space for job creation even within 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 reduce hours worked per employee.

Results of the analysis thus corresponds to other studies that identify significant contribution of technological development, informatization, and digitization, as source or expression of Industry 4.0, in the field of labor productivity [13, 14]. The development of both analyzed economies and further technological investments creates opportunity to maintain prosperity and high level of production and consumption, despite ageing population and in more ecologic economy [15]. 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 been identified for Slovak economy [16].

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, and that area is education in the form of preparation for future occupations. Especially in the field of vocational education, there are and will be changes in the educational content and forms of teaching in the future [3]. It will be necessary to develop new competencies of future employees, related to digitization and other technologically developed areas [17]. 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 [18]. Both in the focus on employees and in the focus on managers and future entrepreneurs [19].

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. However, it confirms that these are not radical changes that threaten employees, but rather a gradual development with a positive potential impact on employees [20].

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