



STRUCTURAL CHANGES OF THE LABOUR MARKET IN THE CZECH REPUBLIC IN TERMS OF SKILLS: IS THERE ANY JOB POLARIZATION?

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Abstract

Job polarization has been proven mainly in the United States and many Western European countries, but the Czech Republic has been relatively neglected in these surveys. This paper explicitly focuses on the Czech Republic and fills this gap from 2004–2017. Moreover, the Czech Republic is examined at the level of individual regions, making this paper new. Descriptive results show that the labour market has been polarized – employment in the high- and low-paying occupations has increased, while employment in the middling occupations has decreased. Furthermore, polarization has been demonstrated in seven regions. The workforce relocation took place to a greater extent in low-paying occupations (both at the level of individual regions and the level of the whole Czech Republic). Regression analysis results show job polarization only between 2004 and 2010 in the occupations of the private sphere.

Keywords

Job Polarization, Employment Structure, Technological Change, Labour Market

I. Introduction

Structural changes in the labour market can be viewed from many perspectives. One of them is to observe changes in the employment structure regarding skill levels. Occupations that required a relatively high level of skills twenty years ago (e.g., accountants) can now be easily replaced by algorithms. Technological change is one of the main factors that has affected the demand for skills² and this has led to the formulation of the *skill-biased technological change* (SBTC) hypothesis, which states that high-skilled workers are demanded more, as the involvement of new technology requires more skilled workers to work with the new technology (Manning, 2004). However, as has been shown over the last twenty years, the labour market structure is evolving differently. In particular, the

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² See Acemoglu (1998, 2002), Autor, Levy and Murnane (2003) and Manning (2004).

influential articles by Autor, Levy and Murnane (2003), Autor, Katz and Kearney (2006) and Goos and Manning (2007) have shown that employment is polarized. While the SBTC hypothesis predicted a directly proportional relationship between skill level and labour demand, reality has shown that this relationship is polarized. Job polarization (“labour market polarization” or “employment polarization”) means that the proportion of middle-skill workers is declining while the proportion of high-skill and low-skill workers is rising. In the context of job polarization, attention was paid mainly to the United States and Western European countries, while the Czech Republic was neglected. This paper aims to find out whether the labour market polarized during the period 2004–2017, i.e., whether the proportion of high and low-skilled workers increased at the expense of middle-skilled workers. This paper fills a gap in the literature with descriptive and regression analysis. Another contribution of this paper is that it does not focus only on aggregated data for the entire Czech Republic but also on the level of its regions.³

Both descriptive and regression analyses are used to determine whether the labour market in the Czech Republic has polarized in the period 2004–2017. In both cases, methods applied in previous research in other countries are used. The descriptive analysis follows Goos, Manning and Salomons (2009, 2014) and Keller and Utar (2016), which observe relative changes in employment between specific occupational groups divided into high, middle and low-skilled. For more formal testing of polarization, regression analysis was proposed by Goos and Manning (2007). We divide the occupations of the private and public spheres by their combination. In the literature, we often encounter their combination; this division is an exception (see Adermon and Gustavsson, 2015).

The structure of the paper is as follows: Section II briefly describes job polarization, especially its causes and consequences. Section III mainly describes data sources, how workers are divided into high, middle, and low-skilled workers, and how polarization is detected. These methods are subsequently applied in Section IV, and their results are discussed. This section presents the results of descriptive analysis, regression analysis and robustness check for regression. Last Section V summarizes the findings and concludes.

II. Job Polarization

Research about job polarization began to appear, especially after the year 2000. Cirillo (2018) explains why job polarization was identified later. The original literature focused primarily on the SBTC hypothesis, and growing income inequality⁴ operated mainly with terms such as *blue/white collars*, *good jobs/bad jobs*, or *skilled/unskilled*, which, in principle, did not allow for clarification of the real dynamics of the employment structure. The popularization of job polarization was brought about mainly by the article by Autor, Levy and Murnane (2003), in which the authors modify the framework established by the SBTC hypothesis to explain polarization. Their explanation of polarization is based on the fact that the content of some occupations is routine. Technological progress has made it possible to reduce the cost of capital, which can substitute the worker (if he

³ At the regional level, polarization was examined only by Dauth (2014), who examined differences between regions in Germany. Abel and Deitz (2012) compare only two regions – New York and New Jersey.

⁴ These were the main topics of labour market research in the 1980s and 1990s (Acemoglu, 2002).

performs manual routine tasks) or which can be a complement to the worker (if he performs non-routine cognitive tasks). Autor, Levy and Murnane (2003) further showed that those workers who perform manual routine tasks are most often in the middle of the wage distribution function, corresponding to their classification among middle-skilled workers. Their *routine-biased technological change* (RBTC) hypothesis, later named by Goos, Manning, and Salomons (2014), became the first widely accepted explanatory factor for job polarization.

However, the rise of new technologies (especially computerization) is not the only explanatory factor of job polarization. Another is globalization and offshoring (Goos, Manning and Salomons, 2009) and consumption spillover, which is caused by the consumption of high-skilled (high-wage) workers, who demand more services from the low-skilled (low-wage) workers, such as au pairs, cleaning services, etc. (Autor and Dorn, 2013; Mazzolari and Ragusa, 2013). The last factor is the labour market institutions (Fernández-Macías, 2012) when their setting – e.g. the level of employment protection – can change the extent of polarization (Pertold-Gebicka, 2014).

Job polarization research examined both individual countries separately⁵, and a larger number of countries together.⁶ Some studies analyze a larger number of countries using data aggregation. The disadvantage may be that the results are telling for a group of countries, but the effect on individual countries is unclear. Keister and Lewandowski (2017) aggregate data for the Czech Republic, Hungary, Poland, Slovakia, the Baltic States and Romania as part of a descriptive analysis, so comparing the results for selected countries is impossible. (In addition, their analysis is directed towards changes in the nature and content of work – tasks – rather than changes in the proportions of selected occupations.) In a similar way, Nchor and Rozmahel (2020) aggregate data for the Czech Republic, Hungary, Poland and Slovakia; the extent of structural changes for individual countries is not clear.

Job polarization has been documented since the 1980s in the United States (Autor and Dorn, 2013) and the United Kingdom (Goos and Manning, 2007), and since the 1990s in Western European countries (Goos, Manning and Salomons, 2014). The presence of job polarization in these countries corresponds to the rise of computer technology and the development of globalization (which is closely linked to technological change). In this context, it would be possible to expect changes in employment, indicating polarization in the Czech Republic.

Especially in recent years, interest in job polarization has attracted economists and sociologists, such as Fernández-Macías (2012) and Oesch and Rodríguez-Menés (2010). The reason is the nature of polarization – middle-skilled occupations are disappearing, and the

⁵ For example, the United States (Autor, Katz and Kearney, 2006; Autor and Dorn, 2013), the United Kingdom (Goos and Manning, 2007), Germany (Dauth, 2014), Denmark (Keller and Utar, 2016), Sweden (Adermon and Gustavsson, 2015) and Portugal (Fonseca, Lima and Pereira, 2018). Polarization has been demonstrated in all these countries.

⁶ Fernández-Macías (2012) examines 15 countries; Goos, Manning and Salomons (2009, 2014) 16 countries; Michaels, Natraj and Van Reenen (2014) 11 countries and Pertold-Gebicka (2014) 12 countries. In none of these cases was the Czech Republic included in the surveys; attention was focused mainly on Western European countries.

middle class is squeezing. Suppose we consider the large middle class the basis of social and political stability. In that case, job polarization poses apparent risks that can result in various forms of political and social revolt.

III. Material and Methods

The International Labour Organization (2016) defines skills as the “*Ability to perform the tasks and responsibilities that are given by the job.*” The division of workers according to skill levels into high, middle and low skills is not based on a single criterion. In principle, the most frequently used is the level of the median wage within the occupation, the level of education, or the affiliation of the job to a specific group of occupations within the ISCO classification, which takes into account the level of education required and reflects (International Labour Organization, 2016).

We use occupational classification ISCO, which has a hierarchical structure and consists of five levels: major group (1-digit ISCO), sub-major group (2-digit), group (3-digit), sub-group (4-digit), and category of occupation (5-digit). Classification into major groups is made based on the necessary skills and knowledge for the major group. The same applies to sorting into sub-major groups where similar occupations are associated.

The most plausible indicator seems to be wage when, according to Autor (2010), it should be true that the wage is a reflection of the size of skills that the worker has.⁷ Goos, Manning and Salomons (2009, 2014) and Fernández-Macías (2012) combine sub-major groups, which they further rank according to their median wage. This approach is replicated in this paper. Acemoglu (1998), Manning (2004), and, for example, Michaels, Natraj, and Van Reenen (2014) use the level of education attained to determine skill levels. Because the construction of the ISCO job classification considers the required level of education, it is further worked with a combination of occupational classification ISCO and the level of wages. The division of skills is then in Table 1.

Within the regression analysis, the examined period is divided into the periods 2004–2010 and 2011–2017. The division was made due to a change in the methodology when the employment classification changed. Until 2010, the Extended Classification of Occupations (ECO; originally “KZAM-R”) operated, replaced by the CZ-ISCO classification based on the international standard ISCO-08. Changes in the methodology took place mainly at the level of sub-groups and categories of occupations (four-digit and five-digit ISCO codes). Regression analysis uses the level of sub-groups (four-digit ISCO code), so to avoid bias, two periods are examined. Descriptive analysis operates at the level of the major groups and sub-major groups (two-digit ISCO code), which have been minimally affected by the changes, so the period 2004–2017 can be examined here.

⁷ On the other hand, it is worth mentioning the note of Goos and Manning (2007), who point out that within one occupation, there may be large differences in the number of wages, which the median wage cannot capture.

Table 1: Wage and skill level of employment groups according to ISCO (1-digit)

Wage level	Skill level	ISCO code	Major groups
High-paying occupations	High-skill	01	Legislators, senior officials, managers
		02	Professionals
		03	Technicians, associate professionals
Middling occupations	Middle-skill	04	Clerks
		06	Skilled agricultural and fishery workers
		07	Craft and related trade workers
		08	Plant and machine operators, assemblers
Low-paying occupations	Low-skill	05	Service workers, shop sales workers
		09	Elementary occupations

Source: Based on Goos, Manning and Salomons (2009, 2014), Cirillo (2018) and Keller and Utar (2016)

The primary data source is the Ministry of Labour and Social Affairs. These are mainly data on the number of occupations, the number of employees and their wages at various levels (according to the ISCO classification) within individual regions provided by the Earnings Statistics (Ministry of Labour and Social Affairs of the Czech Republic, 2019). For a more formal testing of job polarization, suggest Goos and Manning (2007) use a simple regression model:⁸

$$\Delta n_j = \beta_0 + \beta_1 w_{j0} + \beta_2 w_{j0}^2 \quad (1)$$

where Δn_j is the change in log employment in a sub-group of occupations j , and w_{j0} is the initial log median wage in a sub-group of occupations j and w_{j0}^2 is the same squared. In other words, the equation explains the relationship between the change in employment in specific occupations and the level of their initial median wages. Job polarization would be reflected in the negative linear term β_1 and the positive quadratic term β_2 , which should graphically look like a U-shaped curve; this would imply a higher increase in the number of employees in occupations which were considered relatively more and less paid at the beginning of the period, while the number of employees in middle-paid occupations would grow slower or even decline.

This regression equation works with the level of occupational sub-groups (four-digit ISCO code). A total of 6 models are created. The number of observations varies (112 to 390) depending on the period (2004–2010 and 2011–2017) and whether the occupation is in the private sphere, public sphere, or a combination.

We follow Goos and Manning (2007), Acemoglu and Autor (2011) and Autor and Dorn (2013), who use weighted least squares (WLS) for estimation, where the size of a given

⁸ This model has become a standard tool for formal testing polarization, as seen by Goos, Manning, and Salomons (2009), Kämpelmann and Rycx (2011), and Autor and Dorn (2013).

sub-group of occupations (number of employees) serves as a weight (larger sub-groups of occupations have a higher weight in regression).

The primary results are based on the change in the number of employees. For checking robustness results is changed dependent variable, when the change in the share of employees is examined. Therefore, a relative indicator is used instead of an absolute indicator. Empirical studies use mainly absolute indicators (see Goos and Manning, 2007; Adermon and Gustavsson, 2015; Kampelmann and Rycx, 2011); however, the approach explaining the changes in shares should respect different growth rates within individual sub-groups of occupations concerning the whole economy.

IV. Results and Discussion

Descriptive analysis

The literature usually begins with the research of job polarization with the descriptive analysis, where relative changes in employment are examined based on selected aspects. First, results of relative changes in employment are presented at the level of major occupational groups. Changes in employment are presented at the level of sub-major occupational groups, and, finally, we add a regional dimension when we observe relative changes in employment within individual regions.

Table 2 below shows the relative change in employment at the level of major occupational groups (1-digit ISCO).

Table 2: Relative changes in employment shares (1-digit ISCO)

	ISCO code	Employment groups	Δ in p. p. (2004–2017)	
High-paying (high-skill) occupations	01	Legislators, senior officials, managers	–0.21	2.33
	02	Professionals	5.31	
	03	Technicians, associate professionals	–2.76	
Middling (middle-skill) occupations	04	Clerks	1.76	–3.66
	06	Skilled agricultural and fishery workers	–0.59	
	07	Craft and related trade workers	–3.43	
	08	Plant and machine operators, assemblers	–1.39	
Low-paying (low-skill) occupations	05	Service workers, shop sales workers	1.70	1.27
	09	Elementary occupations	–0.43	

Source: own processing based on data from the Ministry of Labour and Social Affairs of the Czech Republic (2019)

Structural changes in employment imply the presence of job polarization – during the period 2004–2017, there was an increase in the proportion of high-skill (by 2.33 p.p.) and low-skill occupations (by 1.27 p.p.), while the share of middle-skill occupations decreased (by 3.66 p.p.). Table 2 above also shows that employment growth in high-skilled

occupations is given by the main class 02 – Professionals, while employment in the main classes 01 and 03 decreased. Such heterogeneity is also evident within middle-skilled and low-skilled occupations. In the group of middle-skilled occupations, major group 04 – Clerks deviates from the assumptions of polarization (increase in the share of employees instead of its decrease). In the group of low-skilled occupations, there is a slight decrease in the share of major group 09 – Elementary occupations.

The results in Table 3 below are based on the approach of Goos, Manning and Salomons (2009, 2014), who propose to take the most numerous sub-major occupational groups and divide them according to the level of their standardized wage into the high, middle and low-skill. Their research has been conducted in 16 European countries, and perhaps because of this, their approach has often been replicated, see Fernández-Macías (2012), Fonseca, Lima and Pereira (2018), Keller and Utar (2016) and others. Here, too, this approach is used. Detailed results of individual sub-major occupational groups are in Appendix (Table A). Unlike changes in the major occupational groups, the division into occupational classes should provide a more detailed view of changes in the employment structure. Due to a change in the methodology in the Czech Republic, part of the occupation has been moved from class 12 to class 11. For this reason, these classes are merged; the nature of these classes (Corporate managers and Managers of small enterprises) allows mergers. Selected occupations were among the most numerous classes in the Czech Republic and other European countries (see Goos, Manning and Salomons, 2009; 2014).

Table 3: Relative changes in employment shares (2-digit ISCO)

Type of occupations	Δ in p. p. (2004–2017)
High-paying (high-skill) occupations	0.88
Middling (middle-skill) occupations	–3.51
Low-paying (low-skill) occupations	2.63

Source: own processing based on data from the Ministry of Labour and Social Affairs of the Czech Republic (2019)

Note: Detailed results are in Appendix (Table A).

A detailed comparison with the results of Goos, Manning and Salomons (2009, 2014) is not possible, as their results bring together 16 Western European countries, while only the Czech Republic is discussed here. However, at the level of sub-major occupational groups, the polarised labour market corresponds to the overall results of 16 Western European countries. The decrease in the share of middle-skill occupations (by 3.51 p.p.) was compensated by the growth in the share of low-skill workers (by 2.63 p.p.); the increase in the share of high-skilled workers was relatively small (0.88 p.p.). As in Table 2, we find heterogeneity within the groups of the high, middle and low-skilled occupations; however, taking into account the literature, this is nothing special, and it can be said that similar anomalies occur within each country where this was studied. An explanation for this heterogeneity can be seen in regional differences and the different characteristics of national economies.

Previous results imply the presence of job polarization in the Czech Republic; however, thanks to data from the Ministry of Labour and Social Affairs of the Czech Republic, it is possible to focus on the level of individual regions. Literature typically deals with the level of a country or more countries. Comparing regional results within a country is a big exception – mainly Dauth (2014) and Abel and Deitz (2012), while the latter compares only two regions, so comparing results is not entirely possible. Table 4 shows the relative changes in employment within individual regions at the level of sub-major occupational groups (two-digit ISCO code) according to Goos, Manning, and Salomons's (2009, 2014) approach.

Table 4: Relative changes in employment shares in regions of the Czech Republic (2-digit ISCO)

Region	High-paying (high-skill) occupations		Middling (middle-skill) occupations		Low-paying (low-skill) occupations	
	Employment share in 2004 (%)	Δ in p.p. (2004–2017)	Employment share in 2004 (%)	Δ in p.p. (2004–2017)	Employment share in 2004 (%)	Δ in p.p. (2004–2017)
Prague	60.30	0.44	25.51	–3.20	14.20	2.76
South Bohemian	37.66	–0.81	45.30	–3.73	17.03	4.54
South Moravian	42.39	2.25	41.27	–4.26	16.35	2.01
Karlovy Vary	31.32	–2.05	45.29	–6.19	23.38	8.24
Vysočina	33.51	–1.71	51.71	–5.30	14.78	7.01
Hradec Králové	37.02	1.37	46.94	–1.74	16.04	0.37
Liberec	30.61	0.33	53.05	–6.87	16.34	6.55
Moravian-Silesian	31.04	–0.45	52.95	–2.64	16.01	3.09
Olomouc	34.85	0.72	48.31	–5.02	16.84	4.31
Pardubice	36.47	0.99	47.03	–1.04	16.50	0.05
Plzeň	38.39	–4.89	48.39	2.18	13.22	2.71
Central Bohemian	35.24	–1.52	46.79	1.99	17.97	–0.47
Ústí nad Labem	35.01	–2.42	48.72	–4.50	16.26	6.92
Zlín	34.04	7.54	50.30	–12.60	15.66	5.06

Source: own processing based on data from the Ministry of Labour and Social Affairs of the Czech Republic (2019)

Note: Bold regions imply job polarization.

Relative changes imply job polarization in half of the regions (7) of the Czech Republic, marked in bold in Table 4. Two trends that describe structural changes within regions can be mentioned: a decrease in middle-skilled occupations (excluding two regions) and an increase in low-skill occupations (except for one region). Generally, the change in the number of employees in high-skill occupations is unclear – in seven regions, their share grew, and in seven, it decreased. Only Dauth (2014), who uses 204 local labour markets

in Germany, can be mentioned in the literature to compare the results. His results imply polarization in about two-thirds of the regions, with richer regions showing a higher level of polarization. A look at the above results and Table 8 in Appendix B may imply a similar connection, but this does not seem to be the rule.⁹ This table shows the average GDP per capita in individual regions of the Czech Republic. Within each region, this is the average for 14 years (between 2004 and 2017). Polarization occurs in the first two richest regions (Prague and the South Moravian Region); in the other two, it does not. Polarization occurs in the penultimate two regions but not in the last. Thus, one cannot certainly be identified with the results of Dauth (2014) above; polarization appears to occur in both relatively richer and relatively poorer regions.

Regression analysis

Table 5 below shows the results of regression equation (1). A total of six models were created, which combine occupations of the private sphere and public sphere and occupations occurring in both spheres within the periods 2004–2010 and 2011–2017. Here, it was appropriate to use the rich data provided by the Ministry of Labour and Social Affairs of the Czech Republic, where it is possible to monitor changes in employment and changes in median wages for each profession separately. The models work with occupations at the level of sub-groups of employment (four-digit ISCO code), which makes it possible to achieve a relatively larger number of observations. The creators of this approach, Goos and Manning (2007) and Kampelmann and Rycx (2011), work only at the level of occupational groups (three-digit ISCO code). The number of occupations gives the number of observations in the models in a period; for an occupation to be counted, it must have a non-zero dimension at the beginning and end of the period. Due to a change in methodology, some employment sub-groups have merged since 2011; this is why we find fewer observations in the models for 2011–2017 than in 2004–2010. Another factor is that some occupations belong only to the public or private spheres.

Table 5 shows the results of the six models. The first two models, which relate to sub-groups of the private sphere, contain statistically significant variables. The results of the first model show job polarization in the private sphere from 2004–2010. The linear term is negative, and the quadratic term is positive – this indicates a U-shaped curve (Figure 1 below) that points to polarization. The variables in this model are statistically significant at the 10% significance level. The results of this model can be interpreted as the fact that employment grew the most in those sub-groups of occupations that had a relatively low and relatively high median wage at the beginning of the period (the year 2004), while employment in sub-groups of occupations that had a middle median wage grew more slowly. The second model from Table 5 above contains statistically significant variables at the 5% significance level; however, their signs do not imply the presence of polarization. The linear term is positive, and the quadratic term is only negative, which indicates the opposite of polarization.

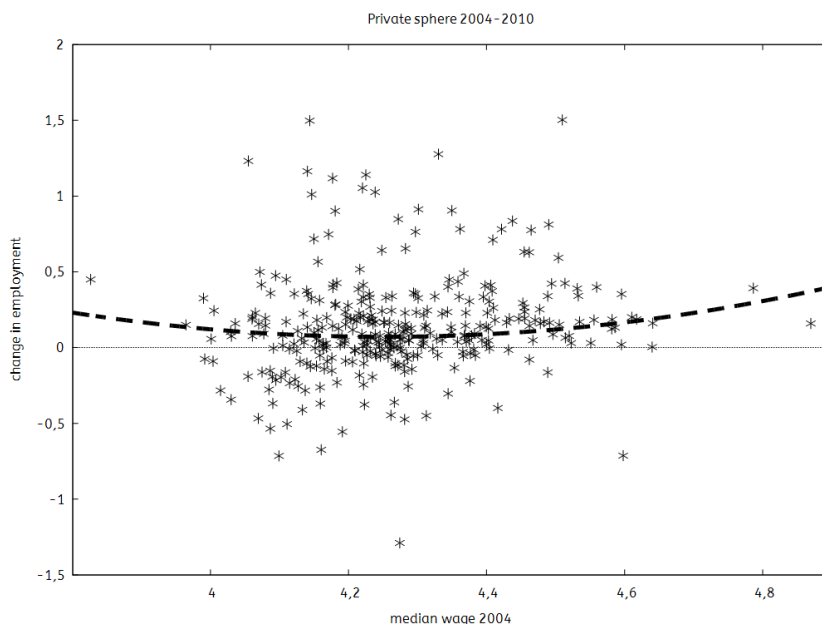
⁹ Assuming that we abstract from different levels of polarization and strictly limit ourselves to determining whether or not polarization occurs.

Table 5: Regression analysis, weighted least squares (WLS)

	Private sphere		Public sphere		Private + Public	
	(1)	(2)	(3)	(4)	(5)	(6)
Period	2004–2010	2011–2017	2004–2010	2011–2017	2004–2010	2011–2017
log median wage	–6.67* (3.68)	11.28** (5.23)	–2.73 (3.79)	1.79 (3.31)	–4.62 (2.94)	6.11 (4.32)
(log median wage) ²	0.78* (0.42)	–1.31** (0.61)	0.32 (0.45)	–0.22 (0.38)	0.55 (0.34)	–0.71 (0.50)
Constant	14.25* (8.01)	–24.34** (11.24)	5.79 (7.98)	–3.66 (7.22)	9.81 (6.38)	–13.11 (9.41)
Adj. R–sq.	0.02	0.04	–0.00	–0.01	0.01	0.00
F	4.36**	4.51**	0.52	0.70	3.48**	1.38
N	333	165	222	112	390	225

Source: own processing based on data from the Ministry of Labour and Social Affairs of the Czech Republic (2019)

Note: The dependent variable is the change in log employment in a sub-group of occupations based on the change in the number of employees (measured by months worked). Robust standard errors are in parentheses. */**/** indicate significance at the 10, 5 and 1 percent levels, respectively.

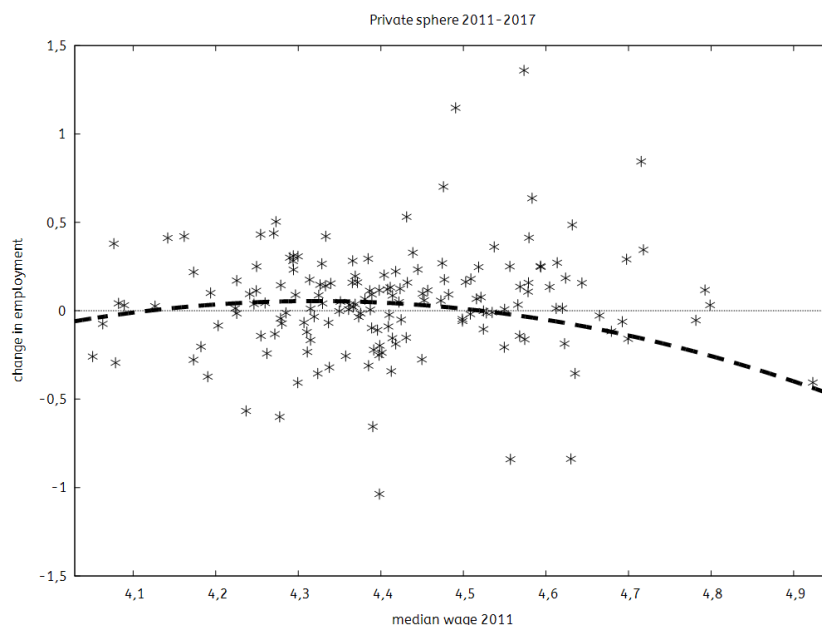
Figure 1: Private Sphere 2004–2010

Source: own processing based on data from the Ministry of Labour and Social Affairs of the Czech Republic (2019)

Figures 1 and 2 show two significant models (1) and (2). The x-axis represents the logarithm of the initial median wage, and the y-axis represents the logarithm of the change in the number of employees in the occupational sub-group. Figure 1, which graphically interprets model (1), shows a typical U-curve that implies job polarization. The minimum of the parabola (4.27) is close to the median (4.25), which, together with visual inspection, indicates polarization.

Figure 2 interpreting model (2) with statistically significant variables at the 5% level of significance corresponds to the opposite polarization: Employment grew the most in those sub-groups of occupations that had a median wage at the beginning of the period (2011), while employment in sub-groups of occupations with relatively high and relatively low levels of the median wage grew more slowly (or even declined).

Figure 2: Private Sphere 2011–2017



Source: own processing based on data from the Ministry of Labour and Social Affairs of the Czech Republic (2019)

Robustness check

The dependent variable in the previous part was the change in the number of employees in the occupational sub-group, i.e. a change in the absolute indicator following the creators of this approach Goos and Manning (2007) and others (Adermon and Gustavsson, 2015; Kampelmann and Rycx, 2011). To verify the robustness of the results, we will look at what change will occur if we explain the change in the share of employees in the occupational sub-group on all employees; thus, not a change in the *number of employees* in a sub-group

of occupations, but a change in their *share*. This approach should respect the differences in the growth rate of the number of employees in individual sub-groups of occupations compared to the growth rate of the number of employees in the whole economy.

First, the number of employees in each sphere during selected periods is calculated, and then the shares of employees for each sub-group of occupations are calculated. These shares are logarithmized, and the dependent variable is calculated as the difference between these logarithms. The results of the weighted least squares are presented in Table 6 below. The size of a given sub-group of occupations (number of employees) serves as a weight.

Table 6: Robustness check, weighted least squares (WLS)

	Private sphere		Public sphere		Private + Public	
	(1)	(2)	(3)	(4)	(5)	(6)
Period	2004–2010	2011–2017	2004–2010	2011–2017	2004–2010	2011–2017
log median wage	–6.67* (3.68)	9.12 (5.80)	–2.73 (3.79)	1.79 (3.31)	–4.62 (2.94)	–23.43 (62.21)
(log median wage) ²	0.78* (0.42)	–1.06 (0.67)	0.32 (0.45)	–0.22 (0.38)	0.55 (0.34)	2.26 (6.94)
Constant	14.13* (8.01)	–19.72 (12.48)	5.80 (7.98)	–3.67 (7.22)	9.74 (6.38)	60.70 (139.27)
Adj. R–sq.	0.02	0.01	–0.00	–0.00	0.01	0.20
F	3.41**	1.25	0.42	0.48	3.26**	11.27***
N	333	165	222	112	390	225

Source: own processing based on data from the Ministry of Labour and Social Affairs of the Czech Republic (2019)

Note: The dependent variable is the change in log employment in a sub-group of occupations based on the change in the share of employees (measured by months worked). Robust standard errors are in parentheses. */**/** indicate significance at the 10, 5 and 1 percent levels, respectively.

Changing the dependent variable leads to slightly different results. The main difference is now only one statistically significant model (1) with statistically significant parameters (vs. two statistically significant models with statistically significant parameters in Table 5). The direction of the model's parameters (1) capturing the sub-groups of the private sphere and the quality of its estimation are similar to Table 5. The positive linear and negative quadratic parameters imply job polarization, which aligns with the previous results. Thus, if the only criterion for determining the skill level is the level of wages, job polarization in the Czech Republic occurred between 2004–2010. Then, there are changes in the employment ratio that do not imply job polarization. Only Adermon and Gustavsson (2015) deal with the division of occupations into private and public spheres. However, their empirical results describing the situation in Sweden did not find differences. In contrast, we can see that polarization in the Czech Republic occurred only in private sphere occupations.

V. Conclusion

The results show that at the level of major occupational groups (one-digit ISCO code) and sub-major occupational groups (two-digit ISCO code), the labour market in the Czech Republic polarized during 2004–2017. The results at the sub-major level (two-digit ISCO code) provide more detailed information on the change in the employment structure. The decrease in the share of middle-skilled workers (by 3.51 p.p.) was mainly compensated by the growth of the low-skilled workers (by 2.63 p.p.). Attention was also focused on structural changes at the level of individual regions of the Czech Republic. The labour market has been polarized in seven regions but not the remaining seven. Descriptive results showed a range of polarization in the order of low percentage points. According to Goos, Manning and Salomons (2009), who had the same length of period (14 years), only the Netherlands achieved similar values. In Denmark, twice as much polarization has been observed over a shorter period (Keller and Utar, 2016), and similar conclusions (a greater extent of job polarization), apply to Germany (Kampelmann and Rycx, 2011), Sweden (Adermon and Gustavsson, 2015) and Portugal (Fonseca, Lima and Pereira, 2018). Furthermore, the regression analysis examined whether the number of employed persons grew more in those occupations that were high and low-paid at the expense of middle-paid ones. In other words, whether employment grew more in occupations at the edges of the wage distribution function. Therefore, if we identify the level of skills with the level of wages, it turns out that job polarization occurred during 2004–2010 in occupations of the private sphere. As part of the robustness analysis, where this result was confirmed instead of a change in the number of employees, the change in the share of employees was explained. The remaining results of the regression analysis were not statistically significant.

Further research is appropriate on several levels. The first is a deeper focus on the regions and their comparison, especially in the developed countries of Western Europe, where it is possible to more accurately determine the causes of job polarization.¹⁰ Another possibility may be to verify the negative aspects of these structural changes, which have been mentioned in the literature review. Due to the inflexibility of the education system, which is unable to respond to rapid technological change, the structural mismatch between the labour market and the education system is deepening, with the education system failing to produce the workers required by the labour market (Goldin and Katz, 2009).¹¹ Appropriately targeted economic policy can contribute to alleviating the pressure on the education system. In addition to strengthening retraining programs and more resources allocated to (underfunded) education, the question of whether the problem of the education system is not its excessive standardization, which makes it impossible to react more quickly to changes in the demand for labour, can be addressed. On the other hand, similar structural changes spillover into the Czech Republic with a lag (and to a lesser extent, as the results

¹⁰ In other words, apply the approaches used at the macro level, such as Mazzolari and Ragusa (2013), who found that the growth in the number of low-skilled workers is due to the growth in consumption of the high-skilled and high-wage workers. This may raise the question of whether this occurs mainly in richer regions.

¹¹ According to Fonseca, Lima and Pereira (2018), this is the main reason for the emergence and spread of long-term unemployment.

of this paper show) beside Western European countries, which may be an advantage for economic policymakers who have more time to adjust the system that would respond more flexibly to relatively new developments.

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Appendix

Table A: Relative changes in employment shares (2-digit ISCO)

	ISCO code		Employment share in 2004 (%)		Δ in p. p. (2004–2017)	
High-paying occupations	11+12	Chief executives, senior officials and legislators and Administrative and commercial managers	6.31	41.74	–1,89	0.88
	13	Managers of small enterprises	0.93		1,93	
	21	Science and engineering professionals	3.02		0,06	
	22	Health professionals	1.36		0,32	
	24	Business and administration professionals	7.62		–3,09	
	31	Science and engineering associate professionals	8.83		–0,21	
	33	Business and administration associate professionals	1.70		15,17	
	34	Legal, social, cultural and related associate professionals	11.94		–11,42	
Middling occupations	41	General and keyboard clerks	5.30	42.48	–0,40	–3.51
	42	Customer services clerks	2.57		–1,05	
	71	Building and related trades workers, excluding electricians	2.90		–2,20	
	72	Metal, machinery and related trades workers	12.32		–2,83	
	73	Handicraft and printing workers	0.84		–0,76	
	74	Electrical and electronic trades workers	1.69		0,12	
	81	Stationary plant and machine operators	4.56		0,39	
	82	Assemblers	6.02		–0,17	
	83	Drivers and mobile plant operators	6.28		3,40	
Low-paying occupations	51	Personal service workers	5.73	15.83	–2,77	2.63
	52	Sales workers	1.92		7,07	
	91	Cleaners and helpers	4.96		–2,20	
	93	Labourers in mining, construction, manufacturing and transport	3.22		0,53	

Source: own processing based on data from the Ministry of Labour and Social Affairs of the Czech Republic (2019)

Table B: Ranking of the regions according to the amount of GDP per capita during the period 2004–2017

Region	Average amount of GDP per capita (in CZK). The order of the region is given in brackets
Prague	816 863 (1.)
South Bohemian	327 355 (6.)
South Moravian	364 858 (2.)
Karlovy Vary	273 509 (14.)
Vysočina	316 622 (9.)
Hradec Králové	335 909 (5.)
Liberec	300 444 (12.)
Moravian-Silesian	321 220 (8.)
Olomouc	294 918 (13.)
Pardubice	315 890 (10.)
Plzeň	357 424 (3.)
Central Bohemian	355 076 (4.)
Ústí nad Labem	301 560 (11.)
Zlín	324 370 (7.)

Source: own processing based on data from the Ministry of Labour and Social Affairs of the Czech Republic (2019)

Note: Bold regions imply job polarization (see Table 4).