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SKILL-BIAS AND WAGE INEQUALITY IN THE EU NEW MEMBER STATES: EMPIRICAL INVESTIGATION

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IES Working Paper 26/2022

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Bibliographic information:
Pintera J. (2022): "Skill-bias and Wage Inequality in the EU New Member States: Empirical Investigation" IES Working Papers 26/2022. IES FSV. Charles University.

Skill-bias and Wage Inequality in the EU New Member States: Empirical Investigation

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October 2022

Abstract:
We use the individual-level data on income and education level from the EU-SILC database to investigate the trends in income distribution and wage polarization in the EU New Member States. We do not confirm the existence of job polarization in wages and employment that has been observed in the United States or other developed countries. Rather, we document decreasing inequality, particularly in Czechia, Poland, Hungary and Slovakia. Also, our estimates of the elasticity of substitution between low and high skill labour are higher than often found in other countries. These results imply a different impact of globalization on the labour markets in the EU New Member States than in other countries. However, it remains unclear whether these differences are temporary or will prevail in the future.

JEL: J30, J31, O14, O31, O33
Keywords: Labor Markets, Technological Change, Polarization, Skills

Acknowledgements: This work was supported by the Grant Agency of the Czech Republic, Grant No. GACR no. 20-14990S.

1 Introduction

The echoes of labour market turmoil in the developed economies have been heard quite often in recent decades. Fears of unemployment, job-quality deterioration, or, more specifically, the "hollowing-out" of the entire middle class appear in the latest government reports (e.g., Rodrik and Stantcheva 2020) and can be documented in the declining relative position of the western middle class in the world income distribution (Milanovic, 2020). These fears are often associated with rising populism and declining trust in democratic institutions.

In this paper, we focus on labour market dynamics in Central and Eastern Europe (CEE). We use the individual-level data from the EU-SILC database to examine the evolution of wage inequality, wage polarisation and the elasticity of substitution between low and high skill labour. Unlike their Western counterparts, the CEE countries have shown signs of declining wage inequality over the last decade (Magda et al., 2021), often accompanied by low unemployment and overheating labour market. To investigate the labour market dynamics and better understand these contrasting developments, micro-data from Eurostat (EU-SILC) were used to examine the labour market developments in greater detail.

Also, there are at least two conflicting phenomena present in the CEE likely to produce outcomes different from the developed economies. First, there is an educational upgrading happening in the region (Hardy et al., 2018), suggesting significant structural change toward a knowledge-based economy at the same time as the US economy is experiencing an educational slowdown (Goldin and Katz, 2010).

Second, the CEE countries, for their favourable unit labour cost and skilled workforce, seem to be ideal recipients of offshoring from the high-wage economies. They also play a rather different role in the global market value chains than developed countries (Baldwin and Lopez-Gonzalez, 2015). The CEE (including Poland) are typical examples of the "Factory Economies" strongly linked to their headquarter economy - Germany. A different position in the global value chains may also mean a different impact of global technological change than in the developed world, where the routine-intensive occupations decline can be linked to offshoring (Acemoglu et al., 2012).

Despite these dissimilarities, a populist drive comparable to the developed countries in the West can be seen in the new EU member states, with the populist parties' vote share tripling between 2000 and 2017. The Agenda of these parties also bear similarities to the populists in the old EU countries (Orenstein and Bugarič, 2022). In Western countries, this rise of populist movement is often linked to the effects of globalisation and labour market polarisation. Given different labour market dynamics, the CEE countries provide an interesting case to understand the link between income inequality and populism.

From a methodological perspective, this work builds on the Skill-Bias Technological change hypothesis (Katz and Murphy, 1992) that is based on the interplay of supply and demand for skill. The latter driven by technological change, the former by investment in human capital. This work will concentrate on potential causes of labour market inequality outlined by the Skill Bias Technological Change (STBC) hypothesis that despite its early origin (Katz and Murphy, 1992) and empirical critiques seem to endure to these days (Aziz

and Cortes, 2021; Goldin et al., 2020).

Further refinement of the SBTC hypothesis postulates job and wage polarization - phenomena seen in the US and other developed economies (Rodrik and Stantcheva, 2020; Temin, 2018). Using the EU-SILC survey micro-level data from 2005 to 2019, this work brings descriptive and regression analysis of labour market polarization and other key labour market trends in the context of Central and Eastern Europe.

To anticipate our results, we found that many of the phenomena identified in the developed economies are not confirmed in the case of Central Europe. The general conclusion reached by our study is a good performance of the lower parts of the wage distribution. Perhaps most notably, we see a relative decline of the 9th decile in both wages relative to median and relative employment. This result contrasts with the characteristic U-shaped behaviour documented by Acemoglu et al. (2012) and interpreted as the job and wage polarization.

We further investigated the elasticity of substitution between high and low skill labour, which is one of the key features of the STBC framework (Katz and Murphy, 1992). One of the motivations for this approach was the significant skill upgrading seen in the region, a phenomenon visible in the US several decades earlier when the framework was found to perform well (Hardy et al., 2018).

Our main contribution to the literature is that we bring a direct application of the skill-biased framework for all the CEE countries instead of testing a particular subsection of the theory (routine-biased technological change as in the case of Arendt and Grabowski (2019) or Hardy et al. (2018)) or concentrating on a single country. It will also use a different source of data (EU-SILC) that provides annual data for all countries of interest. EU-SILC is, due to its annual form and coverage of labour supply, in our view, the best fit for the surveys used in the US studies, such as the Current Population Survey used in Katz and Murphy (1992).

The paper is organized as follows. The first part reviews the labour market development in the CEE, US and Germany. The second part discusses descriptive evidence on the CEE labour market, including the evidence on polarization. The third part introduces the Skill Bias framework and outlines the details of the Canonical model. This part also presents the elasticity of substitution estimates and discusses the construction of variables needed to obtain them. The fourth section concludes.

2 Labour Market Developments

2.1 Wage Inequality Hypotheses - Case of Developed Economies

The utilization of microdata for the investigation of long-run labour market trends dates mainly to the empirical estimation of the link between the U.S. skill premium and the relative supply of high/low-skilled labour by Katz and Murphy (1992). Their results led to the formulation of the so-called skill-biased technological change hypothesis, which explains changes in relative wages using a simple supply-demand framework (the "Canonical model";

Acemoglu et al. 2012) focusing on different levels of skills/education. The Canonical model in its original form is a simple and straightforward model that uses relative high/low skill labour supply and time-dependent "skill-biased" technological progress as a determinant of relative wages. Despite its simplicity, the existence of the link between technology and education as a determining factor in wage setting in the long term seems evident (Piketty, 2018), and the Canonical model was shown to perform rather well in the US data before the 1990s (Katz and Murphy, 1992).

However, Acemoglu and Autor (2011) show that the Katz and Murphy's model overpredicts the skill premium in the 1990s and the 2000s. It also fails to account for several other stylized facts about the recent developments of wages in the US, most importantly, the job and wage polarization represented by strengthening tails of income/employment distribution. This process seems strongly connected to the automation of middle-skill jobs. Based on these findings, Acemoglu et al. (2012) proposes a comprehensive task-based framework (also routine-biased technological change, RBTC) focused on the level of routine content of the tasks involved rather than on workers' skills. A formal representation of the task-based framework can be found in Acemoglu and Autor (2011). This framework is capable of explaining the wage and job polarization phenomena observed in the 1990s in the US.

Mishel et al. (2013) postulate three testable hypotheses derived from the skill-biased technological change literature and its extensions. First, the labour supply and demand interactions determine wage formation. More concretely, technological change causes shifts in labour demand which in turn affect wages. This causality can be considered a general feature of the framework common to both the original skill-biased technological change and its subsequent variant, the routinization-biased technological change. Second, from the empirical point of view, the skill-biased technological change leads to job and wage polarization - phenomena highlighted by Acemoglu et al. (2012), Howell and Kalleberg (2019) and others when discussing the developments of the Western labour markets in the last decades of the 20th century. Note that at this point, both variants of the technological framework differ, with the original SBTC hypothesis predicting monotonic employment and wage development across the occupational distribution, a phenomenon observed in the 1980s. Third, the RBTC hypothesis implies a rise in both employment and wages in a specific type of services - namely the low-wage service jobs characterized by manual non-routine content.

Note that the skill-bias framework always faced critiques such as Mishel et al. (2013), who, rather than explicitly denying the underlying "job polarization" trend, map it to a much earlier time and thus deny its causal link with inequality rise after the 1970s. The link between job polarization and wage polarization is therefore in question. In the interpretation of Mishel et al., technological changes have a significant impact on occupation composition, not on wage inequality. They also point to a general wage deficit - the inability of wages to keep up with productivity growth and rising profits after the 2000s.

Over time, the job polarization has been identified across many developed economies (Rodrik and Stantcheva, 2020; OECD, 2017). Consequently, it has become accepted as one of the defining features of the developed economies' labour market (Howell and Kalleberg,

2019). On the other hand, as shown by Mishel et al. (2013), job polarization in the US economy seems to be a phenomenon linked firmly to the 1990s, and already the early 2000s brought a slowdown in both education premium and high-occupation rise. Therefore, we can also formulate the difference between RBTC and SBTC as the difference between the 1980s and 1990s US labour market. On the other hand, both the polarization itself and declining position of the middle class in general are not limited to the US or a single time period (Temin, 2018; Rodrik and Stantcheva, 2020). Moreover, deeper troubles in Western labour markets can be seen in declining job quality (Howell and Kalleberg, 2019), disappearing middle-class (Temin, 2018), as well as s relative decline in the position of the Western medians in the world income distribution (Milanovic, 2020).

2.2 Labour Market Inequality in Central and Eastern Europe

Until recently, the micro-data on income and inequality have been used for assessment of income inequality in a small number of developed countries.

With newly available micro-data, there has been several attempts to investigate the role of skills in income inequality among the CEE countries so far. Arendt and Grabowski (2019) studied the wage premium in Poland, and Hardy et al. (2018) provide an analysis of task-content development in EU following Acemoglu and Autor's (2011) approach and provide analysis of labour supply development in EU-24 with the emphasis on the CEE countries. Both papers exploit the task-content division of the labour force (classification of jobs according to a required level of cooperation and creativity).

The results of both Hardy et al. (2018) and Arendt and Grabowski (2019) point towards certain deviations of this region from the rest of Europe in terms of the task distribution. Namely, according to Hardy et al. (2018) we see an increase in routine cognitive tasks in CEE countries, which is contrary to both the old-EU countries and routine-replacing technological change hypothesis, similarly Arendt and Grabowski (2019) find relative wages in routine manual jobs in Poland too high for the RBTC hypothesis to hold. Both studies then note significant educational upgrading in the region, especially the rapidly increasing tertiary education attainment (Hardy et al., 2018). We should note that at least in this aspect the CEE countries seem to differ significantly from the U.S. labour market, where as noted by Acemoglu et al. (2012), high-school attainment is actually stagnant since 1960s and post-secondary attainment decelerated already in 1970s. Specificity of the CEE income inequality with respect to the West is also confirmed by Magda et al. (2021) - who notes decrease of wage inequality in the CEE in 2002-2014 period. Before this period the CEE countries experienced significant inequality rise due to their economic transformation but the inequality leveled since then (Tyrowicz and Smyk, 2019) with evidence of wage inequality staying lower than in the developed countries (Mysíková and Večerník, 2018). This conclusion is also confirmed by a recent study by Magda et al. (2021), who find generally decreasing levels of wage inequality in the CEE using the EU-SES database for 2002-2014, with the only country with a slight increase in wage inequality being the Czech Republic. The authors note that this finding stands in contrast to development found in Western countries. From our point of view, this speaks in favour of analyzing the validity of the

skill-bias hypothesis in this region.

We should also note that the CEE region has specific characteristics compared to Western Europe. Above all, thanks to their comparative advantage in labour costs, the CEE countries have a different position in the globalization process than countries of Western Europe. At the same time, giving a closer look at the relationship between the West and the CEE region gives us even more fascinating picture with the CEE serving as a pool of relatively cheap and qualified labour to Germany, strongly influencing Germany's internal labour market in return (Marin, 2004, 2018). Therefore, we provide a brief description of the German labour market below, as it is the most deeply connected neighbouring country (Baldwin and Lopez-Gonzalez, 2015).

Similarly to the US and other Western economies, German labour market shows rising income inequality at least since the 1980s (Biewen et al., 2017). However, Biewen and Sturm (2021) find that the inequality has been stagnating since 2005 and attribute this phenomenon to recent labour market boom. Bossler and Schank (2020) concentrating on the lower tail of the distribution find a rising wage inequality in 2000s and declining trend after 2010s, furthermore they observe a sharp drop in inequality after 2014, that they attribute to minimum wage introduction. Giving a closer look at the development of inequality in different parts of the income distribution Biewen and Seckler (2019) do not confirm wage polarization found in the US. They find much more monotonic development with the highest percentiles gaining relatively the most. In terms of the SBTC, Biewen et al. (2017) find strong influence of composition changes in explaining rising inequality - education (especially in the upper part of the distribution) and changes in recent labor market histories (lower part) and conclude that this finding is in line with SBTC hypothesis.

Last but not least, Glitz and Wissmann (2021) show that after breaking German population to three education levels and two age groups and using the procedure developed by Katz and Murphy (1992) and Card and Lemieux (2001), they find that the labour supplies are to large extent able to explain the changes in skill premium in Germany. They find especially pronounced rise in skill premium of medium skilled to low skilled and link it to decline in the share of population with vocational training. Their findings are therefore very much in line with the original SBTC framework and can be seen as reaching a similar results as the seminal work of Goldin and Katz (2010).

3 Trends in Wage and Employment Development

3.1 Labour Market Polarization?

To analyse the trends in labour market developments, we rely on the Eurostat EU-SILC database with data also from the CEE countries (Czech Republic, Slovakia, Poland, Hungary, Latvia, Estonia, Lithuania, Romania and Bulgaria) between 2005 and 2019. The EU-SILC collects information about income, poverty, social exclusion and living conditions across the EU countries. Our dataset contains more than 2 million observations in total.

For presentation purposes, we aggregated the countries into three regional blocks - the

Central Europe (the "Visegrad" countries), the Baltics (Latvia, Estonia and Lithuania) and two Balkan countries - Romania and Bulgaria. This division was inspired by the geographical and socioeconomic closeness of the countries.[1] The results below refer to these regional blocks, results for individual countries are presented in the Appendix.[2] We choose 2011-2019 as our main period of interest due to data limitations (data for Bulgaria and Romania and various variable changes) and also in order to concentrate on the period after the Great Recession.

Table 1: Changes in Real Wages for Different Groups of Countries

Groups	RO & BG 2010/2007	RO & BG 2019/2011	Cent. Europe 2010/2007	Cent. Europe 2019/2011	Baltics 2010/2007	Baltics 2019/2011
<5	14.581693	65.260985	7.309054	8.120131	-2.965103	36.511753
5-15	7.861526	63.277764	9.162507	-0.852100	13.541349	31.962220
15-25	8.865883	66.529665	9.287660	7.086426	16.848990	38.034179
25-35	8.085102	58.722765	9.636790	0.469503	20.252799	33.171526
35-45	5.013863	61.656307	9.998737	2.844017	18.044866	28.720680
>45	-64.982239	91.008855	1.551521	3.060651	20.611585	35.019766
Female	8.017022	66.750833	7.859075	2.333832	16.875744	32.899632
Male	8.006975	60.959955	9.803801	4.163552	10.660589	35.193105
Primary Education	2.588869	70.827861	-4.752946	-45.600881	23.304905	70.928672
Lower Secondary Education	1.118504	55.677731	13.446450	15.638981	6.002626	27.930662
(upper) Secondary Education	9.310017	59.969078	11.661339	13.946453	10.444225	35.929474
Post-secondary Non-tertiary Education	5.591391	77.938633	9.465074	2.105854	16.559132	32.032608
Tertiary education	8.442430	65.136792	7.749198	-5.664850	14.562024	34.033161

The table presents log changes in real monthly wages of full-time workers between the given years. We use the mean wages of the sex-education-experience groups defined above. The aggregated categories displayed are then weighted averages of relevant groups using the groups' average employment shares over the entire sample period as weights. We calculate the real wages by deflating nominal wages in each period by the country's Harmonised index of consumer prices obtained from Eurostat. To get the results for broader regional groups (as displayed above), we first calculate an average of respective countries' real wages for each sex-education-experience group.

Table 1 shows log changes in real wages for different groups of full-time workers in two time periods - 2007/2010 and 2011/2019.[3] The changes are calculated for males and females, five education categories and six experience groups. First, we observe quite strong real wage growth for the highest education category (tertiary education or higher) in all regions apart from Central Europe, where we find a slight decline between 2011 and 2019. Table 1, however, shows that in none of the regions are the wages of the tertiary educated

[1] We add Slovenia to the Central European countries, as its macroeconomic performance is much closer to them than Romania and Bulgaria.

[2] Note that we calculate the aggregated metrics by pooling all observations in a region together and then treating it as a single territory, i.e. the statistics below are not averages of individual countries' statistics in the Appendix.

[3] Tables 4 and 5 describe the changes for individual countries.

the fastest growing. In all regions the wage growth of the secondary educated surpasses the growth in the tertiary education categories.

Notably, we observe robust growth across all categories in the Baltics and Balkan countries. On the other hand, the situation in Central Europe is somewhat different. Wages of both the highest and lowest education categories decline, which contrasts with wage increases across secondary education.[4] The CEE experience, therefore, contrasts with the US experience, where the less-educated workers experienced real wage declines (Acemoglu and Autor, 2011).

Similarly, Table 2 shows changes in relative labour supply.[5] Concretely we depict log changes in each group's share of total labour supply measured in efficiency units.[6] The results show a steady rise in female share in the labour supply and a similar rise for the highest education categories across the regional groups. Among the experience categories, we see a rising labour supply for the higher experience groups and declines in the case of workers with less than five years of working experience, probably a sign of population ageing.

Table 2: Changes of Labour Supply for Different Groups of Countries.

Groups	2010/2007 RO & BG	2019/2011 RO & BG	2010/2007 Cent. Europe	2019/2011 Cent. Europe	2010/2007 Baltics	2019/2011 Baltics
<5	-2.383018	-31.097151	2.249316	-43.438851	-4.427445	-16.999040
5-15	-4.671684	-3.833148	0.796531	-2.034299	5.413153	17.826651
15-25	6.985925	-3.933818	-7.453282	8.174225	-8.145433	-18.880740
25-35	-10.210762	8.558053	-1.978402	-4.703112	4.217927	-15.607869
35-45	25.112974	12.351141	21.275877	32.029868	10.256839	38.920874
>45	-36.640996	59.656172	14.065841	71.537131	-19.632433	48.323612
Female	1.296522	-1.930132	4.091550	2.007874	8.494020	-4.176115
Male	-0.795805	1.223618	-2.551984	-1.325431	-6.453240	3.177369
Primary Education	-50.254843	-14.738936	-20.863042	-50.979049	-12.331598	-32.205389
Lower Secondary Education	-7.603790	-26.757482	-1.851176	24.034607	-12.826862	-32.896778
(upper) Secondary Education	-0.856678	-1.930573	-5.771289	-2.719726	-12.278409	-17.813729
Post-secondary Non-tertiary Education	-1.729285	5.109752	0.797851	-35.876316	-30.872638	12.805771
Tertiary education	8.452129	10.272401	11.712725	7.441955	20.472786	10.584279

The table presents log changes in the share of total labour supply provided by a given group in a specified period. The labour supply is measured in the efficiency units.

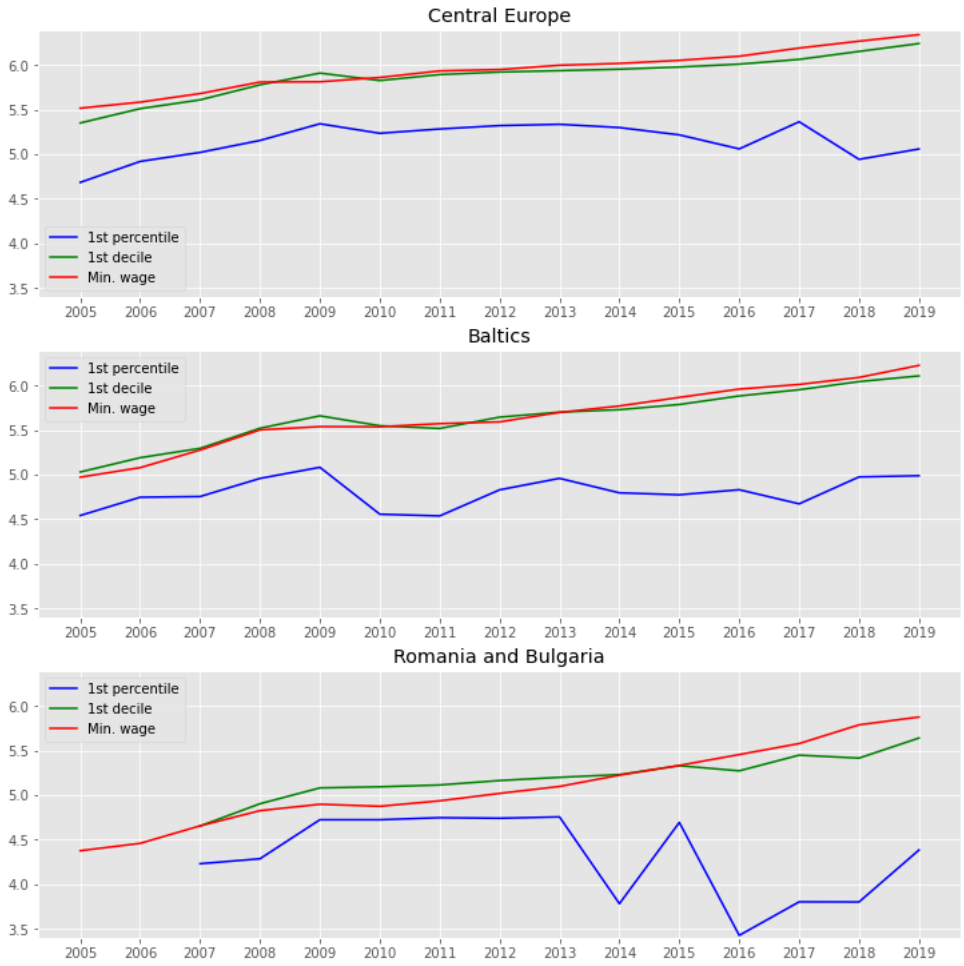
Figures 1 and 2 compare selected sample wage percentiles with the growth of minimum and average wage in the economy. The pictures show the contrast between the volatile 1st percentile and the steadily growing rest of the distribution without significant divergence or convergence.

[4]Note, however, that the results in the primary education category are driven by a relatively low number of observations and only two countries - Poland and Slovakia.

[5]Tables 7 and 6 describe the results for individual countries

[6]Efficiency units are defined in section 4.2.

Figure 1: Minimum Wage against the Lowest Percentiles



Deciles of monthly log wages of full-time workers. The minimum wage statistic is obtained from Eurostat, the rest is calculated from the EU-SILC survey data. We used an average of the official minimum wage figure for the countries in each region as the final minimum wage.

More concretely, Figure 1 shows the development of the log minimum wage against the first percentile and first decile of the wage distribution (we use monthly log wages of full-time workers). We can see that the minimum wage closely copies the first decile of our sample. Figure 2 then portrays a similar picture for the upper segments of the distribution and log of the average wage for a given region. We see the depicted lines going mostly in parallel with the exception of mean and median converging around 2008 in Central Europe and Baltics and in the most recent period in Romania and Bulgaria. Overall, the comparison of both figures shows a significantly higher variation of the lowest percentile compared to the higher ones. This is especially visible in the case of the Baltics as well as Romania and Bulgaria.

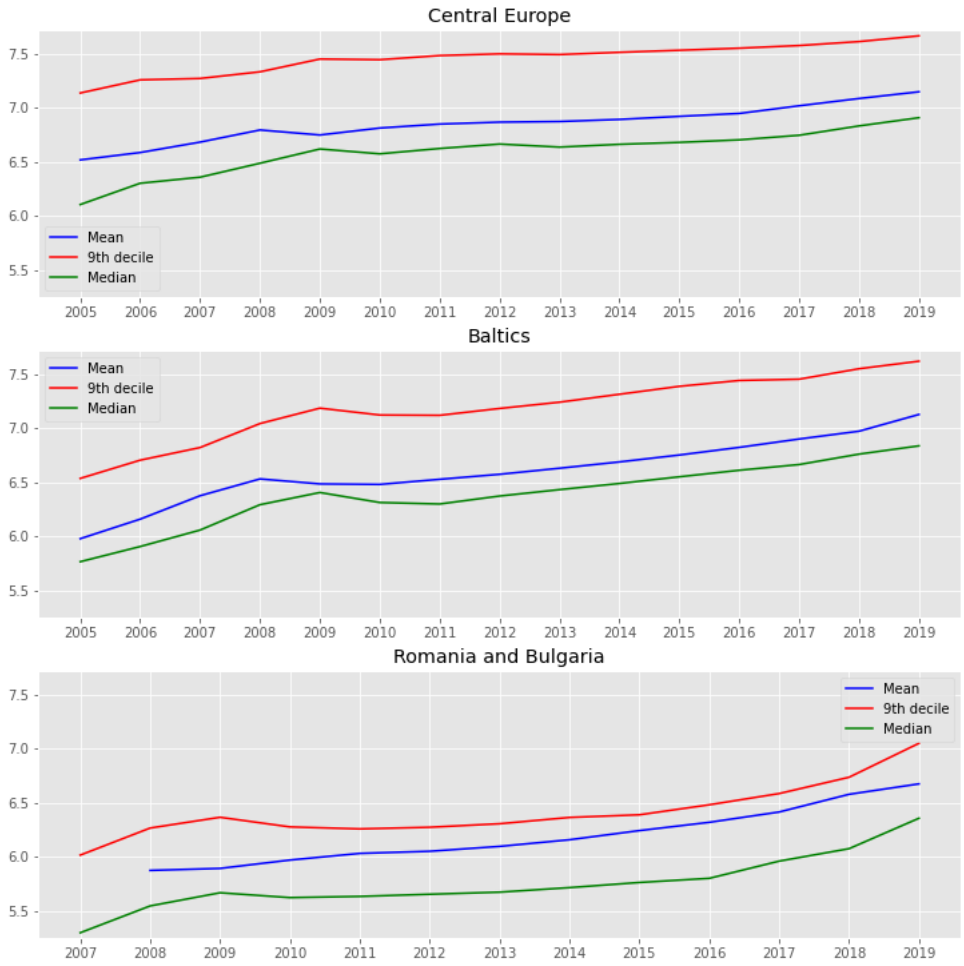
To sum up the general development of labour market inequality, Figure 3 portrays 50/10 and 90/50 wage gap (ratio of percentiles of a monthly log wage distribution) development for full-time workers in the three regions defined above. Figure 3 shows that the pay gaps developed differently in the three regions, despite all being generally different from the US data as found, for example, in Mishel et al. (2013).

In the case of the Central European countries, there is a tendency for a relatively long-term and monotonic decrease in the 90/50 wage gap, which implies decreasing income inequality between the 90th decile and the median, a finding that contradicts the US and Western European evidence as well as the hypothesis of wage polarization. We can also note the mostly decreasing tendency of the 50/10 ratio, a movement more in line with the US evidence as the least paid jobs seem to be catching up with the median. A similar tendency can be observed for the Baltic countries even though the 90/50 curve is significantly flatter in this case and the 50/10 curve more volatile, which is exemplified by a steep rise in wage inequality after the crisis in 2008. The impact of the crisis is also visible, yet less pronounced, in Central Europe. The Balkan countries, on the other hand, experienced a rather flat 90/50 ratio after 2012 and a reversed trend in the 50/10 ratio in recent years. Nevertheless, there was no negative reaction to the 2008 crisis, with the ratios continuing to decline around the year 2010.

Increasing real wages and decreasing wage gaps imply that, especially in Central Europe, the growth of the recent decades led to improved incomes of the median earners as well as people the 10th income percentile. The same development is to a lesser degree present in the other two regions. The development also contrasts with Germany, where a general upward trend for both wage gaps (90/50 and 50/10) was visible at least until 2015 (Biewen and Sturm, 2021). We could also note a difference between the development of the two ratios across the regions. Whereas the median seems to be either gaining or at least keeping its position with respect to the top, the lower part of the distribution is much more volatile and seems to react more to changes in the business cycle.

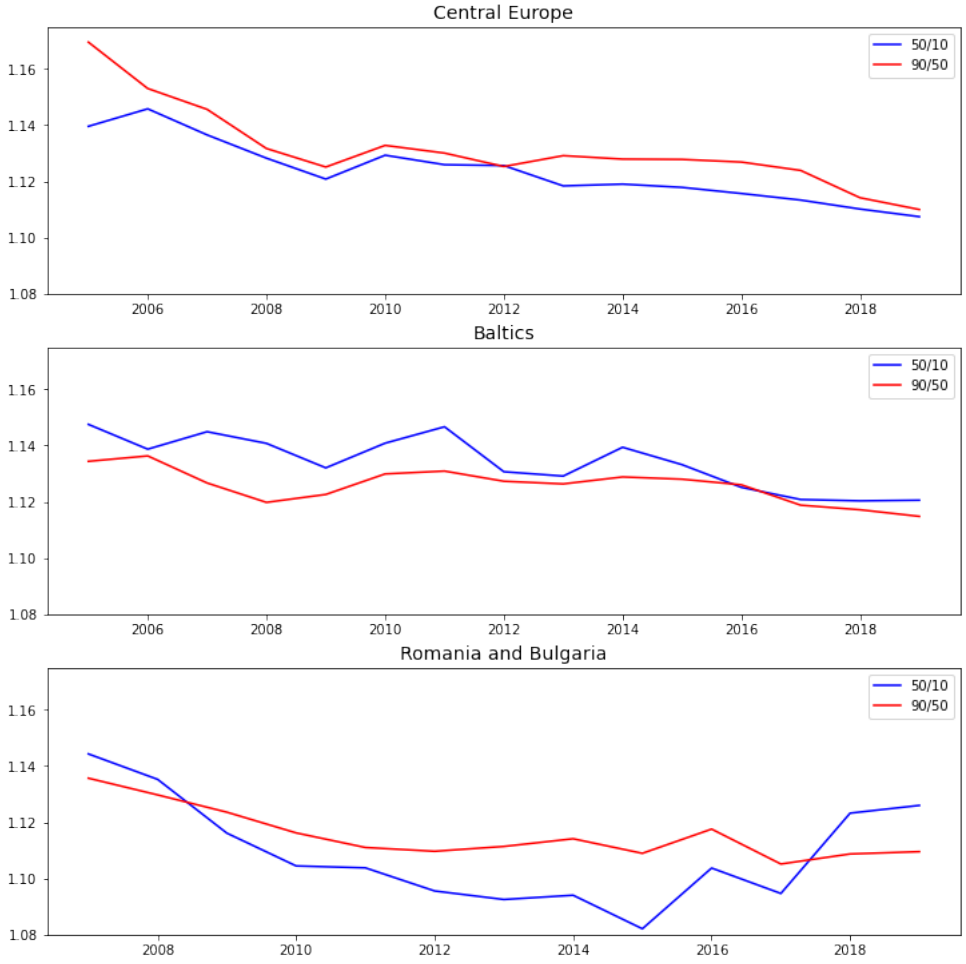
Next, we focus on changes in log wage percentiles of full-time workers relative to the median between 2011 and 2019, visible in Figure 4. We can observe a monotonic behaviour for the Visegrad counties with a clear tendency for a decline of the highest percentiles relative to the median. A Similar yet less pronounced picture is visible for the Baltics, whereas the same plot for Romania and Bulgaria shows a rather contrasting picture with

Figure 2: Average Wage against the Highest Percentiles



Deciles of monthly log wages of full-time workers. The average wage statistic is obtained from Eurostat, the rest is calculated from the EU-SILC survey data. We used an average of the official mean wage figure for the countries in each region as the final mean wage.

Figure 3: Development of (Log) Wage Gaps for Full-time Workers, 2005–2019



Development of ratios of different deciles of log monthly wage distribution for full-time workers.

declining lowest percentiles and a tendency to increase for the two highest deciles.[7] If we compare our results to the Western evidence, we can notice that development in Romania and Bulgaria seems to be closest to the German scenario and the US scenario in the 1980s. Predominately monotonic behaviour is, however, common to all three regions.[8] This is an important conclusion as a similar plot for the US shows a characteristic U-shaped curve with the increases concentrated at the ends of the distribution, such behaviour is interpreted as wage polarization (Acemoglu and Autor, 2011). Moreover, in contrast to the Western evidence, we also do not find a relative rise in the highest incomes even though the outcomes differ among the regions.

Figure 5 comments on a crucial polarizing behaviour in the CEEC. It shows changes in employment shares for the ISCO-08 occupations skill rank between 2011-2019[9], it also depicts a locally-weighted smoothing regression curve. We can notice a rather different and diversified yet mostly monotonic behaviour across the CEE countries. There is a declining tendency for the employment share of high-income occupations, especially in the case of Central Europe. To a lesser degree, we see this behaviour in the Baltic states, with most of the percentiles below the 8th decile being predominately flat. Romania and Bulgaria again represent a certain outlier showing rising employment in high-income occupations. Note that there is also a tendency for employment shares to increase for the lowest percentiles in the two countries, which would indicate the existence of a certain level of polarization. Yet the magnitude of these changes is low in comparison to the changes in the highest percentiles. We can also note an increasing variance of the estimates in Balkan and Baltics in the upper half of the distribution - this makes the conclusions for high percentiles for Baltics and the two Balkan countries less reliable.[10] Last but not least, compared to the US evidence, we again do not see the characteristic U-shape found in Acemoglu et al. (2012) for the 1990s and 2000s US labour market, interpreted as the job polarization.

In sum, our analysis has shown differences between the CEE labour markets and the stylized facts found in the developed countries. In particular, we do not confirm either job or wage polarization in CEE, and we never see a monotonic rise in inequality similar to certain periods of the US development. Yet, at the same time, there is rather diversified behaviour between the investigated regions themselves. In general, we can contrast declining measures of inequality in the Central European countries to the mostly stagnating situation in the Baltic and signs of increasing inequality in the case of the Balkan countries. The difference between the investigated countries comes as a certain surprise to us. All the countries are relatively low-wage and should have a similar position in the global supply chain relative to the "Headquarter economies" such as Germany or the US (Baldwin and Lopez-Gonzalez,

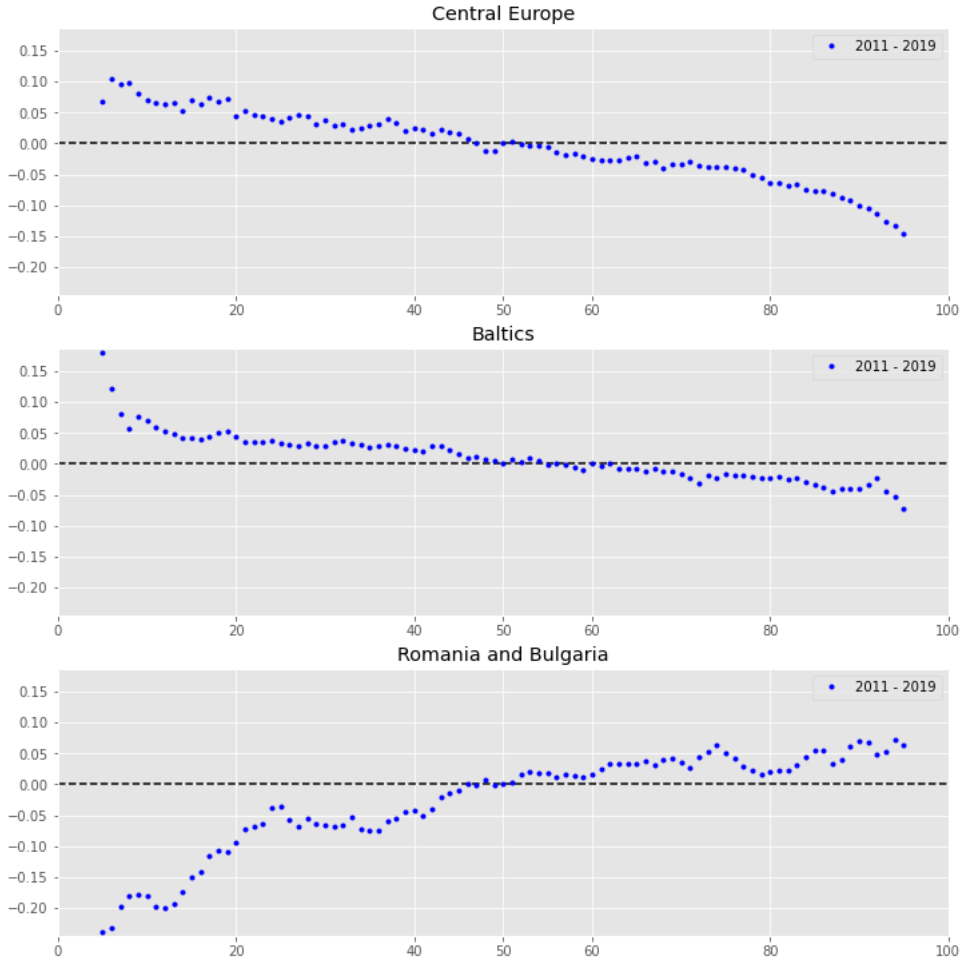
[7] Figures in the Appendix show that the growing inequality seems to be driven by development in Bulgaria (see Figure 17), whereas Romania resembles development in Central Europe.

[8] Note that Figure 13 shows that for the 2007-2019 period, the same graph for the Balkan countries shows a declining tendency for the lowest percentiles and a rather flat behaviour afterwards. Development in the Baltics is then more flat than in Figure 4

[9] The starting year of the analysis is chosen due to changes in ISCO classification in the EU-SILC dataset.

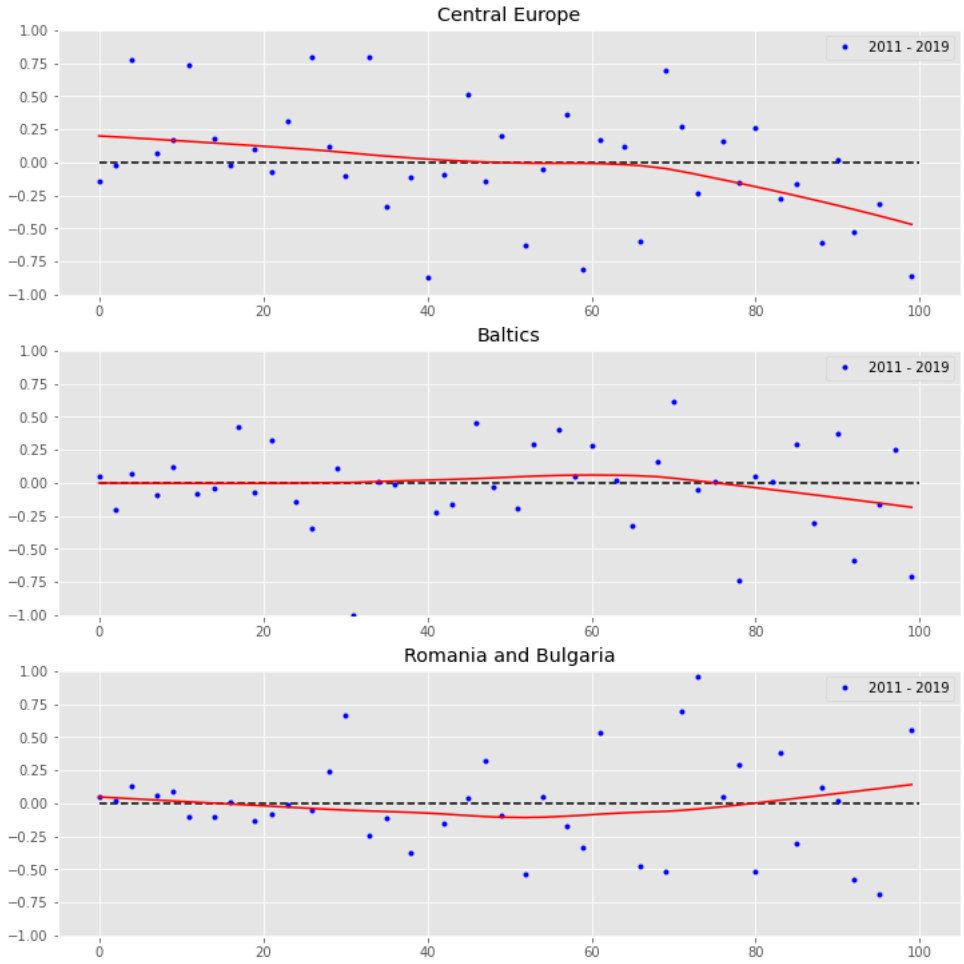
[10] This is also supported the by development visible in Figure 18 where the highest percentiles for both Bulgaria and Romania seems to be rather flat.

Figure 4: Changes in Log Wages by Percentile Relative to the Median (2011-2019)



The figure shows how given percentile of log monthly wage distribution changed relative to the median between 2011 and 2019. The data are for full-time workers. Formally, we depict $\log(\frac{P^n_{2019}}{P^{50}_{2019}}) - \log(\frac{P^n_{2011}}{P^{50}_{2011}})$ for each percentile n of the distribution. Note that in line with Acemoglu and Autor (2011) we depict the 5th-95th percentile.

Figure 5: Changes in Employment by Occupational Skill Percentile, 2011–2019



The vertical axis depicts a change of employment (annual hours worked) in each occupational percentile as a share of total employment in a given region. The occupations are ranked by skill percentiles obtained using employment-weighted mean log wage for each occupation in 2011. A Line representing a locally weighted smoothing regression is also depicted. All employment share changes are multiplied by 100. Also, note that the y-axis range omits some extreme values to better display the smoothed regression.

2015). We should also note that the Central European and Baltic countries have a very similar labour market type. According to OECD (2019), their bargaining systems can, in all cases, with the exception of Slovenia, be classified as fully or largely decentralized (Romania and Bulgaria are not covered). Overall, our results show that the labour income inequality alone cannot explain populist movements in the CEE.

3.2 Sectoral and Occupational Analysis

Figures 6 and 7 show relative changes in wages and employment for NACE classification of economic activities. Particularly, a robust wage growth in manufacturing and construction in Central European countries stands out and seems to be in line with the strong position of these countries in the European manufacturing core (Stöllinger, 2016). On the other hand, key public sectors are falling behind in this region. In the other two regions, we see strong performance of Finance in Baltic countries, while in Romania and Bulgaria, the public sector's relative wages are rising. Figure 7 then documents that changes in relative wages in the NACE categories are often associated with moves in relative employment in the opposite direction (see Construction in Central Europe or Finance in the Baltics). We will notice similar findings in the Figures below as well.

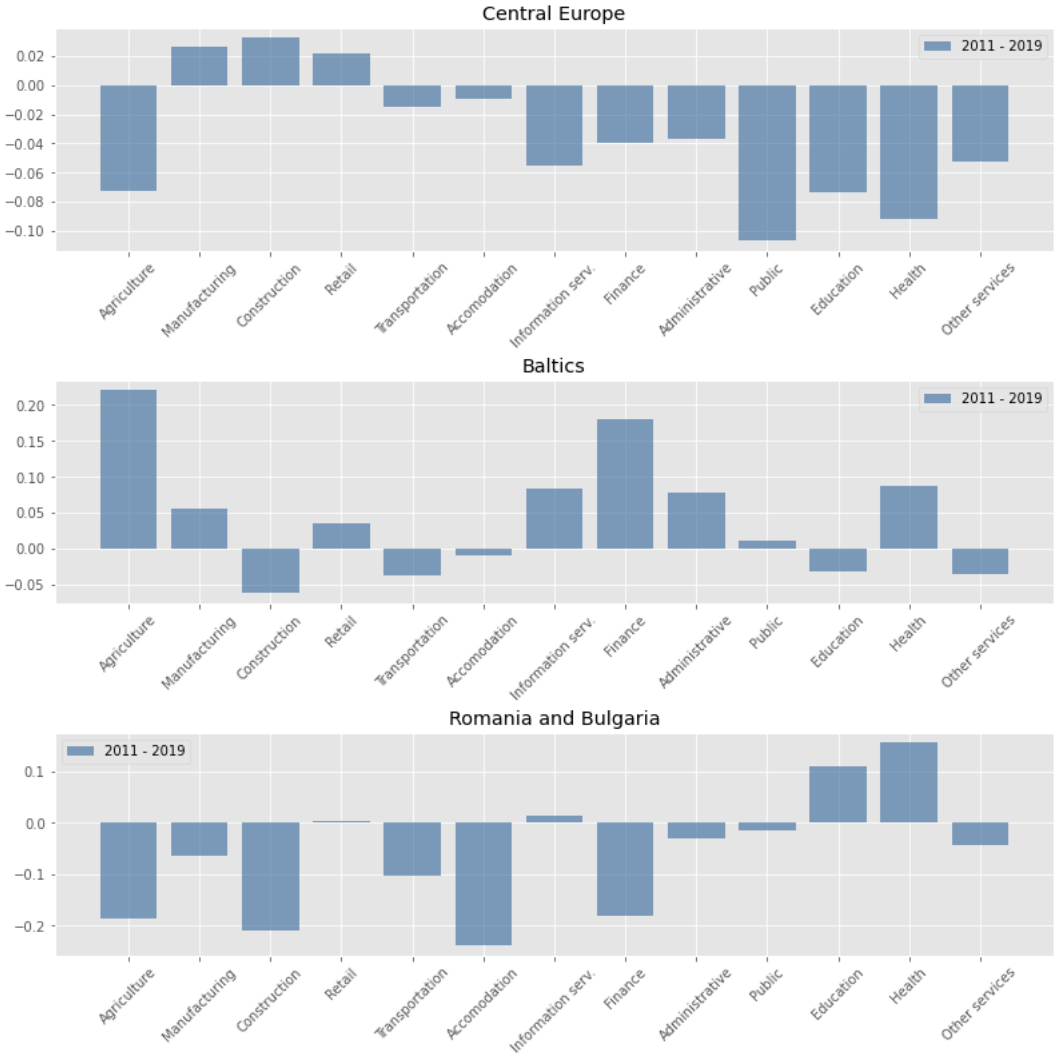
When we compare similar plots using major ILO employment categories in Figures 8 and 9, we again do not find a unified picture among the regions. Figure 9 allows for a basic comparison with trends both in the US and Western Europe, where we, in line with the job polarization hypothesis, find high (Managers, Professionals and Technicians) and low-education occupations (Elementary and Services & Sales) growing at the expense of the middle-education occupations such as clerks, machine operators and crafts and trade jobs (Acemoglu and Autor, 2011). We see similar behaviour for Baltic states with Managers and Professionals growing in the relative employment share together with Elementary occupations at the other side of the spectrum. However, in the two remaining regions, there is little evidence suggesting the validity of this hypothesis, with employment shares of occupations with the same level of education rarely increasing/falling simultaneously (e.g., growth of Professionals versus the decline of Managers and Technicians in Central Europe).

Moreover, our data frequently show changes in relative employment going in the opposite direction to changes in relative wages (note a strong wage performance of Craft and Trade workers in Central Europe together with their decreasing employment share). This may suggest that supply-side causality connected with an overheated labour market rather than demand shifts assumed by the Skill Bias framework is the dominant force. The movement of wages and employment in opposite directions can also be found in other cases. In the case of the Balkan economies, the most prominent employment change seems to be a growth in Services & Sales, which are considered low-education by (Acemoglu and Autor, 2011)[11], combined with a mild decrease in relative wages in this category.

Sectoral specialization documented in Figures 6 and 7 can also help to explain the the differences in labour market developments between the observed regions noted in the pre-

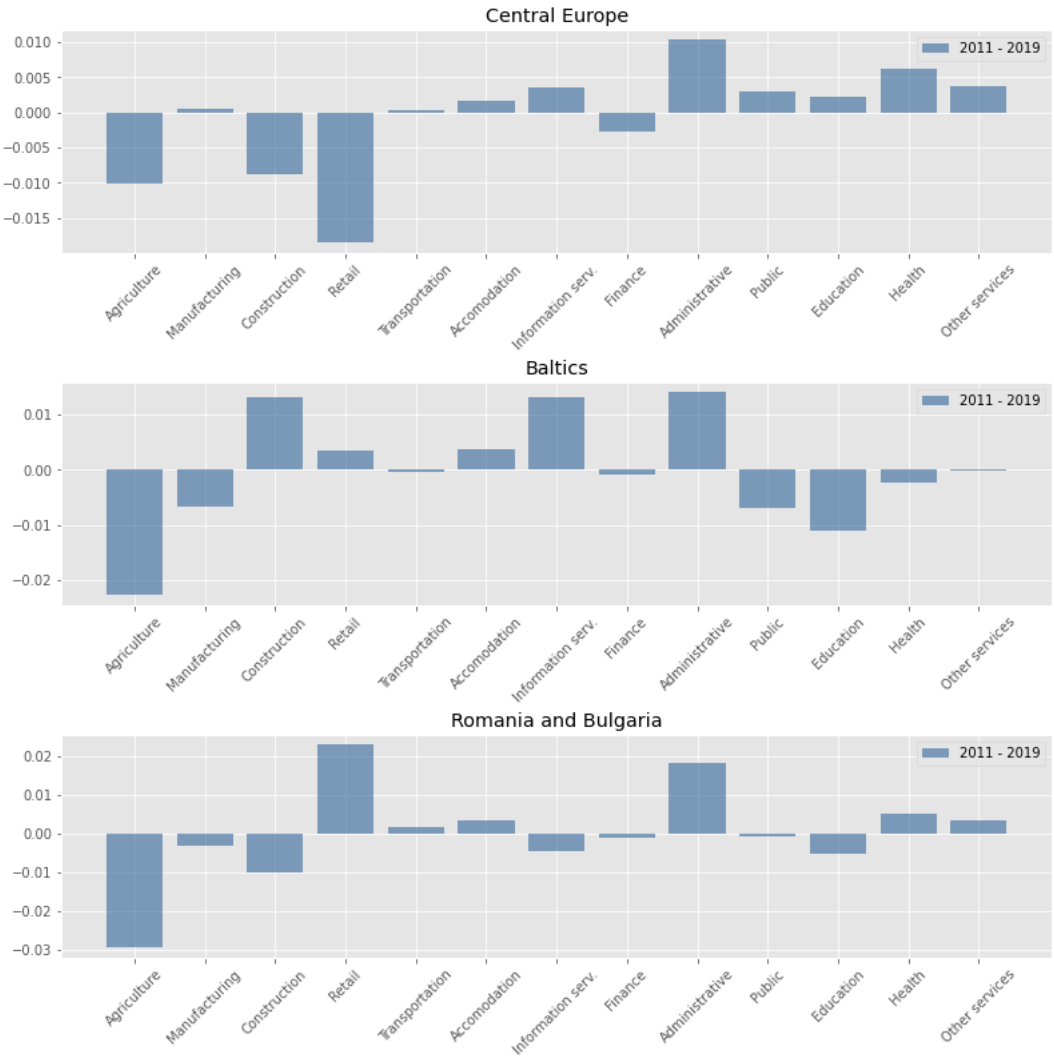
[11] However, this classification is up to debate as the service jobs are here aggregated with sales occupations.

Figure 6: Changes in Log Wages Relative to the Median by NACE category (2011-2019)



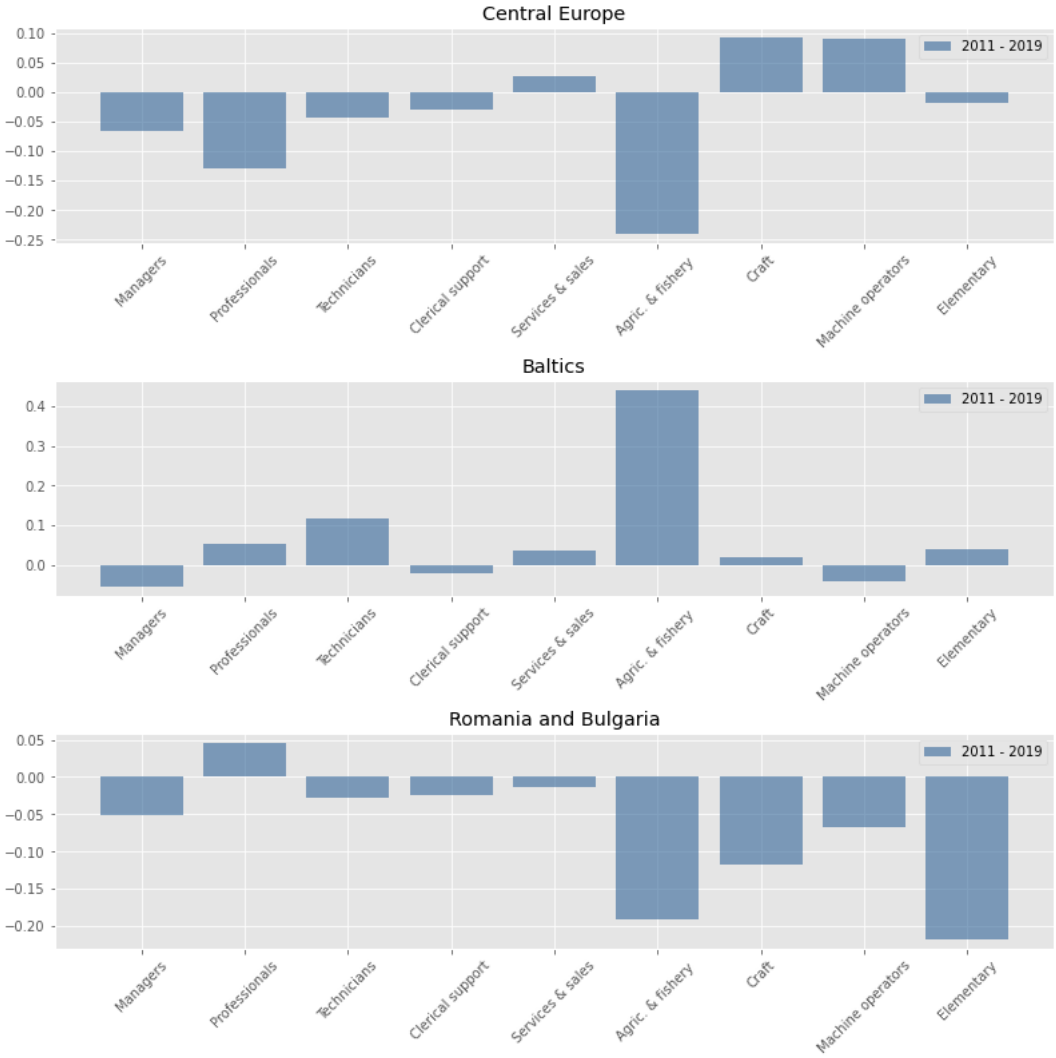
The Figure shows changes in mean log monthly wages in NACE categories relative to the median wage. We use wages of full-time workers and NACE Rev. 2 categories (sections) of economic activity.

Figure 7: Employment Share Changes between 2011-2019 by NACE Category



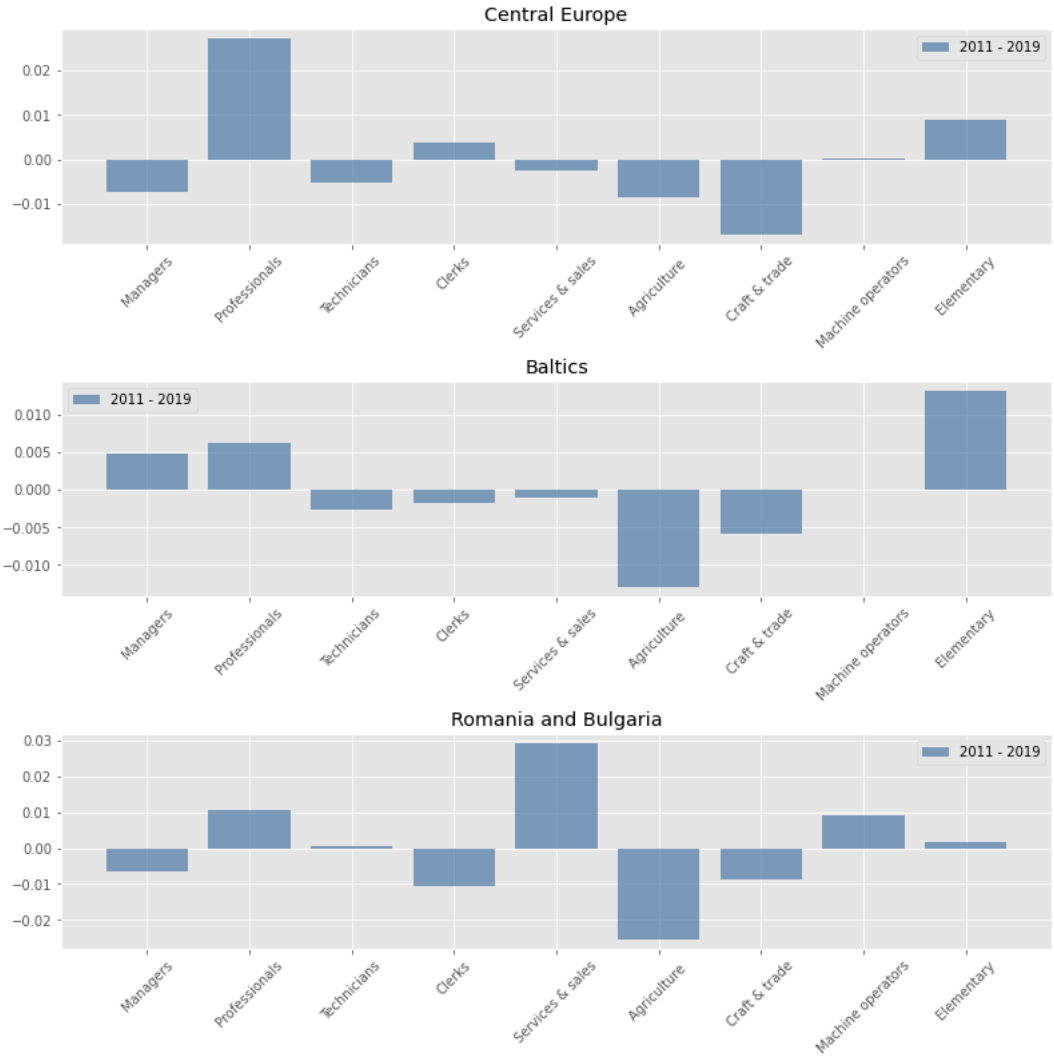
The Figure shows changes in labour supply (using hours worked) shares of different NACE Rev. 2 categories in total labour supply. All workers who worked at least one month in a given year were used.

Figure 8: Changes in Log Wages Relative to the Median by ILO Major Category (2011-2019)



The Figure shows changes in mean log monthly wages in ILO major categories relative to the median wage. We use wages of full-time workers and ISCO-08 major groups for the classification of the occupations. The categories displayed correspond to ISCO major groups 1-9. The names were abbreviated.

Figure 9: Employment Share Changes between 2011-2019 by ILO Major Category



Changes in different ISCO-08 major groups' shares of total labour supply (measured in hours worked). All workers who worked at least one month in a given year were used.

vious section. The Central European countries show the highest pay rise in manufacturing, Baltics in finance and ICT and Romania and Bulgaria in Education and Health. Result pointing to the significantly structurally diverse economies. Stöllinger (2016), for example, speaks about the European Manufacturing core, which does include central European states yet not other states in our data.

Despite bringing an interesting view of the economies, our results so far do not tell us any decisive conclusion about the SBTC hypothesis. We can only tell that our results, especially those for Central Europe (which are inverse to the US scenario), differ from those of the West. They, however, still could be in line with either SBTC or RBTC theory, given that either high skill labour supply growth is high enough or the countries are recipients of routine jobs from abroad thanks to globalization.

4 Skill Bias Technological Change and the CEE

The following section introduces the Canonical Model, a formalisation of the SBTC hypothesis used in this work to estimate the elasticity of substitution between high and low skill labour. As the SBTC model is influential and successfully applied in developed economies (Acemoglu et al., 2012; Glitz and Wissmann, 2021), it represents an ideal basis for comparison of the CEE and Western development. The following section also discusses the construction of the key variables - labour supply and skill premium. Analysis of these two variables provides further evidence about the labour market dynamics.

4.1 The Canonical Model

In the analysis below, we will follow a modelling framework (Canonical Model) developed first in Tinbergen and further elaborated in Katz and Murphy (1992), Goldin and Katz (2010), Card and Lemieux (2001), Acemoglu and Autor (2011) or Glitz and Wissmann (2021). The fundamental assumption behind the framework is the "skill bias" of the technological change that causes relative demand for high-skilled labour to rise permanently. The model departs from a CES production function:

$$Y = [\theta(A_L L)^{\frac{\gamma-1}{\gamma}} + (1-\theta)(A_H H)^{\frac{\gamma-1}{\gamma}}]^{\frac{\gamma}{\gamma-1}} \tag{1}$$

In this setting, H denotes high-skilled (university) labour supply, L low-skilled (non-university) labour supply, γ is the elasticity of substitution between high skill and low skill labour, and θ determines the relative importance of the two types of labour in the production function. The primary measure of inequality used is a (log) skill premium between these two types of labour. We can get this premium by first deriving wages for both L and H and obtaining their ratio:

$$\frac{w_H}{w_L} = \frac{(1-\theta)}{\theta}\left(\frac{H}{L}\right)^{-\frac{1}{\gamma}}\left(\frac{A_H}{A_L}\right)^{\frac{\gamma-1}{\gamma}}$$

and then linearizing the equation by taking logs:

$$\log(\frac{w_H}{w_L}) = c + \frac{\gamma - 1}{\gamma} \log(\frac{A_H}{A_L}) - \frac{1}{\gamma} \log(\frac{H}{L})$$

In this function, the relative supply of skilled labour $\frac{H}{L}$ decreases the skill premium, whereas the unobserved $\frac{A_H}{A_L}$ parameter increases it. $\frac{A_H}{A_L}$ can be interpreted as a relative development of factor augmenting technology for high and low skilled labour and represents the skill-biased technological change. We assume that this variable has a log-linear trend. This assumption contains a key part of the model - permanently ongoing technological change increasing demand for skilled labour. Thus we obtain the final version of the equation:

$$\log(\frac{w_H}{w_L}) = c + \frac{\gamma - 1}{\gamma} \sigma_0 + \frac{\gamma - 1}{\gamma} \sigma_1 t - \frac{1}{\gamma} \log(\frac{H}{L}) \tag{2}$$

OLS regression in the form of is then estimated by Katz and Murphy (1992), (Acemoglu et al., 2012), Goldin and Katz (2020) and others in order to obtain an estimate of the elasticity of substitution and an annual change in skilled labour demand.

Card and Lemieux (2001) and Glitz and Wissmann (2021) offer an extension of the model by incorporating middle skill category and distinguishing between young and old workers. Their framework results in a system of equations, allowing to obtain elasticities of substitution between different sub-group using a seemingly unrelated regression framework.

Routine Biased Technological change is then a further extension of the model above (in fact, it nests the Canonical model as its specific case). The key idea of this framework is an economic activity primarily consisting of tasks that can be divided between routine and non-routine and further between cognitive and non-cognitive. The technological change is assumed to substitute the routine tasks and strengthen the position of non-routine ones. The framework can thus explain polarization patterns visible in the US labour market in the 1990s (Autor, 2014). This framework is formally elaborated by Acemoglu and Autor (2011).

4.2 Variables Construction

We follow the proceedings of Katz and Murphy (1992) and Glitz and Wissmann (2021) while calculating variables used in equation 2. We first divide our data into groups defined by sex, experience level (6 categories based on time after finishing the highest level of education) and the highest attained ISCED education category. We compute an estimate of total hours worked in each group and each year as weeks worked times usual weekly hours and personal sample weight from the survey. Similarly, we compute average weekly wages for full-time workers for each of the education-experience-gender groups defined above.[12]

We start by calculating statistics used further in the process. We sum over all individuals in a group to get a total labour supply in a given group and year (so-called count sample).

[12] As the survey does not contain information about worked weeks but only worked months, we assume a person worked 4 weeks every month to get our estimate. In the rest of the work, we prefer using variables with monthly frequency (e.g., monthly wages)

Subsequently, we compute the relative share of each group in total labour supply in a given year and use this measure to calculate fixed weights defined by a vector of average employment shares for each group over all available years in the sample. We use these fixed weights together with the groups' average wages matrix to the calculate time series of relative wages by groups.[13] An average of this time series through time can be interpreted as an estimate of the average relative wage of a given group.

The relative labour supply and other descriptive statistics below are obtained using efficiency units. Efficiency units are essentially the labour supplies (hours worked) for each education-experience-gender-year group multiplied by the group's average relative wage estimate defined above. The result of this operation is then labour supply for each group in each year. We construct more aggregated measures of the labour supply by summing over these groups in each skill group (education category, high and low).

We calculate the final supply of high (H) and low (L) skill labour (more precisely of tertiary vs non-tertiary education) as a sum of respective cells for tertiary and lower than tertiary education groups. Similarly, the changes in labour supply in Table 2 are also sums of corresponding groups.

To get the skill wage premium, we use the average wages for each education-age-gender-year group mentioned above (so-called wage sample). We calculated the high/low skill group's composition-adjusted wage as a weighted average of the respective groups' wages with weights defined as each group's average share of the respective (high/low) skill group's total labour supply over all observed years (i.e. we give the highest weight to the wages which provided the highest share of labour supply in the given skill group). As before, the groups included in the high skill category are those with tertiary or higher education, the rest of the groups are considered low-skilled. Skill premium is then a ratio of the composition-adjusted wages of the two groups ($\frac{w_H}{w_L}$).

In line with the Equation 2, we then use logs of the skill premium and of the relative labour supply (H/L) in the regressions below to obtain the estimate of the elasticity of substitution. Efficiency units are also used in descriptive statistics.

4.3 Elasticity of Substitution Estimation

In the next part, we investigate the crucial part of the Canonical model - the relationship between the relative labour supply and the skill premium as outlined in Equation 2 and interpreted as elasticity of substitution between high and low skill labour.[14]

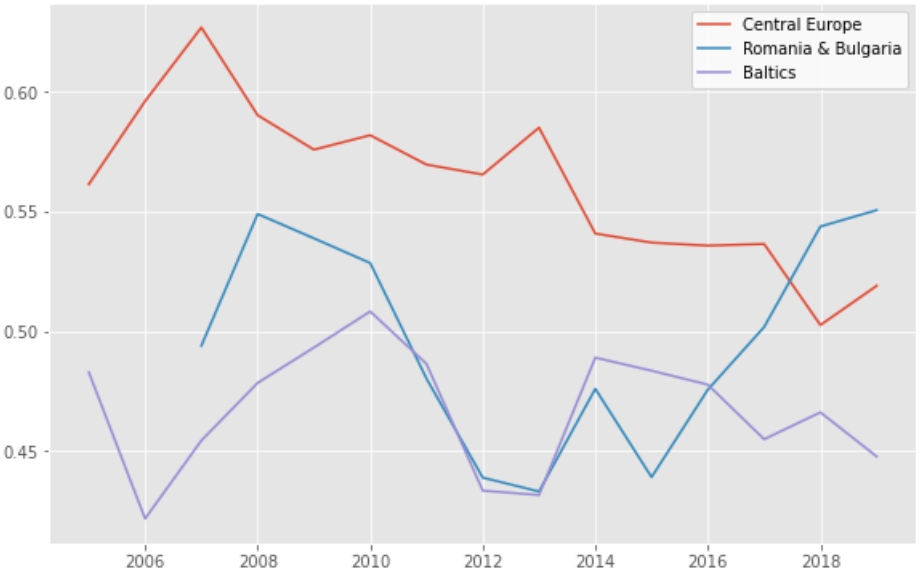
As can be seen in the Figure 11, there is a rising tendency in relative high-skill supply across CEE (as high skill category, we define individuals with the highest ISCED education level attained greater or equal to 5). However, for the university wage premium depicted in Figure 10 the picture looks more complex. A decline in the skill premium can be seen in the case of Central Europe. On the other hand, the Baltics show rather volatile development with a pronounced increase in the premium after 2008 and a downward trend afterwards.

[13] Each group's average weekly wages are weighted by the fixed weights, creating a time series of indices for each year of the sample by which we then deflate wages for all groups in a given year.

[14] Construction of the variables is outlined in the previous section.

Balkan countries experience decreasing trend before 2015 and a sharp rise in the premium after it. These results thus confirm some of the conclusions from the descriptive part - especially concerning the recent development of Romania and Bulgaria.

Figure 10: Changes in Composition Adjusted High/Low-skill Log Wage Premium



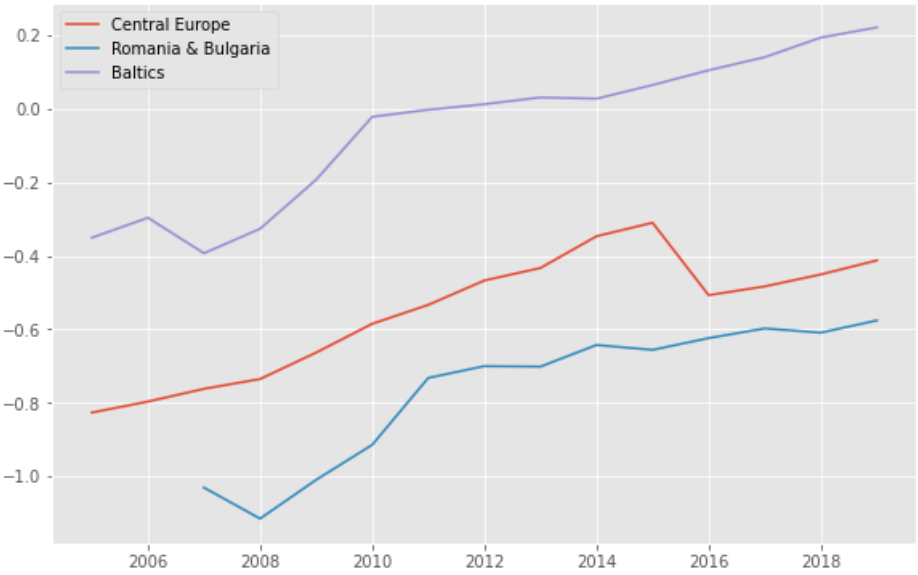
The Figure displays the logarithm of the skill premium described in section 4.2

The original Skill Bias Technological change hypothesis assumes a demand-driven change in the labour market (which in turn results from exogenously given technological change). Corresponding to such change should then be an increase in both skill premium and relative supply of skills, as was empirically documented in the case of the US (Acemoglu and Autor, 2011). The two key variables of this model are therefore positively correlated.

The data for CEEC shown in Figure 11 and 10, on the other hand, suggest a negative correlation between the skill premium and the relative skill supply. Our data indeed confirm that the two variables are negatively correlated both on the level of regional aggregates and on an individual country level, with the exception of Estonia and Bulgaria - two countries experiencing a recent rise in the skill premium.

This finding seems important as it contradicts one of the fundamental assumptions of the SBTC model - demand-driven change would imply a move along the supply curve and, therefore, a simultaneous increase/decrease in both variables. In contrast, the situation in CEE seems to be consistent with a movement along the labour demand curve - and therefore suggest supply changes setting the market trends or at least taking a more prominent role than standard SBTC model logic would imply. This seems to be in line with the evidence of overheating labour market in the CEE and was documented above in the analysis of

Figure 11: Changes in Relative High/Low Skill Labour Supply



The Figure displays the logarithm of the relative labour supply described in section 4.2.

Figures 8 and 9.

If we, following Acemoglu et al. (2012), detrend the series, as can be visible in Figure 12, the negative relationship between the relative labour supply and the skill premium disappears - correlation for all regions as well as the most countries (Figure 21 in the Appendix) becomes positive. This contrasts with the US case as found in Acemoglu et al. (2012). The difference is Romania, Bulgaria, Lithuania and Slovenia - where we confirm the negative correlation, similarly to the US. For further investigation of the two variables, we now look at the panel regression for 2005-2019.

Following the key works in the field, such as Katz and Murphy (1992) or Acemoglu et al. (2012), we perform regression according to Equation 2 separately for each country - the results confirm the conclusions of the detrended series analysis above - the estimates are insignificant with the exception of Romania and Bulgaria that have significantly negative coefficients with magnitude suggesting higher elasticity than in the US case (-0.27 and -0.34 respectively).[15]

However, as the regressions above work with short time series, we decided to utilize panel regression estimation. In Table 3, we see the regression results of several specifications coming from the basic regression design proposed by Katz and Murphy (1992) in the form of Equation 2. This regression equation has been used extensively in studies predom-

[15]Overview of the results can be found in Table 8. We have also done this exercise for the regional groups - elasticities are again insignificant except for the Balkans.

inantly concentrated on developed economies in the last decades (Havranek et al., 2021). We also add other explanatory variables inspired by research on determinants of labour market inequality. As suggested by Farber et al. (2021), we added union density for each year, average minimum wage and unemployment rate in each of the countries as measures of labour market conditions. Note the impact of the minimum wage on labour market inequality found in Germany (Bossler and Schank, 2020).

Table 3: Determinants of Skill Premium

	FE	**FE**	**FE**	**RE**	**RE**
Dependent variable	Skill premium	Skill premium	Skill premium	Skill premium	Skill premium
Relative supply	-0.2198	-0.2285	-0.1783	-0.1086	-0.0927
	(-3.6296)	(-2.1611)	(-1.9811)	(-1.6910)	(-1.0116)
Union density			0.0082		0.0084
			(1.3967)		(1.8800)
Min. wage			0.0002		6.517e-05
			(1.4829)		(0.4416)
Unemp. rate			0.0078		0.0050
			(1.8626)		(1.2477)
Trend				-0.0057	-0.0017
				(-1.0212)	(-0.2188)
Constant				0.4819	0.2824
				(5.6607)	(2.7137)
Observations	144	144	144	144	144
Country effects	Yes	Yes	Yes	No	No
Time effects	No	Yes	No	No	No
Cov. Est.	Clustered	Clustered	Clustered	Clustered	Clustered
$\mathbf{R^2}$	0.3370	0.0836	0.4093	0.3150	0.3764

Clustered Standard Errors reported, t-statistics in parentheses

The H/L parameter in Table 3 can be interpreted as the elasticity of substitution between high and low skilled workers and is therefore of primary interest. The Random effect model also contains a time trend parameter, interpreted as an annual change in relative high skill demand caused by technological change.[16]

The results show that the relative supply coefficient is negative, significant, and between -0.2 and -0.1. As this coefficient represents a negative inverse of the elasticity γ, we get an elasticity of substitution around 5 or 10.[17] These findings suggest that high and low skill labour are gross substitutes. This implies that high and low skilled workers are relatively interchangeable, and crucially, an increase in the supply of high skill workers decreases the demand for the low-skilled ones (Havranek et al., 2020). The results also indicate a significantly higher elasticity of substitution in the CEE compared to the US and German case (Acemoglu et al., 2012; Glitz and Wissmann, 2021). The high elasticity of substitution estimates could be in line with findings of previous literature, such as Arendt and Grabowski (2019) and Hardy et al. (2018) - who notes significant educational upgrading in the region together with high demand for routine (even though cognitive) jobs, a result of CEE being

[16] We estimate the equation with the university (tertiary) education representing the high-skill category and all other categories considered low-skill. Another common specification - where we compare university and high school (secondary) education is in the Appendix in Table 9.

[17] We also performed the Hausmann test in order to choose the preferred model variant. With p-value 0.04551 (for the model including Union density variable) we reject the null hypothesis of RE model.

and offshoring destination. This may create an excessive supply of high-skilled population that is subsequently being pushed into less high-skilled occupations than its formal level of education would suggest - resulting in the higher substitutability of high and low skill labour.

The results for the Random Effect models also show the time trend parameters, interpreted as a pace of technological change and, more importantly, representing the demand shift. Our results show that this parameter is not significantly different from zero in the CEE (indeed, the coefficients are negative, suggesting movement of the demand curve in the opposite direction than assumed by the SBTC theory). A Possible interpretation of this result is a significantly slower pace of technological change in the CEE countries resulting in less pronounced labour demand changes. Note that such interpretation is in line with previously suggested labour supply shifts - technologically driven labour demand shifts are not strong enough to surpass pressure from the supply side caused by the overheated labour market.

Nevertheless, note that the model has a relatively poor fit compared to the results from seminal works such as Katz and Murphy (1992) and Glitz and Wissmann (2021) despite R^2 for individual countries being sometimes around 0.9 (see Table 8).

5 Conclusion

We investigate CEE labour markets during almost the entire period of the countries' EU membership using EU-SILC micro survey data to check key labour market hypotheses found in the developed economies, namely the Skill Bias technological change (SBTC) and its newer Routine Bias variant (RBTC). The former is represented by the Canonical model (Katz and Murphy, 1992), the latter by the job and wage polarization that represent a key finding of the literature, leading to the formulation of the RBTC.

Moreover, we attempt to complement the literature on labour market inequality in the set of countries closely linked to the developed economies for which the inequality is usually measured but at the same time having a very different position in the labour market chains. We find the EU-SILC a good option for emulating the key STBC literature such as Katz and Murphy (1992) in the CEE context and, at the same time, relatively little used dataset in the context of inequality estimation.

First, our findings indicate decreasing labour market inequality for most workers, which can be illustrated by the relative position of the median to the top 10 % and increasing real wages of the workers with secondary education. Our data also suggest that volatility and changes in reaction to the business cycle are concentrated in the lower part of the income distribution.

Next, we do not find much evidence for polarization in terms of wages or occupation. Most importantly, the characteristic U-shaped curve that would suggest growing relative employment and wages on the extremes of the income distribution found in the literature centered around the US is absent in the data of the CEE countries. Our results suggest rather flat or monotonically equalizing behaviour. Such behaviour resembles much more

an inverted version of the monotonic behaviour found in the US in the 1980s. Therefore, there does not seem to be any particular reason to adopt the routine-based technological hypothesis instead of SBTC in the context of these countries.

Second, we have also found differences among the countries investigated, embodied by a recent rise in inequality in Romania and Bulgaria. The phenomenon is, to a certain extent, puzzling and demands further investigation. However, one should remember that these countries are significantly different in their overall macroeconomic performance from the rest of the sample.[18]

We also estimated the elasticity of substitution using the estimates of skill premium of tertiary educated and their relative labour supply. We used a procedure developed by Katz and Murphy (1992) in a panel model framework to deal with the limited number of observations available for individual countries. Our estimates suggest the elasticity of substitution in the CEE between 5 and 10, higher than in the case of the US.

The equalizing and generally pro-worker and pro-median situation in the labour market seems to confirm our assumption that the CEE and the West are on different sides of the globalization dividing line. However, this finding also brings a certain puzzle, as these countries experience their own populist surge with the populist parties' vote share tripling between 2000 and 2017 and many of these parties participating in or even leading the governments in the region. However, the sources of these political tendencies seem to be somewhat different from the developed countries. In the case of the CEE, the populist surge appears to be happening despite the development of the labour market rather than as a consequence of it. In our view, this paradox offers an opportunity for further investigation of material causes of the dissatisfaction in the region.

[18] Also, note that this process seems to be driven by development in a single country (Bulgaria).

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6 Appendix

Figure 12: Detrended Logarithm of Skill Wage Premium and Relative Labour Supply

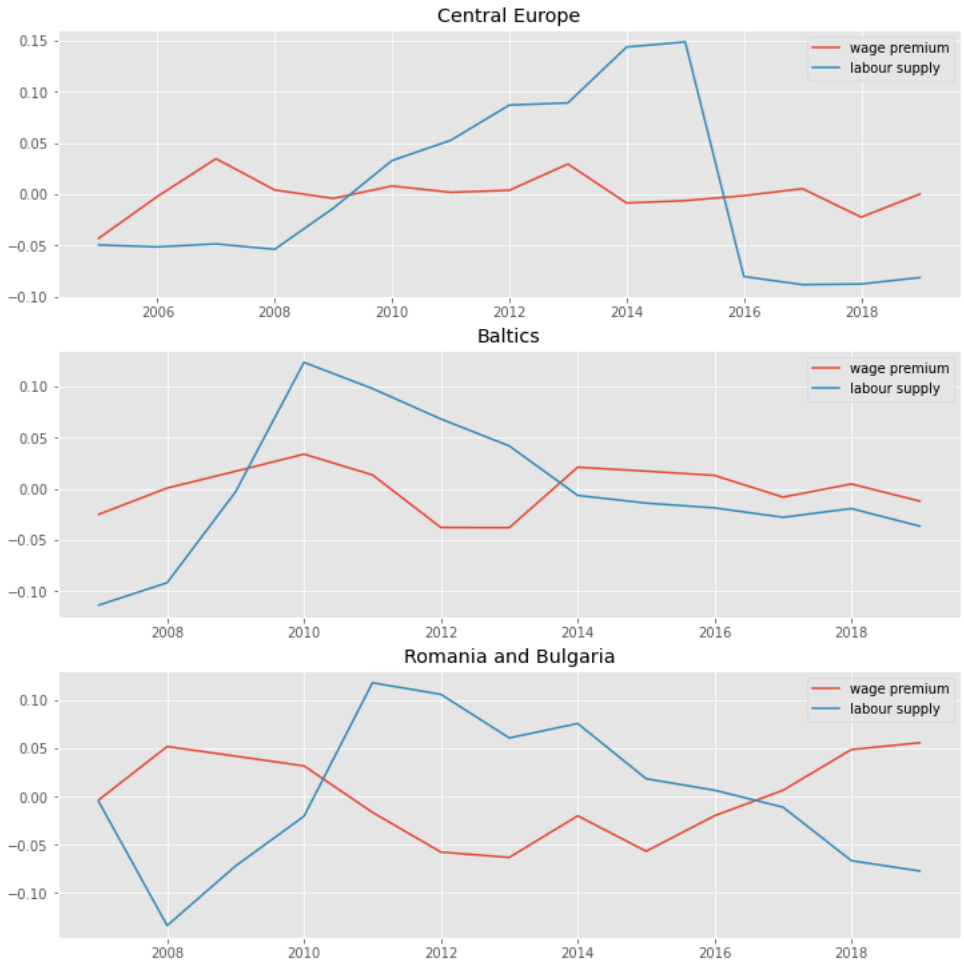


Figure 13: Changes in Log Wages by Percentile Relative to the Median (2007-2019)

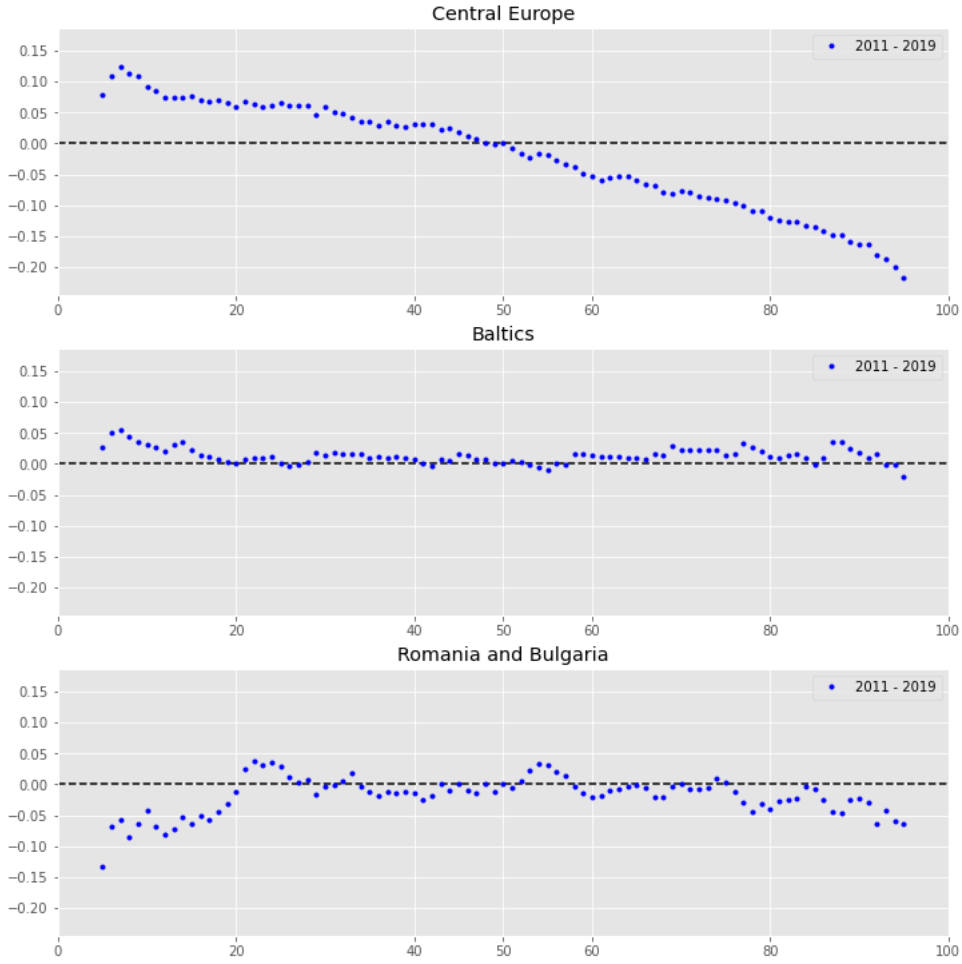
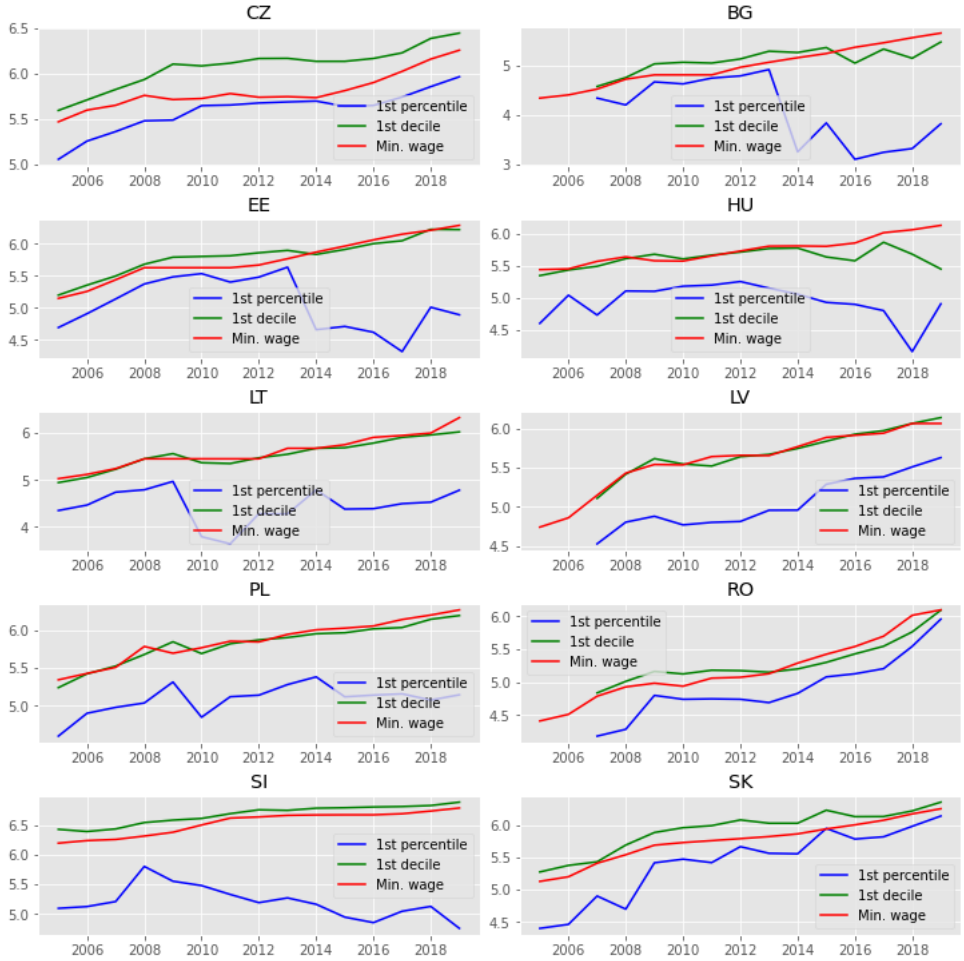
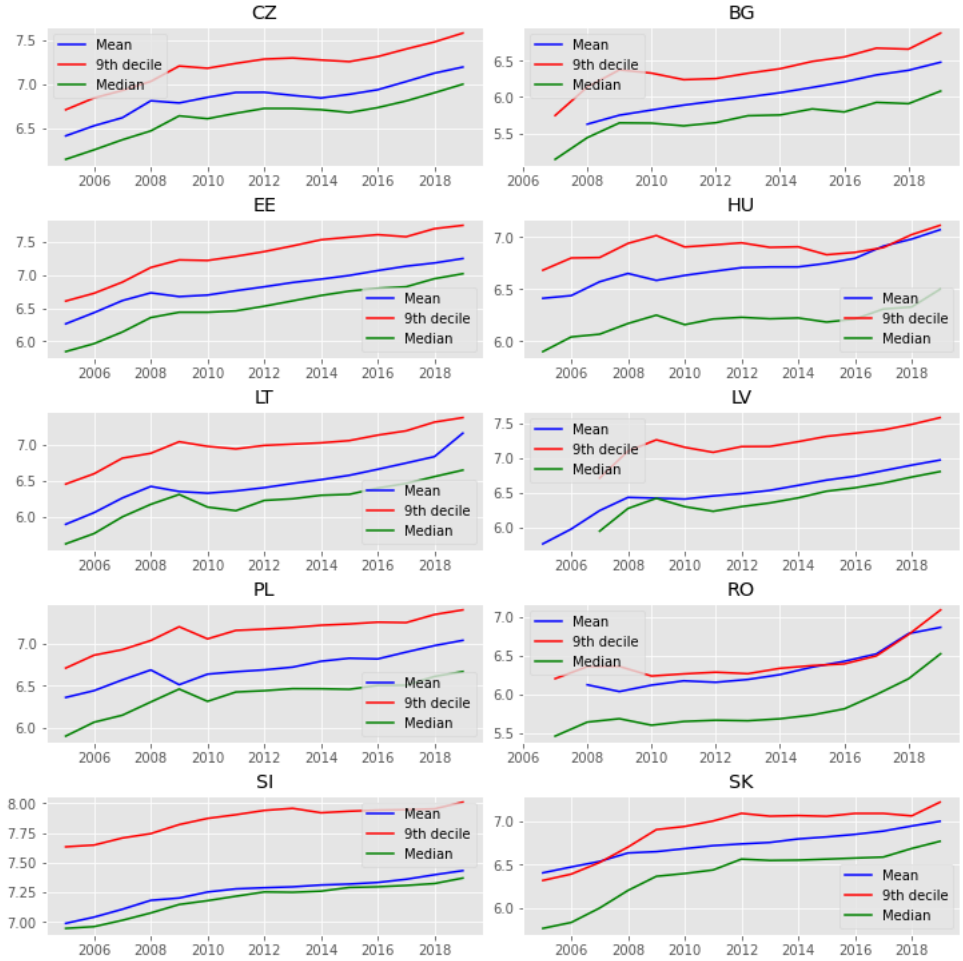


Figure 14: Minimum Wage Against the Lowest Percentiles



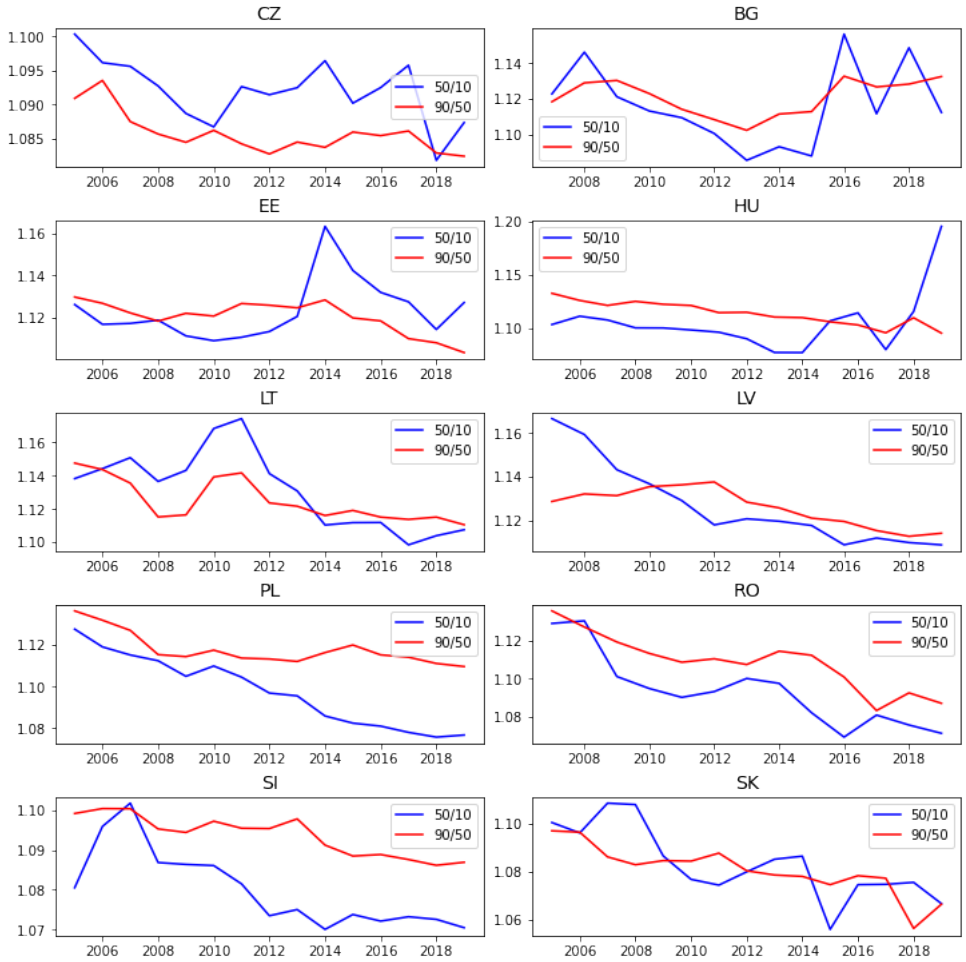
Deciles of monthly log wages of full-time workers. The minimun wage statistic is obtained from Eurostat, rest is calculated from the EU-SILC survey data - individual countries

Figure 15: Average Wage Against the Highest Percentiles



Deciles of monthly log wages of full-time workers. The average wage statistic is obtained from Eurostat, the rest is calculated from the EU-SILC survey data.

Figure 16: Development of (Log) Wage Gaps for Full-time Workers in CEE, 2005–2019



Development of ratios of different deciles of log monthly wage distribution for full-time workers.

Figure 17: Changes in Log Hourly Wages by Percentile Relative to the Median (2011 - 2019) - Individual Countries

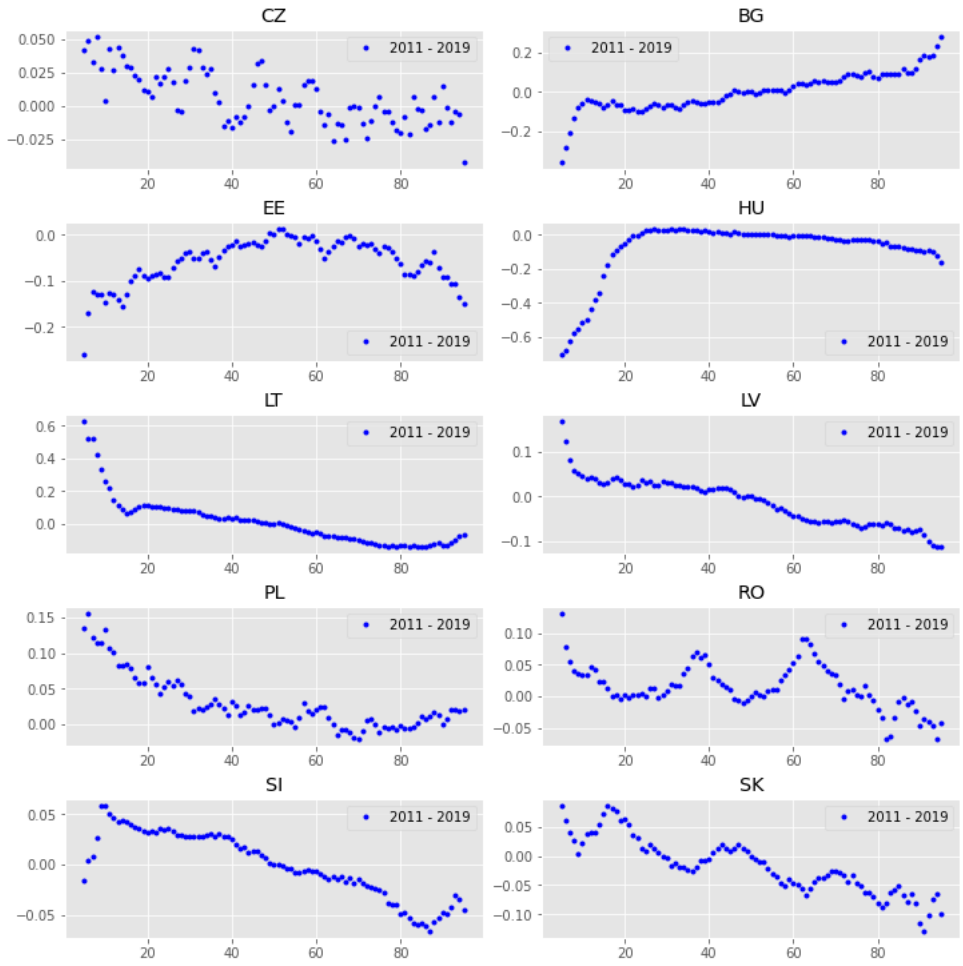
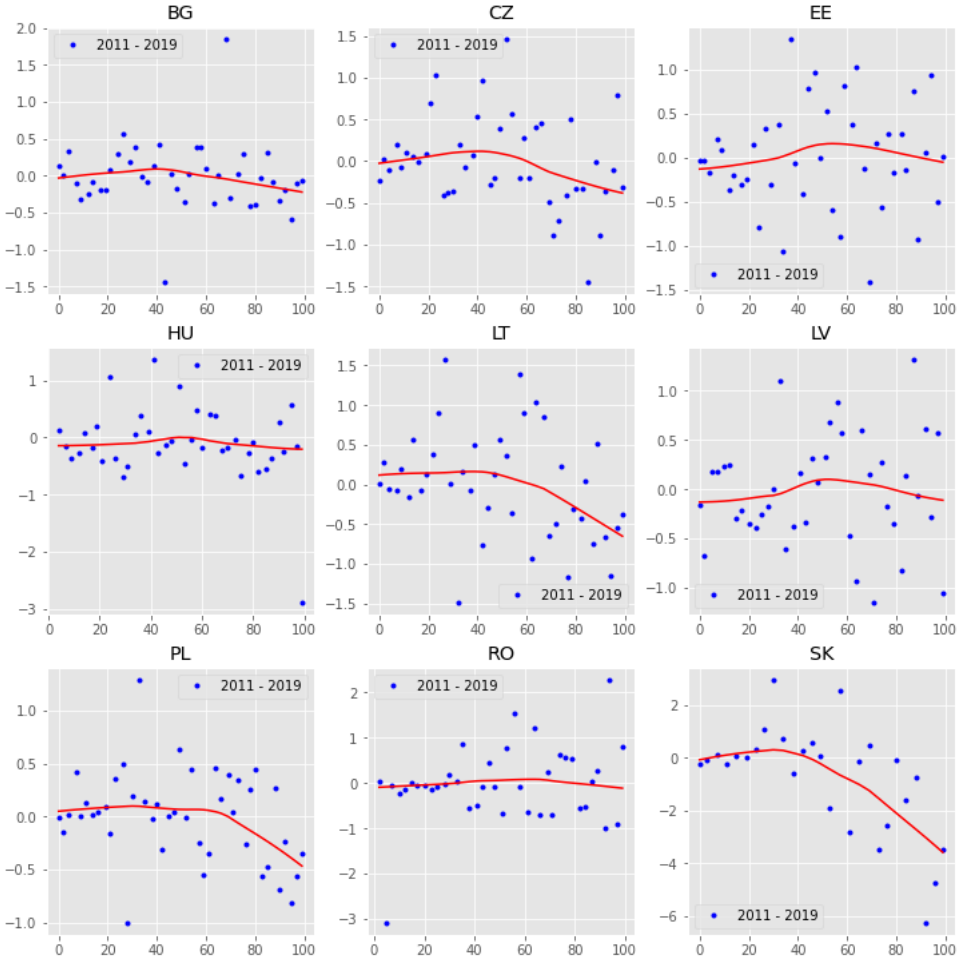
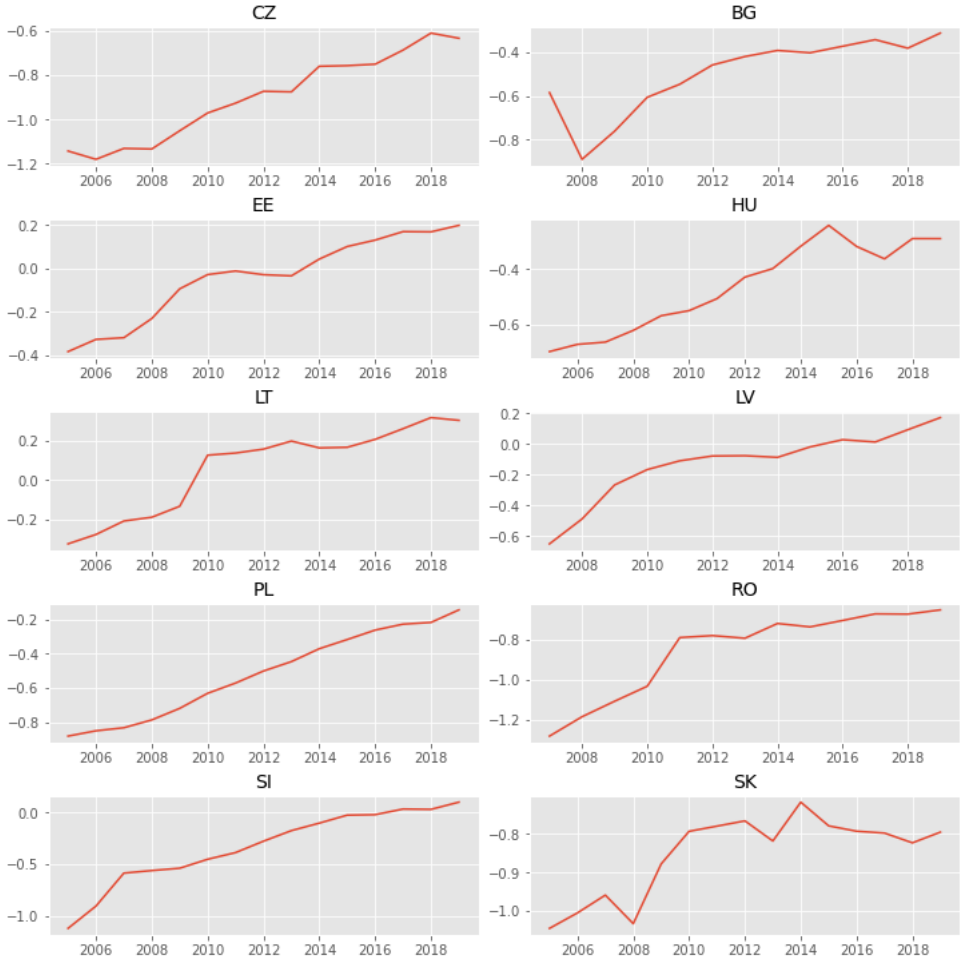


Figure 18: Changes in Employment by Occupational Skill Percentile, 2011–2019.



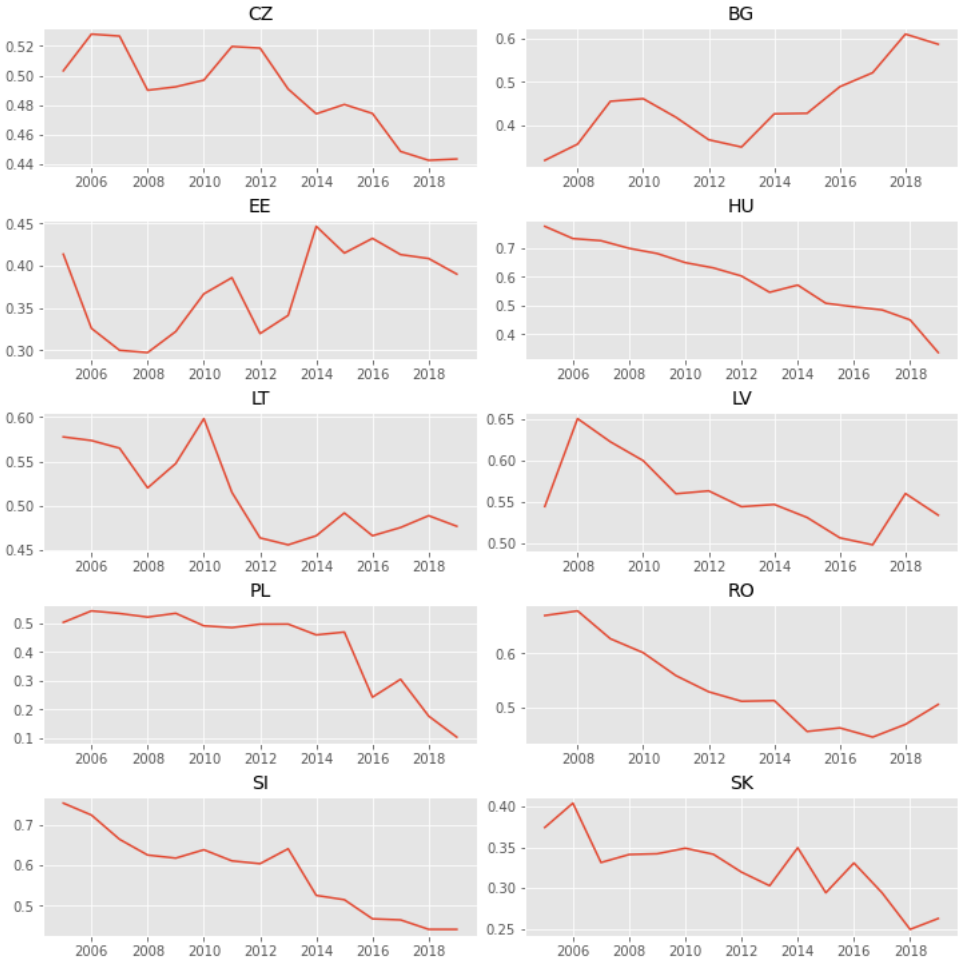
Mean log-wage in 2011 was used for obtaining the occupation skill rank. Slovenia was excluded from this graph due to low number of observations.

Figure 19: Changes in Relative High/Low Skill Labour Supply in CEE



The Figure displays the logarithm of the relative labour supply described in section 4.2.

Figure 20: Changes in Composition Adjusted High/Low-skill Log Wage Premium



The Figure displays the logarithm of the skill premium described in section 4.2

Figure 21: Detrended Skill Wage Premium Against Relative Labour Supply

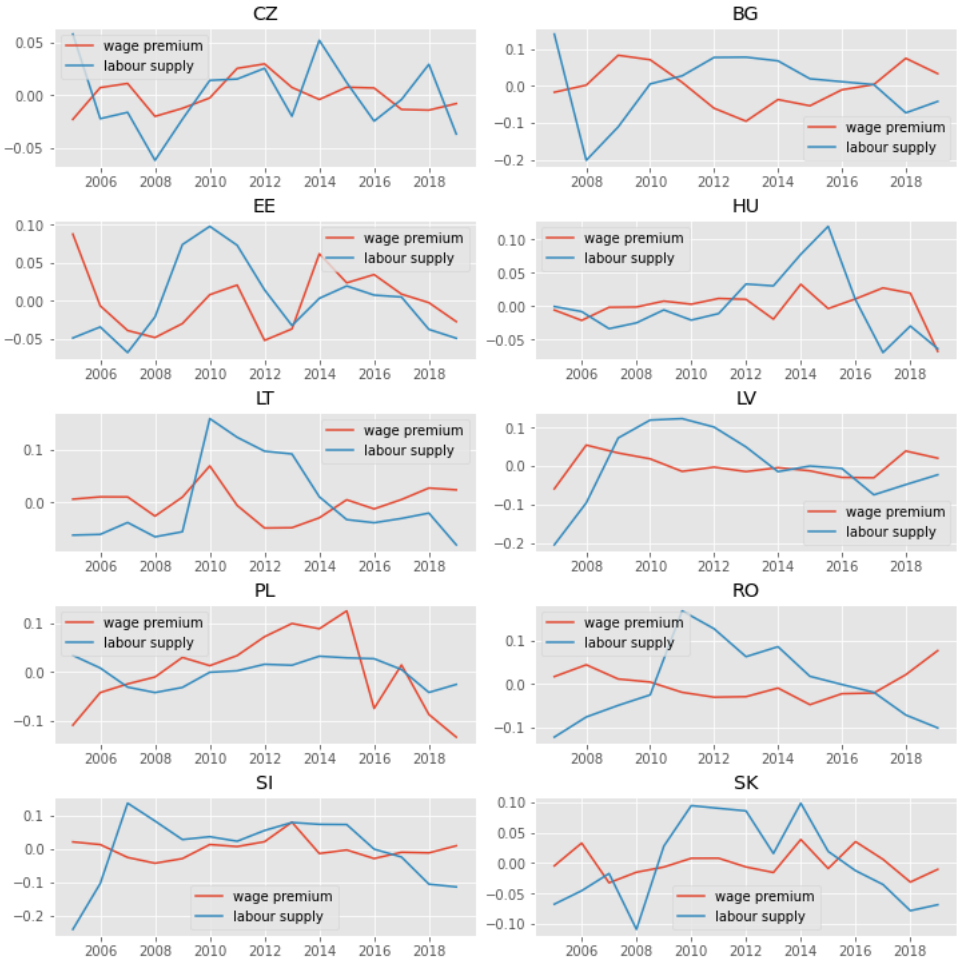


Table 4: Changes in Real Wages by Country - Central Europe

Country	2010/2007	2019/2011	2010/2007	2019/2011	2010/2007	2019/2011	2010/2007	2019/2011	2010/2007	2019/2011
Groups	CZ	CZ	HU	HU	PL	PL	SK	SK	SI	SI
<5	13.292203	12.484792	-13.301797	1.992760	1.404850	2.158435	43.029078	14.963351	2.532791	-4.005816
5-15	15.490846	12.065493	-9.345043	-4.194209	0.206450	-6.249807	44.631900	14.671115	6.545352	-8.444205
15-25	15.974291	15.734025	-5.772473	5.305644	-2.669173	7.435828	36.098234	13.677924	8.370083	-4.945813
25-35	12.657331	13.878316	-6.565035	-4.745099	-0.645663	-2.863376	33.044754	10.769683	9.746011	-2.121099
35-45	14.679464	8.743428	-10.412439	-6.204726	-4.694525	3.389281	34.904562	17.388578	13.090370	-3.692145
>45	16.969656	22.386638	40.081575	-57.108594	-20.501749	-13.079941	86.422321	1.240834	89.739821	2.103319
Female	16.466768	12.904817	-10.231480	-2.504522	0.592534	1.988888	39.512075	16.257187	4.963890	-7.061669
Male	13.726690	13.509837	-6.801153	-1.191443	-2.056478	-0.829993	38.315302	12.038894	9.684599	-3.691119
primary education	NaN	NaN	NaN	NaN	-6.431957	16.742316	14.892138	-19.080876	NaN	NaN
lower secondary education	12.661607	21.167355	-4.838441	17.668417	1.545489	36.688322	41.083019	19.807928	9.676708	8.913304
(upper) secondary education	16.595227	17.727918	-2.792900	17.749656	2.079740	18.991410	37.263530	18.773899	9.003570	4.400152
post-secondary non tertiary education	NaN	NaN	-6.564271	11.965689	3.763429	8.793980	NaN	NaN	NaN	NaN
tertiary education	13.503349	10.458081	-10.876622	-13.326144	-3.078349	-17.315706	39.555843	10.173994	6.793411	-11.944414

Table 5: Changes in Real Wages by Country - Balkans and Baltics

Country	2010/2007	2019/2011	2010/2007	2019/2011	2010/2007	2019/2011	2010/2007	2019/2011	2010/2007	2019/2011
Groups	BG	BG	EE	EE	LT	LT	LV	LV	RO	RO
<5	47.330489	46.999261	-2.786063	27.692451	-21.782520	43.721896	12.934346	40.860507	-10.227069	80.734811
5-15	39.495721	58.990249	17.017189	23.508816	-9.050369	44.872473	27.472710	33.046852	-15.907555	66.301508
15-25	38.971626	62.226653	24.511844	29.143427	3.417652	43.966947	19.711511	45.794507	-11.472192	70.141590
25-35	41.241964	47.981114	25.221330	28.599171	0.019808	37.385062	29.161357	37.007500	-14.133517	67.328592
35-45	48.925777	59.413050	23.044023	23.929130	6.100906	25.092660	23.943484	37.257713	-27.240479	64.900808
<45	16.741057	80.343981	45.896240	51.709741	-24.018872	23.309385	28.600122	28.044531	-170.377774	104.299231
Female	42.140465	59.076116	21.635277	30.356567	0.618485	33.349480	26.489896	34.992677	-14.005371	73.227794
Male	40.929483	54.063529	16.225103	24.603861	-9.107269	46.648602	20.246848	41.156555	-15.908893	66.045212
primary education	18.277370	35.193310	13.006796	52.001774	-10.855238	49.018434	75.204162	87.603874	-8.930614	94.121130
lower secondary education	25.414493	29.361815	12.579510	15.265605	-13.902503	34.663328	14.897043	39.491236	-18.434239	77.152514
(upper) secondary education	34.169631	48.082543	15.294322	28.030395	-9.759740	46.361597	20.016842	39.274502	-9.949148	71.059771
post-secondary non tertiary education	19.765816	79.095391	18.719176	26.865995	-4.276447	40.013376	20.818130	38.422394	-6.907480	73.697912
tertiary education	47.536173	62.580966	20.829847	27.525643	-2.795276	38.959689	25.199548	37.588198	-17.014110	67.006217

Table 6: Relative Labour Supply Changes by Country - Central Europe

Country	2010/2007	2019/2011	2010/2007	2019/2011	2010/2007	2019/2011	2010/2007	2019/2011	2010/2007	2019/2011
Groups	CZ	CZ	HU	HU	PL	PL	SK	SK	SI	SI
<5	8.226937	-8.964951	-10.410914	-7.212603	1.465125	-42.976057	15.683775	-42.556512	1.303569	-38.138896
15-25	1.231744	-12.722249	-4.766265	-7.567406	-11.520447	18.913838	-7.891195	4.435811	-11.531289	1.571734
25-35	2.367041	9.069147	7.254298	1.364161	-5.938776	-24.437601	-2.540541	-12.859471	3.443666	-13.001034
35-45	-2.820841	10.661964	40.908923	28.621185	30.080666	27.337031	14.292898	21.478962	12.836356	64.505852
5-15	-6.422063	-0.039276	-14.599780	-15.640995	5.180733	8.675418	-1.798339	16.635153	4.815126	3.894283
>45	49.114285	53.040895	47.969350	151.887733	4.788782	17.825691	33.106098	41.217003	50.342057	145.376930
Female	1.896840	5.510090	2.314666	-0.537905	6.180807	6.427731	1.206245	-1.029751	2.865350	1.253471
Male	-0.930675	-2.870336	-1.592832	0.402593	-3.707420	-4.259695	-0.772012	0.659910	-2.048722	-0.937857
primary education	inf	inf	NaN	NaN	-20.218391	-53.699785	-81.802288	-105.235923	-62.171101	-inf
lower secondary education	-7.342903	-14.269409	-0.214999	17.948349	59.969552	66.649061	5.393534	6.398527	-16.042602	-54.422373
post-secondary non tertiary education	-1.215507	-inf	-6.539873	6.072272	-0.771252	-61.832275	inf	-5.867509	NaN	NaN
(upper) secondary education	-4.072809	-6.978868	-4.258382	-14.639163	-5.887259	-12.735159	-7.592798	0.478960	-1.317696	-16.957616
tertiary education	11.830884	20.047701	7.377572	12.992954	13.578050	25.139745	11.664222	-1.072560	8.347106	26.038308

Table 7: Relative Labour Supply Changes by Country - Balkans and Baltics

Country Groups	2010/2007 BG	2019/2011 BG	2010/2007 EE	2019/2011 EE	2010/2007 LT	2019/2011 LT	2010/2007 LV	2019/2011 LV	2010/2007 RO	2019/2011 RO
<5	-0.951242	10.550018	-1.107954	-3.477220	-11.578134	-18.084308	5.888761	-27.601205	-3.182683	-48.302524
15-25	-0.552386	-0.697178	-3.466915	-14.004675	-11.787495	-28.160306	-8.130503	-8.438484	9.563295	-5.306868
25-35	-3.163274	-3.337190	0.920876	-9.686528	5.593757	-19.990798	1.250872	-13.213702	-13.230831	12.441937
35-45	21.015362	9.278204	5.498243	21.481766	24.406446	57.209064	-5.444474	26.575962	31.079075	15.631660
5-15	-7.183673	-8.973120	2.123712	9.307710	8.432220	24.372235	7.235132	16.005090	-4.018921	-2.376742
>45	117.220952	85.395334	-9.337257	40.949785	-8.184769	58.456756	-33.811906	46.149722	-71.209834	49.650510
Female	2.279623	-2.792326	7.251265	-5.924975	7.980956	-3.975438	9.192610	-3.627072	1.804030	-0.504534
Male	-1.511782	1.978517	-4.949785	4.096353	-6.727155	3.277389	-7.089635	2.914129	-1.088929	0.314719
primary education	-28.277864	-6.329743	43.808599	-38.810912	4.774837	-66.305449	-134.875227	30.864208	-58.023669	-20.616426
lower secondary education	7.138331	-16.992489	-15.246012	16.672097	9.909781	-47.284491	-25.265803	-61.291948	-14.709289	-30.352261
(upper) secondary education	1.270990	-7.472449	-4.219765	-24.563782	-17.017731	-11.006235	-11.814197	-21.036536	-2.075079	-0.143069
post-secondary non tertiary education	-72.709787	-18.049389	-104.662174	71.492996	-20.440135	-1.336479	-52.989267	41.567394	-0.935263	3.934652
tertiary education	-1.393563	14.118566	15.750078	9.996584	17.107347	7.413791	28.973587	13.829629	19.051972	9.350157

Table 8: Panel Regression Comparison - Individual Countries

Country	Relat. Supply	P-value	t-statistic	R^2
CZ	0.029875	0.828226	0.221766	0.700503
BG	-0.348470	0.051787	-2.207408	0.747515
EE	0.074138	0.759536	0.313159	0.343227
HU	0.110438	0.432270	0.812607	0.964073
LT	-0.020593	0.857309	-0.183709	0.610137
LV	0.084884	0.432266	0.818276	0.489621
PL	0.989898	0.227472	1.271998	0.735357
RO	-0.267396	0.012218	-3.051628	0.905163
SI	-0.048920	0.571804	-0.581287	0.914788
SK	0.114771	0.206714	1.334802	0.741803

Table 9: Panel Regression Comparison - Using Secondary Education as the Low-Skill Category

	FE	**FE**	**RE**
Dependent Variable	skill premium	skill premium	skill premium
==========	==========	==========	==========
Relative Supply	-0.2155	-0.1912	-0.0715
	(-3.3988)	(-2.0002)	(-1.2777)
Trend			-0.0073
			(-1.4830)
Constant			0.4930
			(7.3184)
==========	==========	==========	==========
No. Observations	144	144	144
Country FE	Yes	Yes	
Time Effects	No	Yes	
Cov. Est.	Clustered	Clustered	Clustered
R^2	0.3279	0.0626	0.3154

The high school category was defined as containing ISCED level of the highest attained education 3 and 4.

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