CSABA MAKÓ AND MIKLÓS ILLÉSSY*

Automation, Creativity, and the Future of Work in Europe: A Comparison between the Old and New Member States with a Special Focus on Hungary

Intersections.EEJSP
6(2): 112–129.
DOI: 10.17356/ieejsp.v6i2.625
http://intersections.tk.mta.hu

* [mako.csaba@tk.mta.hu] (National University of Public Services, Faculty of Governance and International Studies);
[illessy.miklos@tk.mta.hu] (Centre for Social Sciences, Eötvös Loránd Research Network)

Abstract

Fear of job losses due to labor-saving technological change is not a new phenomenon, but dates back to the nineteenth-century Luddites in Britain. Recently, similar concerns have reawakened due to the rapid expansion of increasingly inexpensive and capable computers (digitization) and the automatization of some of the tasks that were formerly undertaken by workers. According to the empirical findings of European Working Condition Surveys (EWCS, 2005; 2015), every second workplace involves a form of 'creative work,' which is less threatened by automation, while every fourth worker carries out 'routine' tasks that will be easily replaced by computers. However, important country-group-level differences exist: creative jobs are found at rates above the EU-27 average in the Nordic, Continental, and Anglo-Saxon countries, while Mediterranean and Central and Eastern European countries are characterized by the highest proportion of jobs involving routine tasks. Among the post-socialist countries, Hungary lags behind the European average, and job loss trends suggest that concerns about the impacts of automatization on the job market for unskilled workers are valid.

Keywords: *automatization, digitization, employment, working conditions, EU.*

1. Introduction

For more than half a century, many business organizations and national policies have embraced Drucker's declaration that organizations only have two basic functions: marketing and innovation (Mohr, 2009). There have been attempts by political and social scientists to probe the wider social implications of innovation on labor and employment policy through theoretical and empirical analyses that have stressed the impact of technological advancement in relation to destroying workplaces on the one extreme, and innovation as a panacea for all problems on the other. Apart from literature on national innovation systems initiated by the Scandinavian innovation governance model (Edquist, 2019), more balanced evaluations have been relatively rare.

The significance of the topic has been further growing due to two recent events. The ten-year strategy of the European Union, accepted in 2010, placed smart, inclusive, and sustainable growth at the center of development policy (European Commission, 2010). Of these objectives, 'smart' has almost become synonymous with most modern technological development, 'inclusive' with the risk of widening social inequalities, while 'sustainability' draws attention to the long-term environmental and socio-economic impacts of human activity.

A key concern that has attracted attention, particularly in the industrial, agricultural, and service sectors, relates to the social impacts of technological changes caused by automation, digitalization and robotization. Our study describes the complex social impacts of technological innovation through the example of automation by using American, European, and Hungarian quantitative analyses. On the basis of cluster analysis we intend to answer three main research questions: i) to what extent are European labor markets susceptible to automation, ii) to what extent do EU Member States differ in this regard, and iii) what trends can be identified with respect to this phenomenon over time (i.e., between 2005 and 2015)? Our paper reviews the history of automation and the most relevant literature in the field, presents our own conceptual framework in the second section, describes the methodology and the data sources used in the empirical analysis, summarizes results, and raises some research questions and challenges for the future.

2. Literature review: between automation anxiety and technological optimism

Pessimistic forecasts about the negative impact of technological changes on employment, or so-called 'automation anxiety' has a long history in the social sciences.[1] John Maynard Keynes (1931) signaled that technological unemployment

[1] However, it is important to point out now that although the terms 'automation' and 'digitalisation' are used interchangeably, they slightly differ in content. In a stricter sense, *automation* is the phenomenon of manpower being replaced by machines for the same task. *Digitalisation,* on the other hand, means a process of using sensors and other digital instruments to transform processes of

was the new disease of economic development in the first third of the twentieth century. Moreover, he also drew attention to the possibility that countries lagging behind in development might find themselves in a more disadvantaged situation in the long term, while the hardships of adapting to technological changes are temporary. Leontief (1952) represented the more pessimistic view when he suggested that work would become less important in the future as machines increasingly replace workers, who will not necessarily be employed by newly emerging industries.

While changes in labor always occur, for nearly half a century forecasts that technological change will result in mass unemployment have not materialized. The employment-related problems accompanying new forms of development and technological unemployment have been regarded as temporary, short-term hardships related to adaptation. In addition, development-related failures have also signaled the hidden limits to automation. For instance, in the 1980s Volkswagen launched a project known as Halle 54 that was called the 'automated factory,' involving Computer Integrated Manufacturing (CIM). However, the experiment failed as the number of car rejects that were produced increased enormously, and repairing them made the factory uneconomical. By the end of the 1980s, attempts to totally automate production and entirely phase out the human factor were abandoned. According to Hack and Pfeiffer, VW's unsuccessful attempt at radical automation was the guinea pig and exemplar of a narrow-minded technological approach to modernization according to which every business organization is interpreted as technological in nature. In the authors' opinion, this approach had reached its limits, just as Taylorism did in the past. The basic reason for the failure of both approaches is that their rationalizing strategy was based on a flawed understanding of human-centered work organizations (Hack, 1994; Pfeiffer, 2010; Kopp, Howaldt and Schultze, 2016). The overarching question that has remained unchanged since then is how can human labor best be valued in the context of innovation and social change?

With the advent of intelligent robots, driverless cars, 3D printing, and, more generally, artificial intelligence (AI), we again are witnessing the resurrection of claims that technological development will cause unemployment, or, more broadly, automation anxiety (Brynjolfsson and McAfee, 2014; Ford, 2015). Nevertheless, in contrast to the earlier views of experts, those marketing the benefits of digitalization stress that robots are now partners and not enemies of workers, and increasingly will be so in the future. Nevertheless, estimates vary about the actual impact technological change is having on employment. Andrea Szalavetz (2018) likens the competing prophecies that envisage proximate employment disaster to a 'numbers war.' For instance, according to Frey and Osborne (2017), almost half of all employees (47 per cent) will be replaced by computers and algorithms in the

production or logistics into digitally conveyable and processable forms. Artificial intelligence (AI) – according to the most commonly used terminology 'is a system ability to operate in a goal-oriented fashion and anticipate its environment' (Koski and Husso, 2018: 56). What they have in common is an attempt to capture the efficiency of digital technologies; consequently, their impact on work and employment is similar in many cases.

USA in the forthcoming one or two decades. Bowles (2014) states that 45–60 per cent of the jobs in Europe will be automated. Experts say that within Europe the majority (59 per cent) of jobs in Germany are threatened by the risk of automation (Brzeski and Burk, 2015).

The most recent analyses have drawn attention to the more differentiated consequences of the impacts of automation and robotization on employment, rejecting scenarios that represent and simplify the likely radical changes. For example, one of the most recent studies from the internationally renowned consultancy firm McKinsey & Company, which involved the analysis of more than two thousand activities undertaken in nearly 800 jobs in the USA, found that in the following decade automation will result in the total disappearance of few actual jobs. Instead, a thorough transformation is already underway, affecting all jobs to a greater or smaller extent, regardless of the specific tasks undertaken at work (Chui, Manyika and Miremadi, 2016). The most recent analysis of the OECD 21 (Arntz, Gregory and Zierhan, 2016) came to very similar conclusions to those of the previous research: namely, that only onetenth (9 per cent) of all jobs in America are likely to be wiped out by the digital revolution.

The use of various concepts, levels of analysis and analytical methodologies often lead to incomparable, sometimes conflicting results. The field of labor sciences is no different, but the following two mainstream approaches can be distinguished. The first involves surveying the presence of information-communication technologies (ICT) in certain industries or jobs, and, based on these data estimates, developing forecasts of the future development of these technologies and their future impact on employment. The second approach is more differentiated, relying on surveys and other analytical tools to examine the effect of automation/digitalization on typical tasks in the workplace, from which aggregated estimates about impacts can be made. Our paper deals with the latter approach in detail.

One of the most significant analyses in the related field was carried out by David H. Autor (2014), who interpreted the possible impacts of automation on the level of tasks at work by drawing on Mihály Polányi's ideas, which were used as a theoretical framework. Polanyi examined the role of tacit knowledge by researching the structure of personal knowledge, and came to the conclusion that we know more than we can communicate in words (Polanyi, 1966). Polányi's insights made a contribution by creating a bridge between two main areas of human knowledge: explicit knowledge that can easily be codified and transferred formally, and tacit (personal) knowledge that is hard or impossible to codify.

Autor (2014), after examining the proportion of explicit and tacit knowledge elements necessary for undertaking work-related duties, divided jobs into three main categories: abstract-intensive, routine-intensive, and manual-intensive physical jobs. He argued that these three groups are exposed to the impacts of automation to different extents. 'Human tasks that have proved most amenable to computerization are those that follow explicit, codifiable procedures – such as multiplication – where computers now vastly exceed human labour in speed, quality, accuracy, and cost efficiency. Tasks that have proved most vexing to

automate are those that demand flexibility, judgment, and common sense – skills that we understand only tacitly – for example, developing a hypothesis or organizing a closet. In these tasks, computers are often less sophisticated than preschool age children' (Autor, 2014: 129).

After distinguishing these three groups, Autor started to examine American employment statistics and attempted to fit the ten non-agricultural main groups of jobs into his typology of three. The first category includes managerial positions and jobs that require higher education qualifications or a secondary school certificate, which are associated with higher salaries in general and require a high level of vocational education. Autor classifies employees in sales, office work and administration, production, assembly, repair and other jobs that require manual skills into the second category. These jobs are typically white-collar jobs requiring a secondary education, in relation to which the proportion of women is high, and also some blue collar jobs occupied by men who typically have a secondary or lower-level education. The third group of jobs includes security, the professions of personal assistance, cleaning, hospitality, and other service-oriented positions. These are jobs that offer lower salaries and/or require a lower level of education. According to Autor, digitalization primarily threatens jobs in the second category, as these are the tasks that can be routinized most easily.

In addition, Autor analyzed the employment trends of these three employment groups in the United States, beginning in 1979. Data justify his hypothesis that the proportion of those employed in the second category has historically decreased. The employment statistics span nearly four decades, and show on-going hollowing out of the second group (i.e. white-collar positions associated with a secondary education, and blue-collar jobs requiring secondary or a lower level of education). A similar trend can be traced in the European employment data as well. According to Autor, this decrease can partly by explained by increasing automation and digitalization.

However, the impact of automation does not merely involve the phasing out of jobs; rather, it prevails in a more complex way. 'The fact that a task cannot be computerized does not imply that computerization has no effect on that task. On the contrary: tasks that cannot be substituted by computerization are generally complemented by it. This point is as fundamental as it is overlooked' (Autor, 2014: 136). In these cases, digitalization does not have a direct impact on employment, but clearly influences job quality. As can be seen, the impact of automation prevails via a more complex mechanism that cannot be simplified merely as the 'anxiety and fear of technological unemployment' that arises from time to time. Autor's analysis shows that over the past four decades employment polarization has increased; i.e. there has been growth in the number of individuals with a higher level of education and high-wage jobs, and also of those with a lower level education in low-wage jobs, with a hollowing out in the middle, where a significant reduction in the number of jobs is statistically observable.

However, not everyone agrees with the polarization argument. Fernández-Macías, Hurley and Bisello (2016) in a study published with the support of the European Foundation for the Improvement of Living and Working Conditions

(Eurofound), examined the possible impact of automation on the European employment structure. From an analysis of the literature about employment shifts generated by technological development, the authors concluded that there are two wider-scale streams within it: skill-biased vs. routine-biased technological change. The former appreciates education and finds skill upgrading to be a major contributor to the employment tendencies of the past decades. The latter approach (which includes Autor's analysis) envisages the decreasing significance of routine tasks, and analyses the same data within the theoretical framework of employment polarization, looking for proof of justification. 'With upgrading employment shifts, the expected pattern is a more or less linear improvement in employment structure, with the greatest employment growth in high-paid (or high-skilled) jobs, the weakest growth in low-paid (or low-skilled) jobs, and middling growth in the middle. With polarisation, the main difference is that the relative positions, in terms of employment dynamics of the middle and bottom levels of the job distribution, are swapped: employment growth is weakest in the middle and relatively stronger at both ends of the job–wage distribution, leading to a "hollowed middle"' (Fernández-Macías, Hurley and Bisello, 2016: 11).

This polarization effect has prevailed in European small- and medium-sized enterprises (SME): 'The crisis period of 2008–2010 was characterized by significant job loss in Europe […]. The overall trend towards job polarization could also be observed for SMEs, with a lower level of job loss among the lowest-paid and highest-paid jobs compared with the medium wage categories' (Mandle et. al, 2016: 19). A similar trend may be noted in the most recent IMF review, which concludes that it is the service sector (financial services, public administration, healthcare, and education) that is worst affected by polarization. There are signs that more detailed research is required to confirm that polarization is occurring in the sectors most exposed to technological change (International Monetary Fund, 2017).

In order to obtain a more accurate picture about European employment shifts after the financial and economic crisis (2008) than the general analyses that are available, Fernández-Macías, Hurley, and Bisello (2016) combined the approach of examining employment groups with industrial analyses so that their basic unit of observation was jobs within specific industries. These were then classified into quintiles on the basis of average salaries so that the employment level could be examined before, during, and after the crisis. Due to the constraints of the study, neither the methodology nor the results can be presented in detail here, but the following contains a summary of the three most important findings.

First, European employment trends have always been characterized by the simultaneous presence of skill upgrading and polarization, although the extent of these has changed dynamically throughout the years. Before the global financial crisis and economic downturn that began in 2008, upgrading skills dominated, while polarization also took place, although minimally. In the aftermath of the crisis, polarization obviously increased while employment also climbed in relation to the jobs in the upper quintile, so upgrading also prevailed. The more recent phenomenon (lasting from the second quarter of 2013 to the second quarter of 2015) was a well-balanced increase in employment with a minimal shift to higher

skilled jobs. There was no sign of a lessening of demand for skills on an aggregate European level, but the increase in the level of the former was less obvious than in the years before the crisis (Fernández-Macías, Hurley and Bisello, 2016). While the current economic downturn caused by the response to COVID-19 appears to be hitting Western Europe and the USA particularly hard, even as unemployment levels remain relatively low in Eastern European countries, it remains to be seen whether the trend will increase polarization.

Second, although the most recent trends related to the employment shift are less compatible with skill upgrading than before the crisis, skill downgrading obviously occurred only in two countries. 'Over the four-year period 2011–2015, Hungary and Italy both experienced an obvious downgrading pattern of employment shift. In each of these countries, employment growth was strongest in the lowest-paid jobs and weaker in higher-paid jobs […]. At aggregate EU level (*sic*) over 2011–2015, there was upgrading with some polarization – relatively faster growth in the bottom than in the middle. However, this involved a more even spread of job gains across the wage distribution, as employment growth accelerated from mid-2013 onwards' (Fernández-Macías, Hurley and Bisello, 2016: 13).

Third, while the greatest growth was produced by the service sector, employment also increased in some areas of the manufacturing industry, such as in food processing and car manufacturing. Moreover, in these sub-industries the greatest growth was observed in the highest paid jobs.

3. Automation and creativity: A conceptual framework

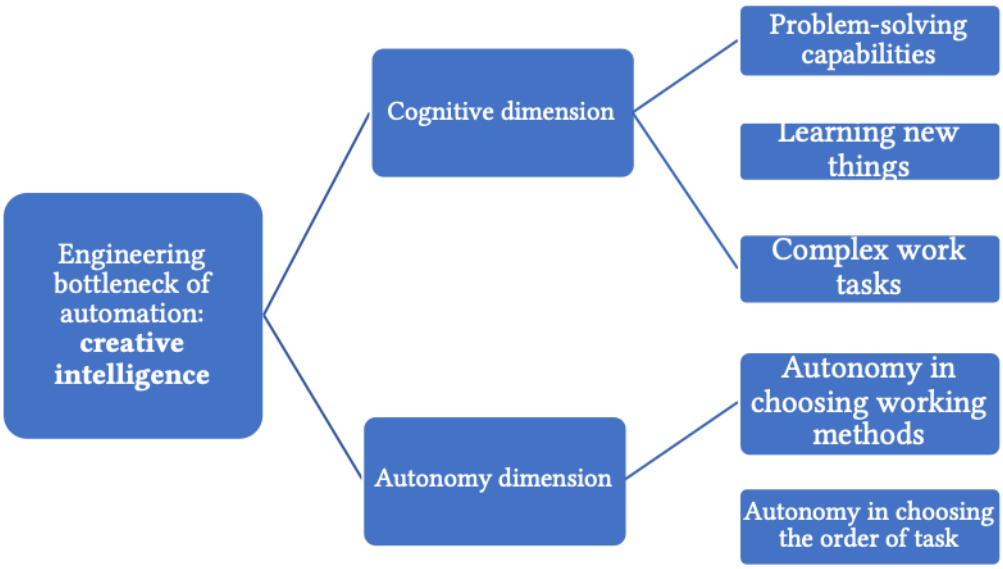
To describe labor markets in the Member States of the European Union from the perspective of the possible impact of current and future waves of automation and digitalization, we draw upon the theoretical basis elaborated by Frey and Osborne (2017), who distinguished three major job characteristics – perception and manipulation, creative intelligence, and social intelligence – that may inhibit the substitution of human labour by computers. The authors conclude that jobs requiring the mobilization of any of these labour inputs are less likely to be automated. Here, we narrow our focus to the creative element of job requirements for two reasons. First, we wanted to keep our model as simple as possible, and second, the creative dimension is relatively easy to measure compared to the perception/manipulation and social intelligence dimensions, which are more difficult to capture using survey questions. We assume that countries where the share of creative jobs is high will be less impacted by automation and digitization in terms of job losses, and that countries where creative jobs are less dominant are more susceptible to the negative effects – in terms of job losses – of automation.

In order to estimate the potential impact of automation in the European Union, we use Lundvall and Lorenz's work (Lundvall and Lorenz, 2010) as a starting point. Inspired by Richard Florida's seminal work on the creative class (Florida, 2002), the authors analyzed the fourth wave of European Working Condition Survey (EWCS) data from 2005 to examine the emergence of the

European creative class. Their conceptual framework, however, permits us to extend their analysis to make a preliminary forecast about the susceptibility of European jobs to automation by combining the data analysis that is available at the job-task level with the analytical conception of Autor about the cognitive aspects of jobs. Instead of predicting the probability of automation on an occupational basis, analysis of the EWCS database makes it possible to investigate directly the likelihood at the job level, which – in our opinion – provides a better estimate of the potential employment impacts of automation and digitalization.

We assume that creative jobs involve highly abstract elements involving more tacit knowledge and complex problem solving that is harder to automate. We also assume that creativity at work is associated with some level of employee autonomy, thus the higher the level of autonomy an employee enjoys at work, the less the probability that their job will be automated. Therefore, following the model of Lorenz and Lundvall, we used two types of variables in our analysis to measure the probability of automation, one capturing the cognitive aspects of jobs, and the other measuring employee autonomy at work.

Figure 1: Analytical framework for predicting the probability of automation



Source: Authors' compilation

Because these data describe job requirements, our unit of analysis is jobs, not employees, which is an important consideration when interpreting our results. It is also important to note that the assumptions we make about the probability of automation are valid only under the conditions of the current technological paradigm. As technology develops over time, new opportunities and development paths will open up; consequently, the real effects of digitalization may vary in

ways that cannot be clearly projected now. What is more, the employment impacts of technological development are not determined solely by technology itself, but are also shaped by societal change that is engineered or driven by stakeholders (governments, trade-unions, civic organizations, employers' associations, the scientific community) and externalities (such as a global pandemic and resulting economic downturn). In other words, while many of the studies about automation that have recently been published are informed to varying degrees by technological determinism and confident predictions about the future, we do not share these approaches and strongly believe in societal agency, and that the future is ultimately unknown. However, we share the following view of Freeman that 'technology in itself is neither good nor bad. It is the use which human beings make of any technology which determines both the nature and the extent of benefits' (quoted in Soete, 2018: 29).

4. Methodology and data sources

Data from several European Working Conditions Surveys (EWCS) represent a unique opportunity to analyze empirically task-based changes over a longer time (i.e. taking a longitudinal perspective). The survey is based on interviews with almost forty thousand European employees that are carried out every five years (Eurofound, 2015). Part of the survey instrument focuses on identifying the cognitive (learning) characteristics of work, as well as the level of autonomy of employees. These two dimensions of work are especially important for identifying the level of exposure to automation: as Autor (2014) suggested, until machines learn to study, only activities whose rules can relatively easily be programmed can be automated, such as those based on transparent, explicit routines that do not require human interaction in ad hoc situations.

Since Lundvall and Lorenz published their above-mentioned paper in 2010, the database of the 2015 survey was also made available, allowing us to identify longitudinal trends between 2005 and 2015. We also extended the scope of analysis by including the New Member States of the post-socialist countries, which is another novel feature. This paper focuses on salaried employees working in organizations with at least 10 employees in non-agricultural sectors as industry and service, excluding public administration and social security; education; health and social work; household activities; as well as agriculture and fishing. In addition, the study excludes several non-market occupational categories such as armed forces occupations; skilled and elementary agricultural, forestry and fishery occupations. To be simple and brief, data from Malta and Cyprus are not listed separately in the tables but as part of the European average. Furthermore, Croatia was also excluded from the sample as it joined the European Union only in 2013.

On the basis of Lorenz and Lundvall (2010), the following six variables were used to identify the cognitive dimensions of work tasks and the level of employee autonomy: i) the importance of problem-solving ability at work, ii) the opportunity for studying new things, iii) the complexity of work tasks, iv) the possibility of using ideas at work, v) the level of autonomy in selecting working methods, and

vi) the level of autonomy in choosing the order of work tasks. First, we employed multiple correspondence analysis (MCA), followed by Ward's method of hierarchical cluster analysis on the basis of the factor scores.[2]

The cluster analysis distinguished three larger groups of jobs. In creative jobs, employees have to make use of their cognitive abilities at work to a large extent, and enjoy a large degree of autonomy. Jobs organized on Taylorean principles represent the other end of the scale, and involve the least use of cognitive abilities and autonomy. Between these two groups, constrained problem solvers can be identified whose jobs are characterized by relatively strong expectancies about cognitive learning, and an extremely low level of autonomy. We assume on the basis of the above that Taylorean jobs will be most affected by automation, while the jobs of creative workers and, to a slighter extent, constrained problem solvers, will be less dramatically affected by the processes of automation.

5. Research results

Analysis of the changes in the EU-27 average shows that within the ten years of the survey, few changes were experienced in terms of single jobs. Almost one-quarter of all the jobs of European employees may be defined as involving constrained problem solving,[3] and half of all employees had creative jobs. However, as can be seen from Table 1, the stable European average masks significant differences and dynamics between the country groups. Not surprisingly, most creative jobs can proportionally be found in *Scandinavian countries*. Almost three-quarters of jobs in that region significantly rely on the cognitive abilities of employees, which ensure a high level of autonomy. Of the three Nordic countries examined during the ten years, the proportion of the former jobs also increased in Denmark and Finland, while Sweden, which originally had the highest proportion, experienced a decrease. In parallel, the proportion of Taylorean jobs is the lowest in Europe, and significantly decreased or levelled off in Sweden between 2005 and 2015.

The Continental country group shows a much more heterogeneous picture. Somewhat surprisingly, Germany, with a downward trend, stands out from this cluster as the number of creative jobs does not reach 50 per cent, while the share of Taylorean ones reaches nearly 30 per cent. The proportion of the latter is the lowest in Luxembourg, almost at the level of the Scandinavian countries, which can be explained by the former's well-developed financial sector. A significant difference, in comparison with the Nordic countries, is that the proportion of constrained problem-solving jobs in Germany is much larger.

The case of the Netherlands is similar to that of Germany, with increasing proportions of Taylorean jobs. This is noteworthy, as in 2005 the Netherlands was

[2] For further methodological details, see Makó et al. (2019) and Lorenz and Lundvall (2010).

[3] It is important to stress that it is not employees but jobs that are characterised as creative or Taylorean. An underskilled employee may also have a creative job, and many highly qualified professionals have less creative jobs.

more similar to the Scandinavian county group than the Continental one. However, the years since the 2008-2009 economic crisis have brought about radical change, but in a negative direction.[4] In contrast, the proportion of creative jobs in Austria has significantly increased.

Table 1: Types of Workplaces: Country Group Comparison – EU-15 (EWCS 2005, 2015)

	2005			2015		
	CW	CPS	TW	CW	CPS	TW
Nordic countries						
Denmark	74	13	13	77	14	9
Finland	67	20	13	73	18	9
Sweden	80	10	10	74	15	11
Continental countries						
Austria	51	29	20	57	25	19
Belgium	56	20	23	59	19	21
France	59	19	21	62	24	14
Netherlands	72	16	13	63	16	21
Luxemburg	63	18	19	65	24	11
Germany	51	25	24	49	23	29
Mediterranean countries						
Greece	40	32	28	28	32	40
Italy	40	28	33	45	16	38
Portugal	42	24	34	41	28	31

[4] To decide what role the crisis, technical changes gaining ground, or a third factor, played in these changes is beyond the scope of the study. Our paper makes reference to the crisis as it is obvious that such shocks do have an impact on job quality, especially the creative dimension of work tasks, and the extent of employees' autonomy.

	2005			2015		
	CW	CPS	TW	CW	CPS	TW
Spain	**37**	**28**	**35**	**47**	**28**	**25**
Anglo-Saxon countries						
Ireland	**58**	**19**	**22**	**55**	**21**	**24**
United Kingdom	**50**	**20**	**30**	**59**	**21**	**20**
EU-27	**50**	**24**	**26**	**52**	**24**	**24**

Source: Authors' calculation from the fourth (2005) and the sixth (2015) waves of the European Working Conditions Survey. Legend: CW= Creative Workers; CPS= Constrained problem-solvers; TW= Taylorized Workers.

The period of the crisis also accelerated convergent processes in the Anglo-Saxon countries within the cluster. In 2005, 58 per cent of the jobs in Ireland were creative, which proportion had decreased to 55 per cent by 2015. In contrast, during the same period in the United Kingdom this share increased from 50 per cent to 59 per cent. Interestingly, this significant growth exclusively impacted Taylorean jobs, while the proportion of constrained problem solvers did not change. Numerically, this means that in the United Kingdom the share of least creative jobs decreased from 30 per cent to 20 per cent within 10 years.

Not surprisingly, within the EU-15 countries the proportion of creative jobs is smallest in the Mediterranean countries. It is more interesting however, that most of the latter countries were able to catch up in this regard with the EU-27 average during the crisis. Spain takes the lead, where the proportion of creative work increased from 37 per cent to 47 per cent, but in Italy the share also grew from 40 per cent to 45 per cent. In Portugal, the proportion did not change. Only in Greece did it dramatically decline, from 40 per cent to 28 per cent.[5] In parallel, the proportion of Taylorean jobs was strikingly high, not only in comparison with the old Member States but also most post-socialist countries The two extremes are represented by Spain and Greece, respectively. The proportion of least creative jobs decreased by 10 percent in the former, and increased by 12 percent in the latter. Another fact worth highlighting is that in Italy not only did the proportion of the most innovative jobs increase, but the least innovative ones did as well during the same time period (between 2005 and 2015).

The Post-Socialist country group also shows a varied picture (Table 2). Estonia stands out from the Baltic *North-Eastern European counties*, as the high proportion of creative jobs and the general distribution of job types are similar to

[5] The latter one also signals that in addition to the technological changes the crisis also played a great role in forming clusters at work.

those of the more developed countries of the Continental cluster. Lithuania is positioned in the middle, as less than half of all jobs were creative, and the rest were evenly distributed among the other two types of jobs. The case of Latvia is unique since it is one of the least developed countries in the EU, although it was one of the leaders in terms of the number of creative jobs in the region in 2005. While 2010 data are not included in the table, it is worth remarking that the country strengthened its position at that time, and the drastic decrease occurred within the last five years. The Visegrad countries and Slovenia were categorized as Central European countries, although the latter significantly differs from the others regarding innovative jobs. The 55 per cent of creative jobs is similar to the proportion in Anglo-Saxon countries, and makes Slovenia stand out in this country group, similarly to Estonia in the North Eastern country cluster. What is striking in connection with the countries of the Visegrad region is that, in all four member countries, the share of creative jobs decreased after the 2008/2009 crisis. This decrease was strongest in Hungary, which went from having 44 per cent to 37 per cent of the latter jobs. Hungary is also the only one of the five countries where the proportion of least innovative, Taylorean jobs exceeds that of the share of constrained problem solver jobs, whose autonomy is minimal but for which the learning capability of employees is crucial. The proportion of these jobs increased by six percent within ten years. The situation in Poland is similar. Creative jobs lost ground due to an increase in Taylorean jobs. The weaker position of the Visegrad countries resulted in the fact that the share of innovative jobs in two *South-Eastern European Member States* (Romania and Bulgaria) further eroded. This occurred in parallel with stasis in the proportion of creative jobs, although the former decrease was much smaller than in Hungary.

Table 2: Types of Workplaces: Country Group Comparison – Post-socialist Countries (EWCS 2005, 2015)

	2005			**2015**		
	CW	**CPS**	**TW**	**CW**	**CPS**	**TW**
North Eastern Europe						
Estonia	**57**	**25**	**19**	**62**	**21**	**18**
Latvia	**52**	**19**	**29**	**35**	**17**	**48**
Lithuania	**39**	**30**	**31**	**45**	**28**	**27**
Central Eastern Europe						
Czech Republic	**43**	**30**	**27**	**38**	**32**	**30**

	2005			2015		
	CW	CPS	TW	CW	CPS	TW
Poland	46	32	22	41	30	29
Hungary	44	29	27	37	30	33
Slovakia	37	32	31	35	35	31
Slovenia	52	24	24	55	26	19
South Eastern Europe						
Bulgaria	40	30	29	38	34	28
Romania	37	39	24	35	37	28
EU-27	50	24	26	52	24	24

Source: Authors' calculation from the fourth (2005) and the sixth (2015) waves of European Working Conditions Survey. Legend: CW= Creative Workers; CPS= Constrained problem-solvers; TW= Taylorized Workers.

6. Summary and challenges for future research

The ongoing increase in info-communication technologies in production and services draws attention to the importance of examining the social – and particularly work-related – impacts of technological changes. During the earlier years of 'automation anxiety' that were generated by automation, digitalization, and robotization, menacing forecasts projected the disappearance of many jobs. The second wave of studies, more empirically focused, revealed a more complex picture and produced more differentiated findings. In parallel, researchers started to concentrate on the content of work tasks, instead of job groups, making estimations of how many employees are endangered by automation. This has also involved examining jobs for which automation does not substitute but rather complements human work, thereby making more differentiated analysis possible.

In our analysis we first applied the analytical framework of Frey and Osborne (2017), which classifies three main elements of job content that may inhibit attempts at automation: perception and manipulation, creative intelligence, and social intelligence. Using the databases of different waves of the European Working Conditions Survey allowed us to measure the risk of automation in line with the creative intelligence dimension of European jobs. We then used the model of Lundvall and Lorenz (2010) to identify three clusters of jobs that are susceptible to automation to different degrees, with creative jobs that are characterized by a high level of employee autonomy and creative skill requirements being at the lowest risk of automation. In contrast, Taylorean jobs can be characterized by low

level of employee autonomy and less room for creativity, meaning that these jobs are more likely to be automated. The third cluster of jobs, constrained problem solvers, are located in between the previous two cluster and can be characterized by a high level of creativity and low level of autonomy. Interpreting more deeply the susceptibility of these jobs to automation poses a challenge, particularly in view of recent social and economic developments, but we estimate that these kinds of jobs are less likely to be automated than Taylorean ones.

The results of the 2005 and 2015 EWCS database were analyzed, and led to the following most important findings:

1) Although the aggregated job cluster patterns of the EU-27 average have hardly changed in the examined ten-year period (2005–2015), significant differences exist between countries and important shifts took place.
2) In European countries, the proportion of creative jobs is the greatest and that of Taylorean jobs the smallest in the Scandinavian countries, followed by the members of the Continental and Anglo-Saxon country groups. With regard to the former metrics, the situation in Mediterranean and the East-Central European post-socialist countries is below the average of their European peers, with the former somewhat more favorably positioned.
3) From 2005 to 2015 strong convergence can be detected within the Scandinavian, Continental, and Anglo-Saxon country groups, while differences between the groups remained or even slightly increased. In contrast, significant divergence can be observed within the Mediterranean and the Post-Socialist country groups.
4) Estonia and Slovenia stand out from the post-socialist countries, as the share of creative jobs is similar to that of the Continental and Anglo-Saxon country groups. In contrast, the share of creative jobs significantly decreased in the Visegrad countries, occasionally approaching the level of Romania and Bulgaria, which countries are considered to be the least developed in the region.

Due to our particular interest in forecasting the employment risks of automation in Hungary, it is worth stressing that negative trends prevail in Hungary. While 2010 data are not included in our tables, it can clearly be seen from the results that the situation had become unfavorable within that timeframe. In 2010, the share of creative jobs was 48 per cent, of Taylorean ones 23 per cent, and within five years the proportion of the former had dropped to 37 per cent, and that of the latter increased to 33 per cent. All these processes are a cause for concern as technological development may result in the high exposure to automation of Taylorean jobs.

Hungary has based its economic competitiveness on a cheap but skilled labor force, and its geographical proximity to the center of Europe. This strategy was successful until the middle of the 2000s. With some significant exceptions, such as automotive, high-tech service, and software companies, Hungarian enterprises have been unable to attract higher value-added activities that could open the way to more knowledge-based economic development. There are signs that the segmented nature of the Hungarian economy has increased in past

decades, as internationally renowned companies that produce and provide services to international markets exist and operate side by side with newly created small- and medium-sized enterprises that operate on the Hungarian market, and growing players in the state-owned or partly state-owned sectors (Makó and Illéssy, 2016). Weak cooperation and networking between these three segments creates a barrier to exploiting the economic opportunities of the country. Automation, digitization, AI, and the related changes in working organizations are the tools for renewing the competitiveness strategy of Hungary. For example, in the United Kingdom, one of the explicit objectives of the strategy that has been defined to improve Industry 4.0 is to rebuild the industrial basis of the economy and relocate (resource) processing industry activities back to the island from low-labour-cost countries (Made Smarter, 2017: 8). If these scenarios play out, such changes may occur that foster the reorganization of global value chains and shake up Hungary's position in this field. Although the cheaper and more disciplined labour force – and extremely developed supplier network – in South East Asia posed less of a threat to Hungarian jobs than expected, German AI-related ambitions and the shift towards the use of electric cars represent a much more realistic danger to jobs that is predominantly associated with routine tasks in the production and service sectors of the global value chain.

References

Arntz, M., Gregory, T. and Zierahn, U. (2016) The Risk of Automation for Jobs in OECD Countries. *OECD Social, Employment and Migration Working Papers,* No. 189. https://doi.org/10.1787/5jlz9h56dvq7-en

Autor, D. H. (2014) Polanyi's Paradox and the Shape of Employment Growth. *National Bureau of Economic Research Working Paper,* No. 20485. https://doi.org/10.3386/w20485

Bowles, J. (2014) The Computerization of European Jobs. *Bruegel,* 24 July. Available at http://bruegel.org/2014/07/the-computerisation-of-european-jobs Accessed 11-01-2018.

Brynjolfsson, E. and Mcafee, A. (2014) *The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies*. New York and London: W.W. Norton & Co.

Brzeski, C. and Burk, I. (2015) *Die Roboter kommen: Folgen der Automatisierung für den deutschen Arbeitsmarkt (The Robots are Coming: Consequences of Automatisation for the German Labour Market)*. ING DiBa Economic Research. Available at https://www.ing-diba.de/pdf/ueber-uns/presse/publikationen/ing-diba-economic-research-die-roboter-kommen.pdf Accessed 21-01-2018.

Chui, M., Manyika, J. and Miremadi, M. (2016) Where machines could replace human – and where they can't (yet) (The Technical potential for automation differs dramatically across sectors and activities). *McKinsey Quarterly,* 2016/3. Available at https://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/where-machines-could-replace-humans-and-where-they-cant-yet Accessed 03-12-2017.

Edquist, Ch. (2019) Towards a Holistic Innovation Policy: Can the Swedih National Innovation Council (NIC) be a Role Model? *Research Policy, 48*(4): 869–879. https://doi.org/10.1016/j.respol.2018.10.008

Eurofound (2015) *European Working Conditions Survey.* Available at https://www.eurofound.europa.eu/surveys/european-working-conditions-surveys Accessed 31-03-2018.

European Commission (2010) *Europe 2020: A Strategy for Smart, Sustainable and Inclusive Growth.* Brussels: European Commission.

Fernández-Macías, E., Hurley, J. and Bisello, M. (2016) *What Do Europeans Do at Work? A Task-Based Analysis: European Jobs Monitor 2016.* Luxembourg: Publications Office of the European Union. Available at https://www.eurofound.europa.eu/sites/default/files/ef_publication/field_ef_document/ef1617en.pdf Accessed 31-03-2018.

Florida, R. (2002) *The Rise Of The Creative Class: And How It's Transforming Work, Leisure, Community And Everyday Life.* New York: Perseus Book Group.

Ford, M. (2015) *The Rise of the Robots.* New York, Basic Books.

Frey, C. and Osborne, M. (2017) The Future of Employment: How Susceptible are Jobs to Computerization? *Technological Forecasting & Societal Change, 114:* 254–280. https://doi.org/10.1016/j.techfore.2016.08.019

Hack, L. (1994) Industriesoziologie (Industrial Sociology). In Kerber, H. and Schmieder, A. (eds.) *Spezielle Soziologien. Problemfelder, Forschungsbereiche, Anwendungsorientierungen.* Hamburg, Rowohlt. 40–74.

International Monetary Fund (2017) *World Economic Outlook October 2017: Seeking Sustainable Growth – Short-term Recovery, Long-term challenges.* Washington: International Monetary Fund.

Keynes, J. M. (1931) *Essays in Persuasion.* London: MacMillan and Co.

Kopp, R., Howaldt, J. and Schultze, J. (2016) Why Industry 4.0 needs Workplace Innovation: A critical look at the German debate on advanced manufacturing. *European Journal of Workplace Innovation, 2*(1): 7–24. https://doi.org/10.46364/ejwi.v2i1.373

Koski, O. and Husso, K. (2018) Work in the Age of Artificial Intelligence: Four Perspectives on the Economy, Employment, Skills and Ethics. Helsinki: Ministry of Economic Affairs and Employment. Available at http://urn.fi/URN:ISBN:978-952-327-311-5 Accessed 31-10-2018.

Leontief, W. (1952) Machines and Man. *Scientific American, 187*(3): 150–160.

Lundvall, B.-Å. and Lorenz, E. (2010) Accounting for creativity in the European Union: A multi-level analysis of individual competence, labour market structure, and systems of education and training. *Cambridge Journal of Economics, 35*(2): 269–294. https://doi.org/10.1093/cje/beq014

Made Smarter (2017) *Made Smarter: Review 2017.* Available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/655570/20171027_MadeSmarter_FINAL_DIGITAL.pdf Accessed 31-10-2018.

Makó, Cs., Illéssy, M. and Borbély, A. (2019) Creative workers in Europe: Is it a reserve of the 'Would-Be Entrepreneurs'? A cross country comparison. In Dallago, B. and Tortia, E. (eds.) *Entrepreneurship and Local Economic Development: A Comparative Perspective on Entrepreneurs, Universities and Governments.* New York: Routledge. 186–207.

Makó, Cs. and Illéssy, M. (2016) Segmented capitalism in Hungary: Diverging or converging development paths? In Delteil, V. and Kirov, V. (eds.) *Labour and Social Transformation in Central and Eastern Europe: Europeanization and Beyond.* London and New York: Routledge. 77–97.

Mandl, I., Hurley, J., Ledermaier, S. and Napierala, J. (2016) *Job creation in SMEs: ERM Annual Report 2015.* Luxembourg: Publications Office of the European Union. https://doi.org/10.2806/342142

Pfeiffer, S. (2010) Technisierung von Arbeit (The Technicisation of Labour). In Böhle, F., Voß, G. and Wachtler, G. (eds.) *Handbuch Arbeitssoziologie.* Wiesbaden: VS Verlag für Sozialwissenschaften. 231–262.

Polanyi, M. (1966) *The Tacit Dimension.* New York: Doubleday.

Soete, L. (2018) Destructive creation: Explaining the productivity paradox in the digital age. In Neufeind, M., O'Reilly, J. and Rauft, F. (eds.) *Work in the Digital Age: Challenges of the Fourth Industrial Revolution.* London: Rowman & Littlefield. 29–46.

Szalavetz, A. (2018) Ipari fejlődés és munka a tudásalapú társadalomban (Industrial development and work in knowledge-based societies). *Magyar Tudomány, 179*(1): 55–60. http://doi.org/10.1556/2065.179.2018.1.6