The Impact of Automation on Employment Growth in Slovakia[1]

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Abstract. The aim of the paper is to examine the relationship between employment growth and automation probabilities (substitution potentials) for occupations in Slovakia. We use detailed employment data provided by Trexima Bratislava, automation probabilities by Frey and Osborne (2017) and substitution potentials by Dengler and Matthes (2018). The results show that between 2014 and 2019, there was an overall increase in employment on the Slovak labor market. However, occupations at a higher risk of automation experienced lower employment growth during the examined period. Even though these results are confirmed by regression analysis, the aim is not to provide any causal interpretation, since the risk of automation (substitution potential) is not the only explanatory factor for the employment growth in Slovakia.

Keywords: Automation, Employment Growth, Slovakia

JEL classification: *J21, O33*

1 Introduction

Recent advances in automation technologies and digitalization are expected to increase productivity and social welfare. On the contrary, new technologies replace human labor in tasks usually considered as the main domain of human activity and there is increasing anxiety related to technologies that may become a threat to humans, labor, employability, and related socio-economic consequences.

According to the newest research, for instance, by Georgieff and Milanez (2021), there has been no support for net job destruction at the broad country level so far. Therefore, we examine the relationship between employment growth and automation probabilities (substitution potentials) in Slovakia. The aim of the paper is to identify,

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whether employment increased or decreased between 2014 and 2019 and if the growth has been higher or lower in occupations with a higher risk of automation. We use detailed employment data provided by Trexima Bratislava, automation probabilities by Frey and Osborne (2017) and substitution potentials by Dengler and Matthes (2018). Based on the analysis, it seems that employment growth is lower with an increasing risk of automation (an overall increase of 11% versus 9% and 4% in occupations at the highest risk of automation based on the taken approach).

The paper proceeds as follows. The first section includes a literature review on the predicted impacts of automation on the national economies. Next, we present the methodology and data used together with the main empirical results. The results cover employment growth between 2014 and 2019 in Slovakia, together with the relationship between this growth and occupations with different automation risks. An understanding of automation's impacts can form a basis for policymakers for targeting scarce public resources on those most in need. The last section concludes.

2 Literature Review

The vision of a fully automated and integrated production process from the very beginning up until the distribution of products is no longer a far-off dream, which raises questions and concerns about future work. Autor et al. (2003) and Autor and Dorn (2013) claim that computerization has been affecting mostly routine tasks, however, Frey and Osborne (2017), McAfee and Brynjolfsson (2018), and many others suspect that current technological changes may allow computers and machines to substitute an increasing amount of non-routine tasks, as well. The literature already provides an extensive list of estimates assessing the liability of jobs or particular tasks to potential technological disruptions. For instance, Frey and Osborne (2017) examined the current jobs susceptibility to technological developments. They used new methods to predict computerization probabilities for 702 occupations and distinguished between high-, medium-, and low-risk occupations regarding their automation probabilities. As the aforementioned authors emphasize, their main aim is not to estimate the number of jobs being automated, but to focus on the potential automatability of jobs over the next period. They claim that a relatively high percentage of U.S. jobs faces a high risk of computerization, 47% to be precise.

Based on the above-mentioned study by Frey and Osborne (2017), some authors were inspired by their approach and used either an *occupation-based* or a *task-based* approach to predict the jobs automation risk in other economies. Using the occupation-based approach, Pajarinen and Rouvinen (2014) showed that the share of jobs exposed to automation is about 35% in Finland while other authors – Brzeski and Burk (2015) – estimated that 59 % of jobs in Germany are considered to be at a high risk of automation. Using more aggregated employment data, Bowles (2014) finds that the share of jobs highly exposed to automation in Europe is between 45% to 60%, with the highest susceptibility in southern Europe. Also, the paper shows that roughly 55% of jobs are at a significant risk of automation in Slovakia. This estimate is in line with the EU member states' average of 54%.

Using a task-based approach offers much lower susceptibility to automation in comparison with an occupation-based approach (Arntz et al., 2016). This group of authors shows that when allowing for the heterogeneity of workplace, the automation risk of jobs drops to 9 % in the United States. Their study for 21 OECD countries provides several results – on average 9% of jobs are highly automatable, the lowest risk of automation is faced by the workers in South Korea (6%), the highest risk is in Austria (12%), while the share for Slovakia accounts for 11%. Also, this paper from 2016 indicates that the highest risk of automation is shared by the low-income population and employees with primary and lower secondary education. When it comes to the labor market in Slovakia, it can be found in fourth place in terms of risk, following countries like Austria, Germany or Spain. Nedelkoska and Quintini (2018) used a very similar method, when they extended the analysis to 32 OECD countries and estimated that the average share of jobs at a high risk of automation is close to 14%. Looking at the country level, the shares range from 6% to 33% and Slovakia was the economy with the highest risk of automation. The average job automatability in Slovakia equal to 57%. Pouliakas (2018) reached the same results for EU countries as Nedelkoska and Quintini (2018) that 14% of a European working age population (from 24 to 65 years of age) are confronted with a high risk of automation.

On the contrary, Dengler and Matthes (2018) used their own expert estimates of the automation risk faced by individual occupations in Germany. According to these authors, compared to the 47% in the case of using the occupation-based approach, the share using the task-based approach is significantly lower, particularly 15% of German employment has to face a high automation risk. They belong to one of the first scientists who confirmed the relationship between probabilities of automation and employment growth. They found that between 2013 and 2016 employment was growing slower with increasing substitution potential of certain occupation. Nonetheless, substitution potentials do not belong to the only explanatory factor for employment growth.

Mihaylov and Tijdens (2019) have chosen a similar approach consisting of the analysis of the task content of the individual occupations in the ISCO-08 (International Standard Classification of Occupations). They categorize the tasks into the following groups – non-routine analytic, non-routine interactive, routine cognitive, routine manual and non-routine manual – and then predict the share of employment at a high risk of automation in the Netherlands, which is 11%. Moreover, Haiss et al. (2020) working with the data from micro-census labor force survey carried out by Statistics Austria (2015), calculated that more than 40% of the Austrian employment is threatened by a high risk of computerization. Their results suggest that three general groups, more precisely clerical support workers, service and sales workers as well as craft and related trade workers, consists of more than 72% of people working in high-risk occupations. However, according to them, only a small proportion of occupations from a high-risk category will be completely automated in the near future. The vast majority of these occupations will rather go through major changes in the requirements in terms of competences, skills and education of workers and also tasks performed within these occupations.

Furthermore, Acemoglu and Restrepo (2019) suspect that automation will have multiple effects. The first will manifest itself in terms of the job's destruction and can

be named as the so-called displacement effect. It will mainly represent the cost of automation. The advantages connected to automation are characterized as a productivity effect that makes industry capable of producing more and cheaper goods leading to more profitable companies and allowing them to hire more employees. Moreover, humans can benefit from the new jobs like a robot technician or a software coder. These benefits of new technologies are often called as the reinstatement effect. The authors (Acemoglu and Restrepo, 2019) were trying to find out which of these effects is more likely to dominate. The productivity and reinstatement effects of new technologies were so large between 1947 and 1987 that they were able to more than make up for the so-called displacement effects. One can explain the recent stagnation of labor demand by an acceleration of automation, mostly in manufacturing, and a deceleration in terms of creating new tasks. Besides that, many economies also experienced a slowdown in productivity growth, leading to a slowdown in demand.

Most recently, one of the first results on how employment has changed in high risk occupations suggests no massive job losses (Georgieff and Milanez, 2021). In their paper, they used a task-based measure of automation risk to study whether countries and jobs that were identified as having a high risk of automation in 2012 experienced declines in employment by 2019. They claim that between 2012 and 2019, all 21 examined countries experienced employment growth, but it has been considerably lower in high risk jobs (6%) in comparison with jobs in a low risk category (18%). Moreover, it is striking that this growth in employment has been very similar across all educational groups, which implies that the employment rate of the low-educated workers has not grown less than of the more educated.

3 Methodology and Data

The aim of the paper is to apply the estimates of automation probabilities used by Frey and Osborne (2017) and substitution potentials by Mihaylov and Tijdens (2019) to detailed Slovak employment data from Trexima. We use the data at the national level for 401 4-digit SK ISCO-08 occupations for years 2014 and 2019.

One can find the estimates of the probabilities of automation for 702 occupations in the Appendix of the aforementioned paper by Frey and Osborne (2017). The estimates of the substitutional potential for more than 300 4-digit ISCO-08 occupations were not directly in the paper by Dengler and Matthes (2018), we had to request them from the authors. These estimates are easily applicable to our data, as they use the same occupation classification. When working with the automation probabilities by Frey and Osborne (2017), we had to use a crosswalk between ISCO-08 and the 2010 SOC. The crosswalk is available at the Bureau of Labor Statistics website. Frey and Osborne (2017) distinguish between various types of occupations, more precisely high-, medium- and low-risk, depending on their automation probabilities. This categorization is also used by Dengler and Matthes. Therefore, this categorization is used in this paper, too.

The possibility of comparing the extent to which automation threatens the labor market of a particular country with other countries is the main advantage of working

with the estimates of Frey and Osborne (2017). This is also the reason why the similar methodology has been applied by several other authors. The disadvantage lies in the process of translating their estimates of the automation probability from the American to the international classification of occupations. This country-specificity issue is to some extent present also in the case of the estimates of Dengler and Matthes (2018) since their estimates are based on the tasks performed within individual occupations in Germany. Their paper assesses the possibilities of replacing approximately 8,000 tasks with computers or computer-controlled machines. Each of these tasks was independently examined by three coders to find out if they could be performed fully automatically by a computer-controlled machine or a computer algorithm in 2013. In this paper, we calculate employment growth in different occupations in Slovakia between 2014 and 2019. For the estimation of the relationship between automation probabilities (substitution potentials) and the employment growth during that period, we use an unweighted OLS regression.

4 Empirical Results

Similar to Dengler and Matthes (2018) or Georgieff and Milanez (2021), we analyze the relationship between automation risk and occupational employment growth between 2014 and 2019. The results for Slovakia are very similar as the one for Germany, suggesting that employment growth declines significantly with the increasing risk of automation.

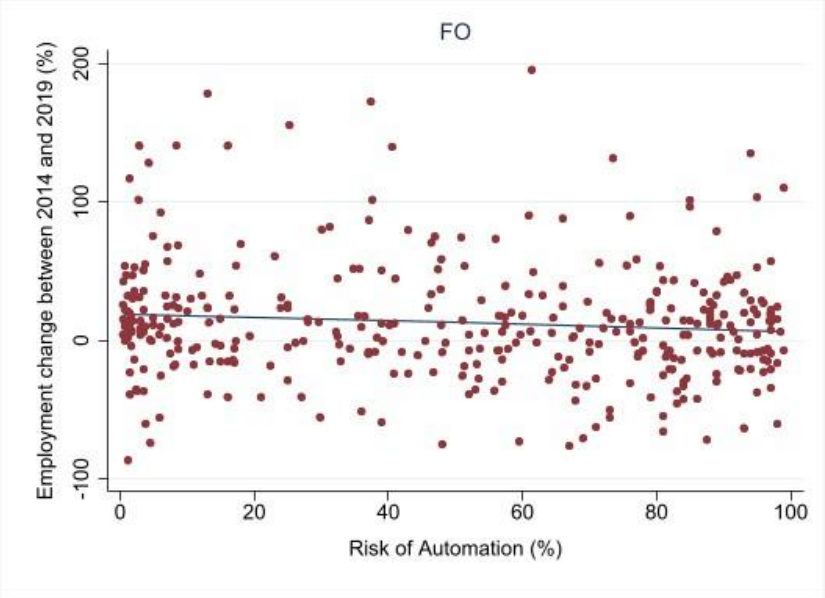

Fig. 11. Employment growth by risk of automation, Slovakia, based on estimates by Frey and Osborne (2017)

As can be seen in Figure 1 and Figure 2, this is true when using both estimates by Frey and Osborne (2017) and Dengler and Matthes (2018). Over the five-year period, Slovakia experienced employment growth of about 11%, however, it was much lower in occupations at a high risk of automation, namely 9% for the most automatable occupations according to Frey and Osborne and only 4% applying the estimates of Dengler and Matthes.

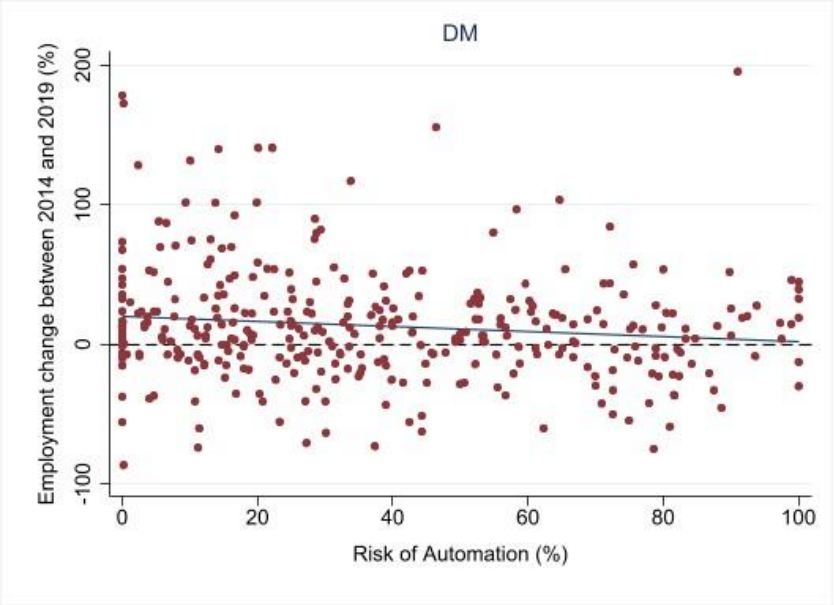

Fig. 2. Employment growth by risk of automation, Slovakia, based on estimates by Dengler and Matthes (2018)

Looking at Table 1, we find that the employment growth declines by approximately 1.3 percentage points if the risk of automation increases by 10 percentage points when applying the Frey and Osborne estimates (column 1), while in the case of Dengler and Matthes substitution potentials, the employment growth declines by approximately 1.9 percentage points if the risk of automation increases by 10 percentage points (column 2). The results are significant at the 5% significance level.

Table 9. Employment growth and a risk of automation in Slovakia (2014–2019)

VARIABLES	(1) Employment change	(2) Employment change
Automation risk_FO	-0.133**	
	(0.0648)	
Automation risk_DM		-0.186**
		(0.0752)
Constant	19.14***	20.24***
	(3.925)	(3.529)
Observations	369	358

R-squared	0.011	0.017

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Furthermore, it is also in compliance with the recent findings of Georgieff and Milanez (2021) that all 21 examined OECD countries experienced employment growth over the past decade with much lower increase in jobs at high risk of automation – 6% versus 18% in jobs at lower risk. However, as they explain, lower employment growth in high-risk occupations has not been accompanied by a shift of the low-educated away from high-risk and into lower-risk occupations. This can be rather explained by the fall in job opportunities for these workers, leading to a decline in their absolute number and accompanied by a general upskilling of the workforce. Also, the remaining low-educated workers have become even more concentrated in high-risk occupations, which represents major policy challenges. They also add that countries with higher automation risk back in 2012 experienced higher employment growth until 2019, which is consistent with a theory that automation contributes to positive employment growth through its productivity effect.

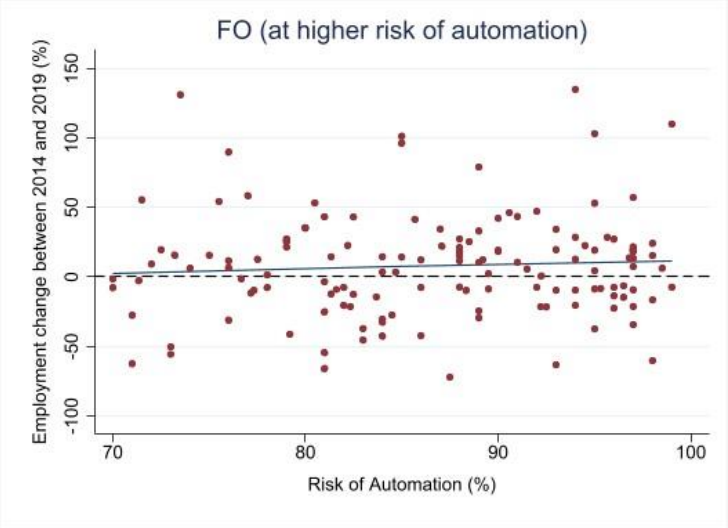

Fig. 3. Employment growth in occupations with high risk of automation, Slovakia, based on estimates by Frey and Osborne (2017)

Looking at Figure 3 and Figure 4, we can specifically examine the employment growth in jobs with the highest risk of automation. As previously mentioned, we see a growth even in the potentially highly automatable jobs, but it is lower than the overall employment growth during the period. Therefore, there is no indication that the higher risk of automation is associated with employment decline. This is true applying both automation probabilities estimates to the Slovak economy.

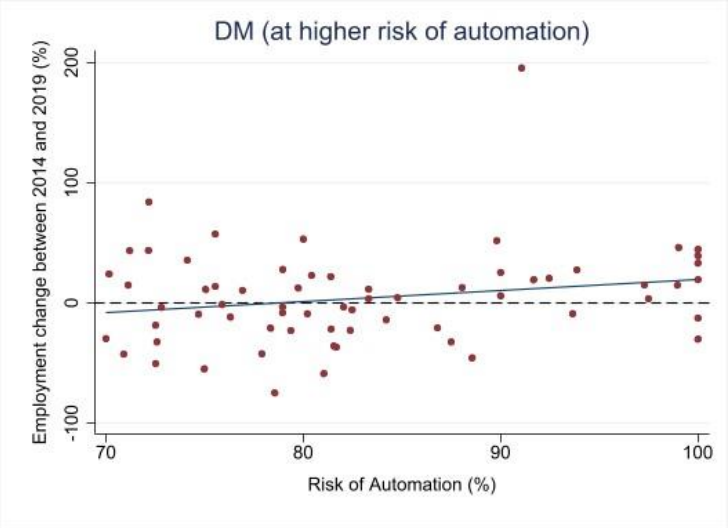

Fig. 4. Employment growth in occupations with high risk of automation, Slovakia, based on estimates by Dengler and Matthes (2018)

Occupations with the highest risk of automation according to Frey and Osborne (2017) that saw significant increase in employment (Table 2) include specific kind of drivers, insulation workers, salespersons, jewelry and precious-metal workers, kitchen helpers, medical secretaries or woodworking-machine tool setters and operators. On the other hand, the highest risk occupations with most prominent decline in the last five years are fast food preparers, hand launderers and pressers, blacksmiths, hammersmiths and forging press workers, legal secretaries, printers etc.

Table 2. Highest increase and decrease in employment for the occupations with the risk of automation above 70 %, Slovakia, based on estimates by Frey and Osborne (2017)

ISCO Code	Name	Employment change (%)	Risk of Automation (FO)
Highest increase in employment (%)			
9331	Hand and pedal vehicle drivers	135,0	94,0
7124	Insulation workers	131,2	73,5
5244	Contact center salespersons	110,0	99,0
7313	Jewelry and precious-metal workers	103,2	95,0
9412	Kitchen helpers	101,4	85,0
3344	Medical secretaries	96,4	85,0
6122	Poultry producers	89,6	76,0
7215	Riggers and cable splicers	79,1	89,0
5132	Bartenders	58,6	77,0
7523	Woodworking-machine tool setters and operators	57,1	97,0
Highest decrease in employment (%)			

9411	Fast food preparers	-72,0	87,5
9121	Hand launderers and pressers	-65,7	81,0
7221	Blacksmiths, hammersmiths and forging press workers	-63,2	93,0
3254	Dispensing opticians	-62,6	71,0
3342	Legal secretaries	-60,3	98,0
7125	Glaziers	-55,7	73,0
4131	Typists and word processing operators	-54,6	81,0
8152	Weaving and knitting machine operators	-50,3	73,0
7322	Printers	-45,5	83,0
7531	Tailors, dressmakers, furriers and hatters	-42,7	84,0

Source: Author based on data from Trexima Bratislava and Frey and Osborne (2017).

Based on the substitution potentials by Dengler and Matthes, the riskiest occupations which experienced highest increase in employment in Slovakia include power production plant operators, woodworking-machine tool setters and operators mechanical machinery assemblers, aircraft engine mechanics and repairers, plastic products machine operators and other, while the highest decline was present in occupations like shotfirers and blasters, upholsterers and related workers, typists and word processing operators, weaving and knitting machine operators, printers, tailors etc. (Table 3).

Table 3. Highest increase and decrease in employment for the occupations with the risk of automation above 70 %, Slovakia, based on estimates by Dengler and Matthes (2018)

ISCO Code	Name	Employment change (%)	Risk of Automation (DM)
Highest increase in employment (%)			
3131	Power production plant operators	195,5	91,1
2529	Database and network professionals not elsewhere classified	84,1	72,2
7523	Woodworking-machine tool setters and operators	57,1	75,6
8211	Mechanical machinery assemblers	53,3	80,0
7232	Aircraft engine mechanics and repairers	51,9	89,8
8142	Plastic products machine operators	46,2	99,0
7535	Pelt dressers, tanners and fellmongers	44,3	100,0
3252	Medical records and health information technicians	43,6	72,1
8143	Paper products machine operators	43,3	71,2
7521	Wood treaters	39,40	100,00
Highest decrease in employment (%)			
7542	Shotfirers and blasters	-75,0	78,6
7534	Upholsterers and related workers	-59,0	81,0
4131	Typists and word processing operators	-54,6	75,0

8152	Weaving and knitting machine operators	-50,3	72,5
7322	Printers	-45,5	88,6
7531	Tailors, dressmakers, furriers and hatters	-42,7	70,9
7113	Stonemasons, stone cutters, splitters and carvers	-42,2	77,9
7317	Handicraft workers in wood, basketry and related materials	-36,9	81,7
7311	Precision-instrument makers and repairers	-36,1	81,6
3522	Telecommunications engineering technicians	-32,7	87,5

Source: Author based on data from Trexima Bratislava and Dengler and Matthes (2018).

5 Conclusion

To conclude, we found that occupations at a higher risk of automation experienced lower employment growth between 2014 and 2019 in Slovakia. While the overall employment growth was 11%, it was 9% for the most automatable occupations identified by Frey and Osborne (2017) and only 4% applying the estimates of Dengler and Matthes (2018). Even though these results are confirmed by regression analysis, we do not provide any causal interpretation, since the risk of automation (substitution potential) is not the only explanatory factor for the employment growth in Slovakia.

Furthermore, high-risk occupations applying the Frey and Osborne estimates with the most prominent decline in the five-year period were fast food preparers, hand launderers and pressers, blacksmiths, hammersmiths and forging press workers, legal secretaries, printers, etc. Using the substitution potentials by Dengler and Matthes, the highest decline was present in occupations like shotfirers and blasters, upholsterers and related workers, typists and word processing operators, weaving and knitting machine operators, printers, tailors and other. Future work could focus on the causal interpretation of the examined relationship and the corresponding policy recommendations.

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