LABOUR MARKET TENDENCIES IN THE ERA OF THE FOURTH INDUSTRIAL REVOLUTION

Julianna Csugány[1]

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Abstract: *In the era of the Fourth Industrial Revolution, technological change is also transforming the labour market. Technological and structural unemployment is simultaneously present in the economy, as well as the labour shortage causes many problems for the firms. The labour market has to respond to both demographic and technological change, while workers' expectations and workers' preferences are transformed in the digital era. The biggest fear in the new technological era is related to robots, which generate the loss of jobs because they can substitute human resources in an efficient way. Technological changes typically threaten lower-skilled workers doing routine tasks, while the need for a high-skilled workforce combined with creativity is increasing. This asymmetry of training already appeared in the earlier industrial revolution, but nowadays digital literacy, as well as the technological knowledge necessary for the operation of machines and equipment, are becoming a basic skill, so new competence requirements are formulated for the employees. In the era of the Fourth Industrial Revolution, not only robots cause problems in the global labour market, but also international trends that cause major transformation in both the supply and demand side of the labour market. Effective labour market adaptation to technological change can be the key to competitiveness in the new technological era. This research aims to provide a short analysis of the differences in the European labour market in the era of the Fourth Industrial Revolution. The labour demand and supply will be analysed in order to highlight the main tendencies related to the qualitative features of labour market in the new technological era.*

Keywords: *The Fourth Industrial Revolution; Skill-biased technological change; European labour market; Qualitative features of labour market, Skills.*

1. INTRODUCTION: HOW THE FOURTH INDUSTRIAL REVOLUTION IMPACT ON THE LABOUR MARKET?

The Fourth Industrial Revolution induces fundamental changes in economic processes, mainly in the labour market, to which we have to adapt. Many workplaces are in danger due to the new technologies, but at the same time, new jobs are required where people create innovations and using new inventions. The new technologies can substitute the human resources in production process, because they are more efficient and make less mistakes than people. Through machine learning, routine tasks can be automated but machines cannot do the full range of tasks that humans can do. Because of this, the substitution of humans by machines and the complementarity of machines and humans exist in the same time in the labour market that should be managed by skills development. This will be the most important challenge in the labour market in the future.

According to the estimation of Frey and Osborne (2013) about 47% of total US employment is at risk by automation. The authors examined 702 jobs and they estimated that for example the work of telemarketers and library technicians with 99%, while accounting and credit analysts with 98% can be robotized within two decades. According to Chui et al. (2015), fewer than 5

[1] Eszterházy Károly University, Faculty of Economics and Social Sciences, Institute of Economics, HU-3300 Eger, Egészségház u. 4.

percent of occupations can be entirely automated using current technology, however, about 60 percent of occupations could have 30 percent or more of their constituent activities automated. The World Economic Forum (2016) forecasted that 7.1 million jobs will be disappeared globally, while 2 million new ones will be created by the technological progress. This report estimated that more than a third of the knowledge and skills needed for current jobs to load changes within five years (will not be part of the knowledge currently in use longer needed, however, increases the demand for new skills specified). According to a joint survey by the ILO and the EU, technological progress is eliminating only 10% of jobs, elsewhere changing tasks and creating new job opportunities (Artner, 2019:20). Szalavetz (2018:56) also emphasized that the diffusion of new technologies creates new workplaces too. A significant employment growth is expected, for example, in manufacturers, service providers and installers of industrial robots, infrastructure providers of cyber-physical systems, including suppliers of security solutions for these systems. The number of people employed in business intelligence activities and cyber-physical production systems will increase. In sum, a significant rearrangement is expected in the labour market, which favours mainly the skilled workers with up-to-date knowledge. According to Andor (2018:47) it seems to be more difficult to reconcile the flexibility required by economic competition with the stability of employment and the quality of jobs and the exploitation of the possibilities of the technology with the need to maintain quality jobs and social cohesion. The society needs to be prepared to receive, process and evaluate the rapidly expanding amount of information and knowledge (Simai, 2018:94). Kovács (2017) also emphasized that this industrial revolution transforms our working and living conditions.

Technological progress generates changes not only the structure of labour market but also the content of jobs. The survey of Chui et al. (2016:8) finds that in practice, automation will depend on more than just technical feasibility, other factors are important such as costs to automate, the relative scarcity, skills, and cost of workers who might otherwise do the activity; benefits of automation beyond labor-cost substitution; and regulatory and social-acceptance considerations. Based on these results skills are very important to realize technological progress. A survey so-called 'The Revolution of Skills' was commissioned by ManpowerGroup finds that creativity, emotional intelligence, and cognitive flexibility are the skills which that differentiate human resources and allow them to rise above machines without being replaced (ManpowerGroup, 2016). This survey is pointed out the relevance of staff training which allows employees to develop their skills in the workplace. The relevant literature (i.e. Autor et al, 2013; Frey and Osborne, 2013; Nedelkoska and Quintini, 2018) pointed out that the automation is not possible in the case of tasks requiring perception and/or skilful handling as well as creative or social intelligence (MKIK 2019). Fazekas (2019:23) emphasizes that the share of jobs requiring both mathematical and non-cognitive skills has increased rapidly in recent years. At the same time, a high decline is observed in jobs requiring neither mathematical nor social skills. The author pays the attention to young people have to have the skills needed to adapt to technological changes and to be motivated and able to learn new skills which are required by new technologies. The early school leaving is dangerous because, as school time increases, these skills can be acquired more confidently.

The Fourth Industrial Revolution generates skill-biased technological changes, where developed countries have a competitive advantage. It's because, in higher-income countries, there are more skilled workers, and therefore, these countries choose technology that requires high-skilled labour, whose labour productivity is higher. In contrast, lower-income countries choose technology that is better suited to the unskilled labour force which is better available to them.

The acquisition of new skills is essential both in higher and lower-income countries, but the productivity will be different so the gap becomes bigger between them. It is interesting that in the long run, in developed countries they fear a decline in job opportunities while the labour market of less developed countries labour demand is expected to increase (Boda 2017; Fülöp 2018).

This research aims to highlight the main trends in the European labour market from the aspect of the Fourth Industrial Revolution. It is assumed that there is a strong correlation between innovation capability and labour market adaptability, so if the labour market adapts faster to the new challenges, the benefits of innovation can be exploited more effectively. Summarizing the labour market trends in the European Union since the millennium, Artner (2018) finds that although employment is growing, working conditions become worse. At the same time, unemployment is growing and mainly the youth unemployment causes problems, the ratio of neither in employment nor in education and training increases. It is favourable for technological development that the atypical forms of employment are spreading rapidly in the European labour market which facilitates the situation of workers through flexibility. *This analysis focus on skills and other qualitative features of labour market. The research question is what differences can be observed between European countries grouped by innovation performance in terms of new labour market trends.*

2. DATABASE AND METHODOLOGY

This research focuses on the qualitative features of the European Union labour market. The current 27 member states of the European Union were involved in the analysis and they were classified into innovation performance groups based on the Summary Innovation Index (SII) which is calculated from the European Innovation Scorecard. Based on SII, countries are classified into four innovation performance groups: innovation leaders, strong innovators, moderate innovators and modest innovators. According to EIS (2020) EU 27 countries can be grouped as follows (the order fits for innovation performance):

- *Innovation leaders*: Sweden, Finland, Denmark, Netherlands, Luxembourg,
- *Strong Innovators*: Belgium, Germany, Austria, Ireland, France, Estonia, Portugal,
- *Moderate Innovators*: Cyprus, Spain, Slovenia, Czech Republic, Malta, Italy, Lithuania, Greece, Slovakia, Hungary, Latvia, Poland, Croatia
- *Modest Innovators*: Bulgaria, Romania

The Europe 2020 strategy was aimed at the improvement of flexibility and efficiency of the European labour market in order to realize smart, inclusive, and sustainable growth but this strategy is pointed out the heterogeneity of Europe in terms of competitiveness (WEF 2012). It's because the labour market is analysed by innovation performance groups to give a comprehensive picture of main differences.

Firstly, it is worth comparing the labour productivity of innovation performance groups because despite the intensive technological progress there is no rapid productivity growth in developed countries. Figure 1 illustrates the changes in real labour productivity in the EU member states grouped by innovation performance groups related to 2010.

Based on Figure 1, the highest growth in real labour productivity is observed in modest innovator countries (Bulgaria and Romania), it is around 18% on average per year while innovation leaders' productivity growth is only 2% on average per year. The dynamism of growth in labour productivity is very similar in strong innovators and moderate innovators, it is around 6%. This tendency is associated with income convergence but it is interesting because new technologies appeared mainly in developed, innovation leader countries. Nevertheless, productivity grew faster in less developed, less innovative countries although it is assumed that new inventions generate intensive growth in innovation leader countries.

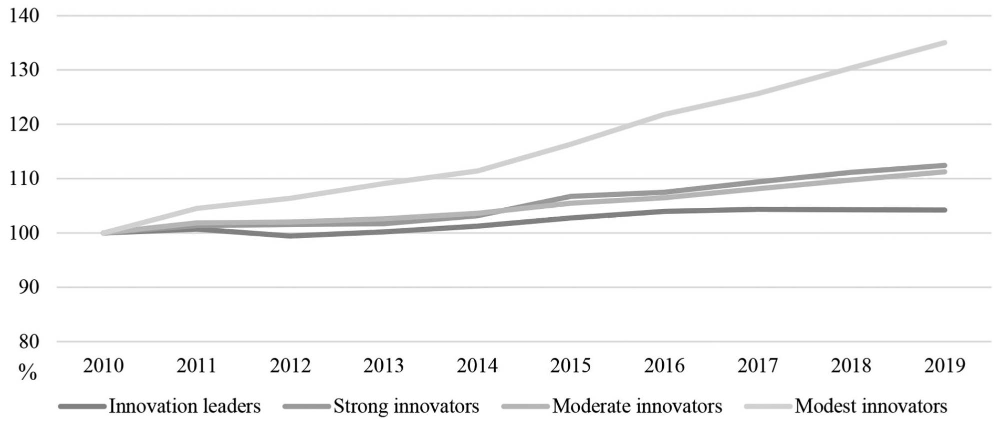

Figure 1. Changes in real labour productivity per person by innovation performance groups (2010=100%)

Source: own calculations based on Eurostat (2020)

To analyse the differences of European labour market, the Global Competitiveness Index 4.0 was used which contains a wide range of variables related to the labour market, skills and innovation capability[2]. The GCI 4.0 is organized into 12 main drivers of productivity and it contains variables related to the new phenomenon of the Fourth Industrial Revolution. The pillar of Skills includes variables related to the current and future workforce. Mean years of schooling, extent of staff training, quality of vocational training, skillset of graduates, digital skills among active population and ease of finding skilled employees, school life expectancy, critical thinking in teaching and pupil-teacher ratio in primary education are measured in this pillar. The pillar of Labour market divided into two parts as flexibility and meritocracy and incentivization. It can be measured the redundancy costs, hiring and firing practices, cooperation in labour-employer relations, flexibility of wage determination, active labour market policies, worker's rights, ease of hiring foreign labour, internal labour mobility, reliance on professional management, pay and productivity, ratio of wage and salaries female workers to male workers, and labour tax rate. It is assumed that the more competitive economics typically have greater innovation capability. The Summary Innovation Index 2019 and Innovation capability of EU member states are strongly correlated (the correlation coefficient is 0.8679) so the innovation performance groups are suitable for analysis the labour market trends with the variables of GCI 4.0. Figure 2 shows the standardized values of two variables related to the EU member states grouped by innovation performance which reflects the relationships between them.

Using parametric and non-parametric tests, the qualitative features of labour market are compared to highlight the significant differences between EU member states grouped by innovation performance. Firstly, the normal distribution of variables is tested using Kolmogorov-Smirnov test. If a variable has a normal distribution, ANOVA and Independent-Samples t test is used to compare the means of country groups. There is another prerequisite of t test, it is the homoscedasticity which is tested by the Levene's test. If equal variances are not assumed, Welch's t test is used to compare means.

2 The units and the source of the variables included in the analysis can be found in the appendix (Table A1).

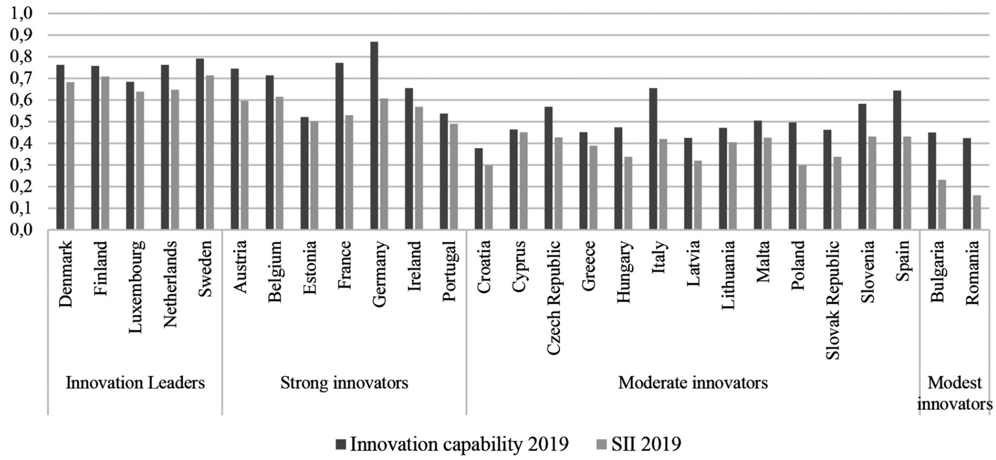

Figure 2. The comparison of standardized values of Innovation capability and Summary Innovation Index in EU 27 by innovation performance groups

Source: own construction based on Global Competitiveness Index 4.0 (2019) and EIS 2020

3. EMPIRICAL RESULTS

Before the detailed analysis of labour market, the relationship between innovation capability and skills and labour market (Figure 3) is analysed because it is assumed that if the labour market is more adaptable to the technological changes, the innovation capability is better. The innovation capability pillar contains variables related to diversity of workforce, state of cluster development, international co-inventions, multi-stakeholder collaboration, scientific publications, patent applications, R&D expenditures, research institutions prominence, buyer sophistication and trademark applications. Because of this, the qualitative features of labour market and innovation can be compared in EU member states.

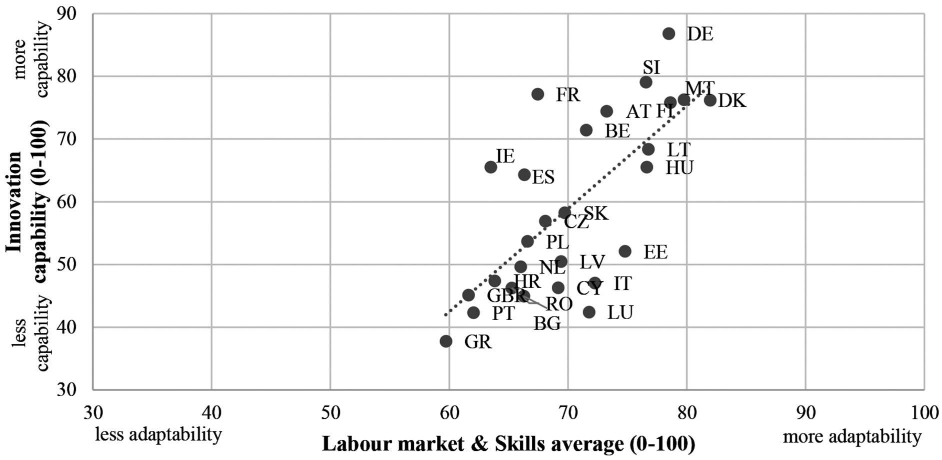

Figure 3. The relationship between the average of labour market and skills and innovation capability in EU member states

Source: own construction based on Global Competitiveness Index 4.0 (2019)

There is strong correlation between the average of labour market and skills and innovation capability in EU member states, the correlation coefficient is 0,7077. Based on Figure 3, we can conclude that if the qualitative features of labour market and skills are better, the innovation capability is higher in a country. Nevertheless, the causal relationship is not clear for innovation performance groups. The moderate and modest innovator countries' labour market and skills are better than their innovation capacity while innovation leaders and strong innovators have more capability to innovate than their labour markets' adaptability. This trend reflects that countries with less innovation performance can improve their situation if their labour market adapts well to the challenges of the Fourth Industrial Revolution.

In the next step of the analysis, normal distribution of variables related to skills and labour market is tested. Using Kolmogorov-Smirnov test there is normal distribution in the case of all variables of Skills pillar (results are seen in Appendix, Table A2), so ANOVA is used to compare means of innovation performance groups. The results of ANOVA related to the elements of Skills' pillar are in Table 1.

Table 1. The results of ANOVA comparing means of Skills' pillar variables

Variable	F	Sig.
Mean years of schooling	*0.636*	*0.599*
Extent of staff training	20.688	0.000
Quality of vocational training	17.999	0.000
Skillset of graduates	22.292	0.000
Skillset of secondary-education graduates	20.905	0.000
Skillset of university graduates	19.579	0.000
Digital skills among active population	12.591	0.000
Ease of finding skilled employees	7.305	0.001
School life expectancy	3.300	0.038
Critical thinking in teaching	28.263	0.000
Pupil-to-teacher ratio in primary education	4.138	0.017

Source: own calculations based on Global Competitiveness Index 4.0 (2019)

Table 1 shows that there is a significant difference between innovation performance groups for almost all indicators except mean years of schooling. In Innovation leader countries 12.6355 years, in strong innovators 11.9994 years, in moderate innovators 11.8562 years while in modest innovators 11.3966 years are the mean of schooling. These average values are close to each other, but the difference between countries are higher. Comparing the mean years of schooling in EU member states, the lowest value is in Portugal (9.1909), while the highest value is in Germany (14.1322). These countries are also strong innovators, so the variable of years of schooling cannot affect significantly on innovation performance of EU member states.

Table 2. The results of t test/Welch test comparing means of Skills' pillar variables by innovation performance groups

Variable	Innovation leaders and strong innovators		Strong and moderate innovators		Moderate and modest innovators	
	t/Welch test	*Sig.*	*t/Welch test*	*Sig.*	*t/Welch test*	*Sig.*
Mean years of schooling	*0.953*	***0.370***	*0.201*	***0.845***	*0.849*	***0.464***
Extent of staff training	4.030	0.004	4.204	0.001	2.070	**0.067**
Quality of vocational training	1.886	**0.089**	4.258	0.001	1.228	**0.241**
Skillset of graduates	3.552	0.005	5.342	0.000	2.610	**0.097**
Skillset of secondary-education graduates	3.300	0.010	4.902	0.000	1.945	**0.225**
Skillset of university graduates	2.908	0.016	5.223	0.000	3.433	0.007
Digital skills among active population	4.067	0.002	2.524	0.024	-0.398	**0.697**
Ease of finding skilled employees	1.536	**0.156**	2.784	0.014	1.682	**0.195**
School life expectancy	0.715	**0.498**	1.361	**0.204**	3.924	0.012
Critical thinking in teaching	4.533	0.002	4.934	0.000	0.381	**0.760**
Pupil-to-teacher ratio in primary education	-1.297	**0.224**	0.263	**0.798**	-5.214	0.020

Source: own calculations based on Global Competitiveness Index 4.0 (2019)

ANOVA is a statistical method which is able to compare means of more than two groups so we got a comprehensive picture of significant differences between innovation performance groups. It is worth comparing means of groups by pairs too because several differences can emerge between them. Independent-Samples t test can be run to compare the means of innovation performance groups. Equal variances are not assumed in the case of 30 variables from 33 based on this test. In these cases, Welch's t test is used instead of t test to compare means. The results are in Table 2 highlighted t test and significant differences (the difference is significant if P value is higher than 0.05).

As a result of this analysis, there are significant differences between groups in several cases. The skillset of university graduates is the only variable which is not different significantly in innovation performance groups. The extent of staff training, the skillset of graduates, the skillset of secondary-education graduates, digital skills among active population, and critical thinking in teaching are the variables that can differentiate moderate and modest innovators, but there is no significant difference in other innovation performance groups. There is a significant difference in the quality of vocational training, the ease of finding skilled employees between innovation leaders and strong innovators while the school life expectancy and pupil-to-teacher ratio in primary education as metric variables can differentiate the more innovative groups. Summarizing the results, we can conclude that the differences in metric variables are more clearly seen between groups and the informal trainings are more important for innovation leaders. The biggest difference is measured between moderate and modest innovators, while strong innovators and moderate innovators are less different.

To continue the analysis, using Kolmogorov-Smirnov test there is normal distribution in the case of all variables of Labour market pillar (results are seen in Appendix, Table A2), so ANOVA is used to compare means of innovation performance groups. The results of ANOVA related to the elements of Labour market pillar are in Table 3.

Table 3. The results of ANOVA comparing means of Labour market' pillar variables

Variable	**F**	**Sig.**
Redundancy costs	*0.983*	*0.418*
Hiring and firing practices	*2.906*	*0.056*
Cooperation in labour-employer relations	12.720	0.000
Flexibility of wage determination	*2.078*	*0.131*
Active labour market policies	7.666	0.001
Ease of hiring foreign labour	*1.398*	*0.269*
Internal labour mobility	*1.112*	*0.365*
Reliance on professional management	17.878	0.000
Pay and productivity	6.037	0.003
Ratio of wage and salaried female workers to male workers	5.485	0.005
Labour tax rate	*1.464*	*0.250*

Source: own calculations based on Global Competitiveness Index 4.0 (2019)

Table 3 shows a quite different picture in labour market than skills between innovation performance groups. There is significant difference in redundancy costs, hiring and firing practices, flexibility of wage determination, ease of hiring foreign labour and internal labour mobility. It reflects that the qualitative features are different depending on a country's innovation performance. The adequate human resources are essential to exploit the advantages of innovation potential. It is worth comparing means of groups by pairs too; Independent-Samples t test can be run to compare the means of innovation performance groups. Equal variances are not assumed in the case of 30 variables from 33 based on this test. In these cases, Welch's t test is used instead of t test to compare means. The results are in Table 4 highlighted t test and significant differences (the difference is significant if P value is higher than 0.05).

Table 4. The results of t test/Welch test comparing means of Labour market' pillar variables by innovation performance groups

Variable	Innovation leaders and strong innovators		Strong and moderate innovators		Moderate and modest innovators	
	t/Welch test	*Sig.*	*t/Welch test*	*Sig.*	*t/Welch test*	*Sig.*
Redundancy costs	*-0.454*	***0.663***	*0.361*	***0.726***	*2.613*	***0.128***
Hiring and firing practices	*1.094*	***0.307***	*1.445*	***0.176***	*-3.080*	***0.058***
Cooperation in labour-employer relations	3.321	0.008	2.357	0.036	1.395	**0.270**
Flexibility of wage determination	*-1.226*	***0.249***	*-0.733*	***0.483***	*-1.025*	***0.324***
Active labour market policies	1.553	**0.152**	3.085	0.007	1.362	**0.200**
Ease of hiring foreign labour	*-0.019*	***0.985***	*1.605*	***0.136***	*-1.513*	***0.320***
Internal labour mobility	*0.021*	***0.984***	*1.682*	***0.110***	*-0.813*	***0.531***
Reliance on professional management	2.855	0.019	3.965	0.002	2.543	0.025
Pay and productivity	1.063	**0.321**	2.562	0.025	0.618	**0.577**
Ratio of wage and salaried female workers to male workers	1.032	**0.343**	2.723	0.014	0.448	**0.722**
Labour tax rate	*-1.791*	***0.105***	*0.948*	***0.367***	*1.094*	***0.355***

Source: own calculations based on Global Competitiveness Index 4.0 (2019)

It can be seen only the reliance on professional management which is not different significantly in innovation performance groups. The strong and moderate innovators do not differ significantly in other features. There is a significant difference in active labour market policies, pay and productivity, and ratio of wage and salaried female workers to male workers between innovation leaders and strong innovators as well as between moderate and modest ones. Summarizing these results, we can conclude that the European labour market is heterogeneous related to innovation performance. The less flexible and less adaptable labour market creates worse opportunities for innovation.

4. CONCLUSION

The Fourth Industrial Revolution induces changes in the labour market to which we have to adapt. Many workplaces are in danger due to the new technologies, but at the same time, new jobs are required where people create innovations and using new inventions. The substitution of humans by machines and the complementarity of machines and humans exist in the same time in the labour market that should be managed by skills development. This research aimed to illustrate the differences related to skills and labour market in EU member states grouped by innovation performance groups based on Summary Innovation Index. There is a strong correlation between the quality of labour market and innovation capacity – if the labour market is more adaptable, the innovation capability is higher. Using parametric and non-parametric test, we can conclude that the qualitative features of labour market are more different than skills between innovation performance groups. The biggest difference is measured between moderate and modest innovators, while strong innovators and moderate innovators are less different. Innovation leader countries create the most favourable environment for innovation, the labour market can adapt more efficient to technological changes. There are no significant differences in reliance on professional management and the skillset of university graduates between country groups. Summarizing the results, the European labour market is heterogeneous in terms of skills and qualitative features related to innovation performance. The less innovative countries have to adapt to technological changes in a more efficient way to provide adequate human resources for innovation which can generate productivity and economic growth.

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APPENDIX

A1. Variables of Skills and Labour market pillars of the Global Competitiveness Index 4.0

Pillar	Variable	Units	Source
SKILLS	Mean years of schooling	years	UNESCO: Wittgenstein Centre for Demography and Global Human Capital
	Extent of staff training	1–7 (best)	WEF Executive Opinion Survey
	Quality of vocational training	1–7 (best)	WEF Executive Opinion Survey
	Skillset of graduates	1–7 (best)	WEF Executive Opinion Survey
	Skillset of secondary-education graduates	1–7 (best)	WEF Executive Opinion Survey
	Skillset of university graduates	1–7 (best)	WEF Executive Opinion Survey
	Digital skills among active population	1–7 (best)	WEF Executive Opinion Survey
	Ease of finding skilled employees	1–7 (best)	WEF Executive Opinion Survey
	School life expectancy	years	UNESCO: Wittgenstein Centre for Demography and Global Human Capital
	Critical thinking in teaching	1–7 (best)	WEF Executive Opinion Survey
	Pupil-to-teacher ratio in primary education	ratio	World Development Indicators
LABOUR MARKET	Redundancy costs	weeks of salary	World Bank: Doing Business
	Hiring and firing practices	1–7 (best)	WEF Executive Opinion Survey
	Cooperation in labour-employer relations	1–7 (best)	WEF Executive Opinion Survey
	Flexibility of wage determination	1–7 (best)	WEF Executive Opinion Survey
	Active labour market policies	1–7 (best)	WEF Executive Opinion Survey
	Workers' rights	0–100 (best)	WEF calculations based on International Trade Union Confederation. 2019 Global Rights Index
	Ease of hiring foreign labour	1–7 (best)	WEF Executive Opinion Survey
	Internal labour mobility	1–7 (best)	WEF Executive Opinion Survey
	Reliance on professional management	1–7 (best)	WEF Executive Opinion Survey
	Pay and productivity	1–7 (best)	WEF Executive Opinion Survey
	Ratio of wage and salaried female workers to male workers	%	WEF calculations based on ILO
	Labour tax rate	%	World Bank: Doing Business

Source: WEF (2019)

A2. The results of Kolmogorov-Smirnov test of variables

Pillar	Variable	Kolmogorov -Smirnov Z	Asymp. Sig. (2-tailed)
SKILLS	Mean years of schooling	0.498	0.965
	Extent of staff training	0.690	0.728
	Quality of vocational training	0.579	0.890
	Skillset of graduates	0.587	0.881
	Skillset of secondary-education graduates	0.504	0.961
	Skillset of university graduates	0.657	0.781
	Digital skills among active population	0.739	0.646
	Ease of finding skilled employees	0.783	0.572
	School life expectancy	0.634	0.816
	Critical thinking in teaching	0.809	0.529
	Pupil-to-teacher ratio in primary education	0.890	0.407
LABOUR MARKET	Redundancy costs	0.858	0.453
	Hiring and firing practices	0.540	0.932
	Cooperation in labour-employer relations	0.463	0.983
	Flexibility of wage determination	0.754	0.620
	Active labour market policies	0.524	0.947
	Workers' rights	0.672	0.757
	Ease of hiring foreign labour	0.699	0.713
	Internal labour mobility	0.522	0.948
	Reliance on professional management	0.524	0.946
	Pay and productivity	0.631	0.821
	Ratio of wage and salaried female workers to male workers	0.516	0.953
	Labour tax rate	0.858	0.453

Source: own calculations based on GCI 4.0