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Wage inequality, skill inequality, and employment: evidence and policy lessons from PIAAC

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Abstract

This paper investigates international differences in wage inequality and skills and whether a compressed wage distribution is associated with high unemployment across core OECD countries. Wage dispersion and wage structure are widely debated among policymakers; compressed wage structure is often perceived as an important cause of high unemployment. Firstly, this paper examines differences in wage dispersion across OECD countries and their link to skill dispersion. Some countries that have more compressed (dispersed) wage structures simultaneously have more compressed (dispersed) skill structures as well, and skill differences explain part of the differences in wage dispersion. However, even when accounted for skills, some countries have a more compressed wage structure, most likely caused by labor market institutions. We do not find an effect of wage compression on the labor market performance in the low-skill sector. Based on the Program for International Assessment of Adult Competencies (PIAAC) survey of adult skills for core OECD countries, this paper cannot confirm the skill compression nor wage compression hypotheses. Rather than insisting on the deregulation of labor market institutions and reductions in public welfare policy as the main policy recommendations to achieve higher employment (and higher wage inequality), policymakers should reconsider aggregate demand deficiency and the variation in macroeconomic policies as potential explanations for the employment differences across countries.

JEL Classification: J31, J24, E24

Keywords: Wage distribution, Earnings, Skill distribution, Employment

1 Introduction

The variation in wage inequality across developed countries has puzzled economists for many years, and different theoretical explanations and empirical evidence have been presented on this issue. Some economists argue that these differences can be explained by supply and demand factors, whereas others emphasize the influence of wage-setting institutions on the wage structure. Consistent with the first theory, the variations in wage inequality across different countries can be explained by variations in skill inequalities. Countries that have more compressed (dispersed) wage structures simultaneously have more compressed (dispersed) skill structures as well (Nickell and Bell 1995;[1] Leuven et al. 2004). According to neoclassical theory, supply and demand factors, skill-biased technical change (SBTC), and globalization are responsible for the

increase in wage inequality in the past decades (Katz and Murphy 1992; Juhn et al. 1993; Katz and Autor 1999; Goldin and Katz 2008; Acemoglu and Autor 2012) and market forces play a more significant role in explaining cross-national differences in wage inequality and return to skill than institutional factors (Gottschalk and Joyce 1998). Since the Anglo-Saxon countries had simultaneously higher wage and skill inequalities compared to continental and Nordic Europe, this was taken as proof of the theory. The reasoning behind this theory is that higher wage inequality is a consequence of higher return to skills. A high skill premium goes along with increased motivation to invest in skill formation (Heckman et al. 1998; Welch 1999) and, consequently, greater supply of highly skilled labor. This explanation, however, fails to explain the high educational attainment in Nordic countries, which exhibit among the lowest rates of wage inequality when compared to other developed countries. Alternative explanation for variation in wage dispersion is based on the variation in wage-setting institutions. Economists who are in favor of this hypothesis stress the importance of decreasing real minimum wages and union membership in order to explain the widening wage gap (Freeman 1991; Freeman and Katz 1994; Blau and Kahn 1996; Bach et al. 2007; Machin 2016). A similar conclusion comes from Dew-Becker and Gordon (2005, 2008), who, in addition to these explanations, identify peer-group behavior as responsible for increasing wage dispersion at the top of the distribution in the USA. Card and DiNardo (2002) reach similar conclusions and also criticize the skill-biased technical change argument as being unable to account for gender and racial wage inequalities and differences in return to education.

Variation in wage inequality in the bottom half of the wage distribution is also often linked to variation in employment in the low-skill sector. According to neoclassical theory, differences in wage dispersion are often credited as an important explanation for differences in unemployment rates. Whereas dispersed wage structure can contribute to employment creation, wage compression in the bottom half of the wage distribution (usually assumed by labor market institutions) can cause unemployment in the low-skill sector (Siebert 1997; Heckman and Jacobs 2010). Due to the skill-biased technical change, relative demand for low-skilled workers in developed countries exhibited a decline; their relative marginal productivity deteriorated (relative marginal productivity of skilled workers rose). However, wage compression and excessively high wages (higher than marginal productivity) at the low end of the wage distribution cut low-skilled workers out of employment. Consequently, countries should allow for higher wage dispersion in the bottom half of the wage distribution and lower wages for the low skilled (institutional reform) which should push their employment levels up. This is in line with a trade-off between efficiency and equality (Okun 1975), according to which it is impossible to achieve high employment and low inequality at the same time. In order to achieve high employment, countries must accept high wage dispersion. By comparing the distribution of wages and employment in Germany and the USA, Siebert (1997) concludes that the relevant policy recommendation to increase employment in Germany at the low end is to allow for dispersed wage structure (higher wage inequality).

High and increasing wage inequality as well as high unemployment in some OECD countries shifted the focus of policymakers to differences in wage dispersion. This paper discusses theoretical and empirical backgrounds of wage compression hypothesis.

The wage compression hypothesis is based on the perfect market model and its rigid assumptions. However, many of these assumptions are flawed—as the empirical analysis of this paper shows. Cross-country differences in wage dispersion cannot be explained by cross-country differences in skill dispersion; educational attainment does not seem to be higher in countries where return to schooling is high, and there is wage dispersion within skill levels, which is in stark contrast with marginal productivity theory. These arguments are in contrast with theoretical foundations of the wage compression hypothesis. Finally, unemployment/e-pops/average hours worked are not correlated with compressed wages. Thus, this paper shows that the wage compression hypothesis is not supported by empirical evidence and therefore challenges the theoretical assumptions it is derived from. The results of this study (although descriptive) have some important consequences for policy-making. Recommended policies for eliminating wage compression, and allowing for higher wage dispersion, are the deregulation of labor market institutions (collective bargaining, unemployment benefits, unions, minimum wages, etc.) and a reduction of public welfare policies. However, since wage compression is not correlated with labor market performance in the low-skilled sector (contrary to the theory), these policy recommendations need to be revised. Moreover, higher wage dispersion is related to major social and health problems, as well as the higher share of low-paid jobs. This study shows that countries that have good labor market performance in the low-skill sector have good labor market performance in general and this is likely due to macroeconomic policies. Consequently, the role of expansionary macroeconomic policies in fostering employment needs to be revisited.

The analysis presented in this paper extends the existing literature by examining these issues. This paper shares the most similarities with the work of Freeman and Schettkat (2001) and Devroye and Freeman (2001). Freeman and Schettkat (2001) examine the wage compression hypothesis based on differences between the USA and Germany in relation to employment. They find that skill compression can only partly explain wage compression. However, the wage compression hypothesis cannot explain the US-German difference in employment. Devroye and Freeman (2001) study the relationship between the distribution of earnings and the distribution of skills and find that skill inequality explains only 7% of wage inequality. Within-skill-group inequality plays a larger role than inequality between skill groups; this contradicts the theory. In contrast to the first two studies that were based on the international literacy survey in the 1990s (International Adult Literacy Survey—IALS), in this paper, a more recent data set is used, with a larger number of countries and larger sample sizes. It is important to check whether the results based on the IALS survey can be confirmed by using the Program for International Assessment of Adult Competencies (PIAAC).

This paper is organized as follows. In Section 2, the data set and data adjustments are presented in more detail. This section is followed by the empirical analysis in Sections 3 and 4. Firstly, international differences in skill levels, wage inequality, and the relationship between skill inequality and wage inequality are examined. In Section 5, the dispersion of wages within skill levels is investigated. Section 6 analyzes the wage compression hypothesis and its effect on employment. Finally, Section 7 concludes.

2 Data description

This analysis is based on the PIAAC data set that was collected between 2011 and 2012 and initiated by the OECD. PIAAC is a unique data set that provides numerous opportunities for research, because it comprises various individual-level indicators of skill competencies, earnings, demographic, and socio-economic characteristics and other internationally comparable information across OECD countries. Since countries' sample sizes are bigger than in previous similar data sets (around 5000 observations per country), such a sample facilitates more comprehensive analysis and better investigation of different subgroups. People were questioned on the basis of a 1.5–2-h interview, which was performed by a specially trained interviewer (tests were done either on computer or on paper). The adult competency skills are measured by literacy, numeracy, and problem solving in technology-rich environments[2] that are central for good performance in the labor market. That is why the skills tested in the survey should be a good proxy for the skills needed in the workplace. According to the test score results, six different proficiency levels are defined. The pooled data set used in this paper contains national representative samples of around 120,000 observations based on working age populations (16–65) from 16 different highly developed core OECD countries. Countries included in the data set are Austria, Belgium[3] (Flanders), Canada, Denmark, Finland, France, Germany[4], Ireland, Italy, Japan, Netherlands, Norway, Spain, Sweden, Great Britain (England and Northern Ireland), and the USA.[5]

The definition of the PIAAC literacy test is as follows: "understanding, evaluating, using, and engaging with written text to participate in society, to achieve one's goals, and to develop one's knowledge and potential." Numeracy assessment is defined as the ability to access, use, interpret, and communicate mathematical information and ideas and to engage in and manage mathematical demands of a range of situations in adult life. Finally, problem solving accounts for "using digital technology, communication tools, and networks to acquire and evaluate information, communicate with others, and perform practical tasks" (OECD 2013a:59).

The correlation coefficient between different test results is slightly lower than in previous test surveys (ALL or IALS) but is still highly positive. The correlation coefficient between numeracy and literacy scores is the highest and equals to 0.89, followed by the correlation coefficient between literacy scores and problem-solving skills (0.79). The smallest correlation coefficient is found between numeracy scores and problem-solving scores in technology-rich environments (0.75). In this analysis, numeracy test scores are used as a measure of skill test results,[6] which is standard in this literature, but further analysis actually showed that the same results are confirmed when literacy test scores are used.[7] For further analysis, it is vital to compare the wage data from the micro data set—the PIAAC survey with the macro data from the OECD database. Figure 1 displays wage inequality taken from both databases, and apart from a couple of outliers (Japan, Italy, and Germany have higher wage inequality; France and the USA have lower wage inequality in the PIAAC survey compared to the OECD database[8]), the micro data seems to correspond well to the aggregate macro data. According to both data sources, ranking of the countries in terms of inequality is almost unaffected. If D9/D5 and D5/D1 are observed, deviations between the data sets are even smaller.

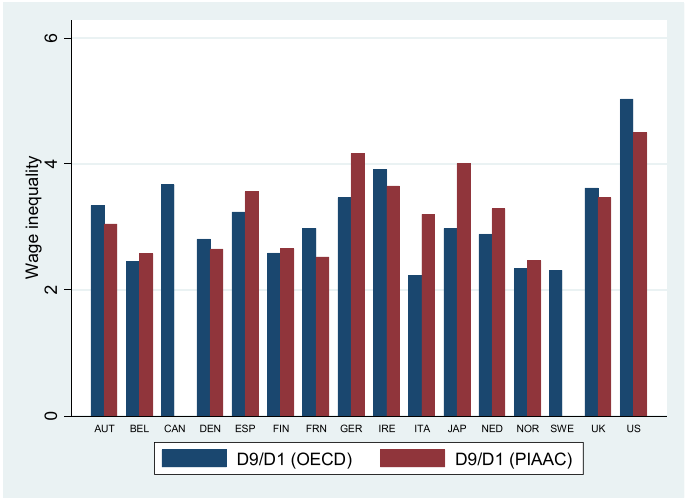

Fig. 1 Wage inequality (D9/D1) for OECD countries, only employed persons. Source: OECD earnings database and PIAAC

3 Skills and wages across OECD countries

3.1 Skill dispersion

According to the OECD database, in the past 30 years, wage inequality has been on the rise in almost all of the OECD countries (see OECD 2011; Jovicic and Schettkat 2013). On the one hand, the increase in inequality has been criticized by many economists; on the other hand, many others have justified this development as a result of the rise in skill inequality (see Section 1). In order to get a better insight on wage inequality and skill inequality, a deeper look into the data set and some descriptive statistics is necessary. Table 1 presents the mean, median, standard deviation, and coefficient of variation of numeracy scores in core OECD countries. If all people are included, independent of their employment status, Anglo-Saxon countries together with France and Spain have the highest dispersion of skills, whereas Japan has the lowest inequality of numeracy skills. In terms of employed persons, the countries with the highest skill inequality among employed workers are the USA, France, and Italy (followed by Canada, the UK, and Ireland). Japan, Finland, and the Netherlands (followed by Denmark and Belgium) have the lowest coefficient of variation of numeracy test results. Coefficients of variation of numeracy scores are higher for all persons than for employed persons in all countries, which implies that the unemployed are likely to be lower skilled than the employed. Another very important conclusion can be drawn from this table. Countries with higher skill inequality exhibit lower average skill scores, whereas the countries with lower skill inequality perform better in terms of average skill scores (mean). If the median is observed instead of the mean, the conclusion is the same. In every country, the median is only slightly higher than the mean; the difference between the two measures ranges between a maximum five points and a minimum two points (the distribution of skills is just slightly skewed to the left). This leaves the ranking of the countries according to their average results unaffected if the median is used (instead of the mean).

Table 1 Mean, median, standard deviation, and coefficient of variation of numeracy scores for all and employed persons

	All persons				Employed			
Country	Mean	Median	St dev.	Var. coef.	Mean	Median	St dev.	Var. coef.
Canada	265.2	269.6	55.60	0.21	271.6	275.0	52.77	0.19
Denmark	278.2	282.0	51.23	0.18	285.7	288.9	47.63	0.17
Finland	282.2	285.8	52.21	0.18	291.3	293.2	47.63	0.16
France	254.1	259.1	56.17	0.22	260.9	265.1	54.42	0.21
Germany	271.7	275.9	53.07	0.20	277.5	280.4	49.71	0.18
Ireland	255.5	259.5	53.66	0.21	264.5	267.0	49.91	0.19
Italy	247.1	249.2	49.99	0.20	255.1	258.0	49.9	0.20
Japan	288.1	290.8	43.98	0.15	292.5	294.7	43.44	0.15
Austria	275.0	278.2	49.29	0.18	279.7	282.8	47.53	0.17
Netherlands	280.3	285.8	51.07	0.18	287.4	291.7	46.99	0.16
Flanders (Belgium)	280.3	284.4	50.59	0.18	286.6	290.2	48.42	0.17
Norway	278.3	283.5	54.21	0.19	285.8	289.9	50.55	0.18
Spain	245.8	250.3	51.32	0.21	257.5	261.3	47.58	0.18
Sweden	279.0	284.0	54.87	0.20	287.2	290.4	50.26	0.17
England/N. Ireland (UK)	261.7	264.9	54.88	0.21	270.9	273.3	51.6	0.19
USA	252.8	256.0	57.03	0.23	260.0	264.0	55.95	0.23

Source: calculations based on PIAAC

In order to develop a better understanding of the cause of the difference in average numeracy score results, one must examine the share of people within different skill levels. Skill levels are defined according to test scores and divided into six different groups. People with the highest scores are assigned to group levels 5 and 4, whereas levels 0 and 1 are the groups with the lowest numeracy scores.[9] Table 2 shows that the countries with the lowest numeracy test scores (and the highest skill inequalities) have the highest proportion of workers in the lowest skill group (below level 1 and at level 1)—Italy, the USA, France, and Spain. Japan, the Netherlands, and Finland (followed by Denmark and Belgium) have the lowest percentage of least skilled workers. These countries, however, also have a slightly higher percentage of people in the highest skill group.[10] According to the PIAAC survey evidence, countries with the highest numeracy test performance simply have more high-skilled workers and fewer low-skilled workers.

Next, we examine differences in performance between different subgroups. Table 3 shows average numeracy test scores according to gender, immigration status, and age groups. The difference between men and women is not large; it varies roughly between 8 points and 12 points. On average, men have slightly higher numeracy test scores than women and this is true for every country. However, since women often demonstrate poorer scores in the quantitative tests, comparing additionally the literacy test results shows that there is almost no difference in the test performance (both men and women have average literacy scores of around 277 points). On the other hand, immigrants[11] have much lower results than non-immigrants—around 35 points less on average. The biggest reason for this is the fact that the test was done in the countries' national languages; immigrants are disadvantaged comparatively to the non-immigrants and often experience difficulty with the foreign language. This may suggest underestimation

Table 2 Share of population in 6 different skill levels, employed persons

	Level 0 + 1	Level 2	Level 3	Level 4 + 5
Country	%	%	%	%
Canada	18.76	32.00	34.84	14.39
Denmark	10.12	28.67	42.11	19.11
Finland	8.18	27.28	41.46	23.08
France	24.31	33.57	31.73	10.4
Germany	14.93	31.59	37.51	15.98
Ireland	20	37.63	32.66	9.71
Italy	26.55	37.59	29.61	6.24
Japan	6.84	26.03	45.35	21.78
Austria	12.11	32.20	40.11	15.57
Netherlands	9.63	27.26	43.34	19.77
Flanders (Belgium)	10.62	27.57	41.36	20.45
Norway	11.03	27.41	40.93	20.63
Spain	23.07	39.75	31.40	5.77
Sweden	10.84	26.97	40.34	21.86
England/N. Ireland (UK)	18.79	33.41	33.82	13.99
USA	25.41	33.43	30.47	10.69

Source: calculations based on PIAAC

of their proficiency skills. The only two countries where the difference is moderately small are Ireland and to some extent Canada. Canada is a large immigration country where immigration and integration policies probably play a big role and contribute to higher language proficiency of immigrants. When age subgroups are compared, the difference is only marginal in almost all groups, aside from the oldest age group. People

Table 3 Mean of numeracy scores in different gender, immigrant and age groups, employed persons

Country	Men	Women	Non-immigrant	Immigrant	Age (16–24)	Age (25–34)	Age (35–44)	Age (45–54)	Age (55–65)	All
Canada	277.32	265.33	275.95	262.5	271.71	281.94	277.63	266.11	258.61	271.6
Denmark	289.96	281.55	289.43	254.26	276.87	290.96	295.59	283.4	275.58	285.7
Finland	297.04	285.93	293.95	235.79	289.11	306.47	296.51	288.9	270.07	291.3
France	265	256.85	267.24	226.17	260.97	276.59	268.15	251.24	237.58	260.9
Germany	283.59	270.89	282.62	255.51	277.74	284.96	286.12	271.59	264.14	277.5
Ireland	270.05	259.66	265.4	261.01	262.43	271.13	270.8	257.91	243.34	264.5
Italy	255.82	254.19	258.65	222.72	232.03	265.66	257.54	252.8	240.83	255.1
Japan	298.07	285.35	292.56	266.98	282.61	301.13	299.47	295.66	275.15	292.5
Austria	285.77	273.26	285.14	254.9	274.1	285.03	285	277.38	269.32	279.7
Netherlands	294.13	280.31	291.8	255.46	287.44	298.73	292.58	282.48	268.82	287.4
Flanders	292.75	280.17	290.08	247.65	278.4	298.8	290.91	282.82	268.42	286.6
Norway	292.16	279.36	291.67	246.83	277.99	289.73	295.24	286.3	272.43	285.8
Spain	263.63	250.8	261.33	230.15	258.98	262.94	264.37	253.4	234.01	257.5
Sweden	292.2	281.69	294.12	255.36	286.57	297.08	293.2	282.35	276.34	287.2
UK	276.96	264.64	275.51	249.84	263.29	279.51	278.94	264.14	261.01	270.9
USA	265.71	253.79	265.64	235.46	249.81	260.34	257.48	250.39	247.07	260.0

Source: calculations based on PIAAC

in the older age subgroups have lower results on average, probably due to the fact that older people tend to forget and experience decline in skills after age 45, but especially after the age of 50, according to Table 3. This is in line with various other studies that dealt with literacy and numeracy skill surveys; however, this might not hold for other skills. In general, wages increase with age, as well as the experience and some experience-related skills. In most countries, the lowest age group also tends to have slightly lower proficiency scores than the age groups from 25 to 45. What stands out is that, in Denmark, Italy, and the USA, these age subgroups have similar results to the oldest age subgroups, which is particularly alarming (especially in the USA and Italy, since they also have very low scores). One reason for this (and comparatively lower young age subgroup results in general) could be that the education systems alone do not produce relevant work-related skills and that the quality of schooling and the standard of education system are deteriorating.

Table 3 reveals some differences between various subgroups; thus, it is reasonable to see whether compositional differences have an effect on average numeracy test scores and dispersion of numeracy test scores. Population subgroups characterized by lower average numeracy test scores were immigrants, followed by the oldest age group and women. Whereas the share of women[12] is comparable across countries, there is considerable variation in the share of immigrants across countries, and this probably affects the average numeracy score results and their dispersion.[13] Some of the countries with a high share of immigrants in the sample are found to have lower average numeracy test scores. Lower average numeracy test scores in Canada, Ireland, the USA, and the UK may be partly explained by higher shares of immigrants whose skills are underestimated due to language difficulties. When immigrants are excluded from the sample, the average numeracy test scores increase in these countries and the coefficient of variation is slightly reduced as well. This is true for every country, but the reduction is the highest in the USA. The USA has the highest dispersion of skills, but this phenomenon can be partly explained by the lower score of immigrants, and suggests that immigration status should be controlled for in the regression analysis. There is also a moderate variation in the share of the oldest age group in the employed population across countries, but this does not appear to affect average scores nor the dispersion of scores considerably.[14]

3.2 Wage dispersion and skill dispersion

In addition to the individual skill scores, the PIAAC data set provides information on hourly wages[15] of employed persons. Table 5 shows the dispersion of numeracy test score results, wages, and years of schooling[16] measured by the coefficient of variation. This data already shows that there is no clear empirical relationship across countries between wage dispersion and numeracy skill dispersion. Countries with the highest dispersions of numeracy test scores are the USA, France, Canada, and the UK, whereas the countries with the lowest dispersions are Japan, the Netherlands, and Finland. In terms of wage inequality, countries with the highest wage dispersion are Japan, the USA, and the UK, and the countries with the lowest wage dispersions are Belgium, Norway, Denmark, and Finland. If there was a strong link between skill dispersion and wage dispersion, the data would be expected to show that the countries with the

highest skill dispersions exhibit the highest wage dispersion and vice versa; this is not always the case here. Additional analysis also shows that the same conclusions hold when wage inequality between different population subgroups is observed. In all the population subgroups examined (men, women, immigrants, non-immigrants, different age subgroups), the countries with the highest wage dispersions are still Japan and the USA, and the countries with the lowest wage dispersions are Belgium and the Scandinavian countries (ranking of the countries remains intact).[17]

In order to develop a more comprehensive view of the relationship between skill dispersion and wage dispersion, in addition to measuring skills by proficiency score results, years of schooling are also included in the analysis. However, when years of schooling is used in the analysis, this must be based on the assumption that 1 year of schooling has the same effect on human capital formation in every country, which is difficult to confirm. International skill proficiency surveys are thus becoming more and more popular, since their comparability is likely to be more reliable. According to the estimates, there is a positive but weak correlation between numeracy test scores and years of schooling—correlation coefficient for the entire PIAAC sample is 0.44 (correlation coefficient varies between 0.36 and 0.60 for individual countries). The fact that years of schooling and numeracy skills are positively correlated is expected, since longer schooling produces higher levels of skills and, at the same time, higher skilled individuals acquire more schooling. However, the rather small size of the correlation is somewhat surprising.[18] One potential explanation is that schooling is related to unmeasured competencies and unobserved non-cognitive skill (or some dimension of cognitive skills other than numeracy skills). Table 5 shows that dispersion of years of schooling is slightly higher or the same as the dispersion of test scores in most countries. The only three countries that have relatively high dispersion in years of schooling are Italy, France, and Spain;[19] countries with the lowest skill dispersion measured by schooling are the UK, Norway, and Germany.

In addition to the distribution of numeracy test scores, years of schooling, and wages, Table 4 reports correlation coefficients between these variables. The correlation coefficient between wages and numeracy scores is positive but ranges between 0.14 and 0.37 only. This could be additional proof that cross-country variation in numeracy scores is not strongly associated with cross-country variation in wages. Although the variable of years of schooling performs a bit better (its correlation to wages is higher and ranges between 0.24 and 0.51), it can hardly confirm the skill compression hypothesis. Possible explanations for why there is a stronger link between years of schooling and wages (than between numeracy test scores and wages) could be that either unmeasured competencies are related to years of schooling or years of schooling is positively associated with wages through the signaling effect—the employer assumes that more schooling is positively correlated with having advanced abilities. It could be that years of schooling has a large effect on wages, without having a large effect on skills measured by numeracy test scores.

In order to conclude the discussion on skill and wage dispersion and get a more comprehensive description of their relationship, in addition to the coefficient of variation, other measures of inequality are examined. Table 6 shows decile ratios (D9/D1, D9/D5, D5/D1[20]) of skill and wage dispersion. Decile ratios reveal additional evidence against

Table 4 Coefficient of variation of average numeracy scores, hourly wages, and years of schooling and their correlation coefficient, employed persons

	Coefficient of variation			Correlation coefficient		
Country	Scores	Wages	Schooling	Scores–wages	Scores–schooling	Wages–schooling
Canada	0.19		0.21		0.42	
Denmark	0.17	0.38	0.20	0.31	0.39	0.46
Finland	0.16	0.38	0.22	0.31	0.43	0.46
France	0.21	0.43	0.29	0.33	0.60	0.37
Germany	0.18	0.52	0.18	0.33	0.46	0.51
Ireland	0.19	0.55	0.19	0.33	0.47	0.36
Italy	0.20	0.53	0.33	0.23	0.41	0.34
Japan	0.15	0.69	0.18	0.26	0.46	0.29
Austria	0.17	0.58	0.22	0.27	0.43	0.38
Netherlands	0.16	0.46	0.19	0.27	0.40	0.45
Belgium	0.17	0.37	0.20	0.32	0.49	0.39
Norway	0.18	0.37	0.17	0.31	0.37	0.42
Spain	0.18	0.53	0.28	0.34	0.51	0.46
Sweden	0.17		0.21		0.39	
UK	0.19	0.61	0.17	0.36	0.36	0.36
USA	0.23	0.67	0.23	0.37	0.55	0.47

Source: calculations based on PIAAC

the skill compression hypothesis. Since wage inequality in the top half of the distribution is higher and varies most across countries (D9/D5 is higher than D5/D1), it was expected that the same would be true for skill inequality. However, Table 5 shows that the opposite is the case. The highest skill inequality and the highest variability in skill inequality are observed for measures of skill inequality in the bottom half of the skill

Table 5 Distribution of individual average numeracy test scores and wages, by country

Decile ratios	Literacy scores			Hourly earnings			
Country	D9/D1	D9/D5	D5/D1	D9/D1	D9/D5	D5/D1	D8/D5
Canada	1.71	1.23	1.39				
Denmark	1.59	1.20	1.32	2.65	1.56	1.70	1.30
Finland	1.59	1.21	1.31	2.65	1.75	1.51	1.44
France	1.79	1.24	1.44	2.52	1.77	1.43	1.43
Germany	1.66	1.21	1.37	4.16	1.91	2.18	1.52
Ireland	1.68	1.23	1.37	3.65	2.11	1.73	1.65
Italy	1.69	1.24	1.36	3.20	1.88	1.70	1.47
Japan	1.48	1.17	1.26	4.01	2.34	1.71	1.74
Austria	1.57	1.20	1.31	3.05	1.81	1.69	1.43
Netherlands	1.58	1.19	1.33	3.29	1.79	1.84	1.47
Belgium	1.60	1.20	1.33	2.58	1.67	1.54	1.38
Norway	1.63	1.20	1.35	2.47	1.60	1.54	1.30
Spain	1.73	1.23	1.41	3.56	2.08	1.71	1.61
Sweden	1.63	1.21	1.35				
UK	1.72	1.24	1.38	3.47	2.08	1.67	1.59
USA	1.81	1.26	1.44	4.5	2.2	2.00	1.78

Source: calculations based on PIAAC

distribution. In every country, skill inequality at the bottom of the distribution is higher than at the top, whereas the opposite holds for wage inequality (the only exceptions are Denmark, Germany, and to some extent the Netherlands where wage inequality in the bottom half of the skill distribution is higher than that in the top half of the distribution). These patterns contradict the skill compression hypothesis, and this conclusion is further confirmed by looking at the last column of Table 5. If the top wage decile is excluded (instead of D9/D5, we look at D8/D5), wage inequality drops significantly in every country. It leads to the conclusion that the primary contributors of high wage inequalities are excessively high wages at the top. These high wages are most likely a consequence of "celebrity" and "managerial" wages, usually caused by peer behavior and rent seeking. This observation contradicts the view that higher wage inequality will do much to improve the outcomes of the people at the bottom, as is promoted by the economists who support the wage compression hypothesis. On other hand, this exercise shows that wages are indeed more compressed in the bottom half of the distribution than in the top half of the wage distribution in all countries (despite more dispersed skills at the bottom). This is a starting point that could offer support for a wage compression hypothesis. In order to investigate if the wage compression hypothesis is correct, and whether compressed wages are related to unemployment, an examination of employment differences between countries is necessary (see Section 6).

Regardless of whether the relationship between skill inequality and wage inequality is measured by decile ratios or coefficient of variation, the relationship is not statistically significant (see Fig. 2). The correlation coefficients[21] are 0.11, 0.24, and 0.19, respectively. Inequality in numeracy test scores is not correlated with wage inequality, and this is why the variation in numeracy skill inequality cannot explain the variation in wage inequality across core OECD countries. The same is true if years of schooling are used as a measure of skill. The relationship between the coefficient

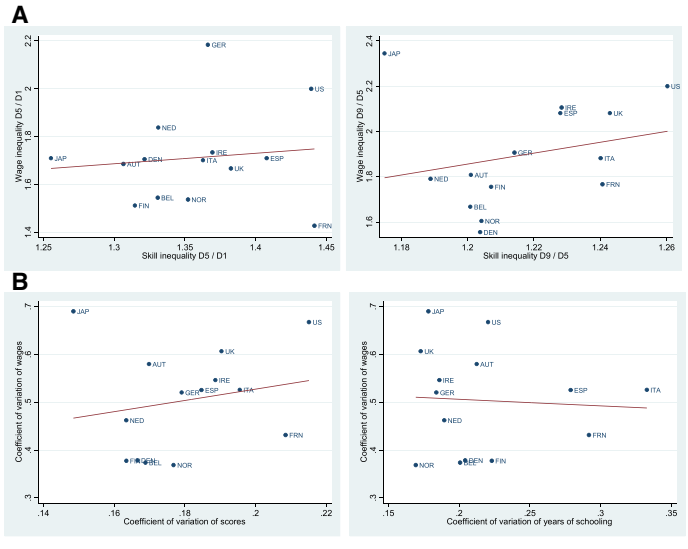

Fig. 2 Relationship between skill inequality and wage inequality, employed persons. **a** D5/D1 and D9/D5 ratios of wages and numeracy test scores, employed persons. **b** Coefficient of variation of wages, skills, and schooling, employed persons. Source: calculations based on PIAAC

of variation of wages and years of schooling is flat—there is no significant relationship between the two; the correlation coefficient is low: −0.06. It does not hold that countries with higher skill dispersion (either measured by numeracy test scores or years of schooling) have higher wage dispersion and vice versa, as the lower panel of Fig. 2 suggests. Countries with similar skill inequality differ significantly in terms of wage inequality. The skill compression hypothesis cannot be confirmed based on the cross-country analysis presented here.

Although there is some criticism (see Broecke et al. 2016), these rather descriptive results are in line with other wage and skill distribution analysis conducted previously with the PIAAC data set (and this is why deeper analysis is not necessary). Paccagnella (2015) investigated the relationship between skill inequality and wage inequality based on PIAAC data and 22 OECD countries. He finds no strong relationship between the two. Based on his decomposition exercise, he concludes that the wage structure effect (differences in the rates of returns to observable characteristics) seems to be more important in explaining cross-country differences in wage dispersion than the composition effect (differences in observable characteristics). Pena (2016) also uses the decomposition method similar to Juhn et al. (1993) and finds that unobservable factors (such as labor and product market institutions) play a major role in explaining cross-country differences in wage dispersion; the effect of skills is rather small. Thus, both papers suggest that institutions are potentially likely to explain a larger share of cross-country differences in wage dispersion.

4 Wage dispersion and return to skills

The wage compression hypothesis is based on the perfect market theory, according to which, wages correspond to marginal productivity. Empirically, wage regression analysis should be able to explain the variation in wages. In this body of literature, Mincer (1958, 1974) was the pioneer in defining earnings as a function of schooling and experience in the log-linear form. The Mincer earnings equation proved to be a big empirical success in labor market economics, and the model is still a good specification for estimating the relationships between schooling, experience, and earnings relatively accurately (see Lemieux 2006). The empirical model that is to be estimated in this paper is based on the Mincer earnings equation and has the following principal form:

$$\ln(\mathrm{w}) = a + bS + cX + dG + eI + u \quad (1)$$

where ln(w) is the natural logarithm of the hourly wage, S corresponds to the qualification level (numeracy test scores or years of schooling, or both), X is experience (defined as years of labor market experience), G is a gender indicator, I denotes immigration status, u is a residual, and a, b, c, d, e are parameters to be estimated.

Table 6 reports the results from OLS regressions of log wage on numeracy test scores and years of schooling in models which include controls for gender, experience, experience squared, and immigrant status (see Eq. 1). Model 1 results show considerable variation across countries. In some countries, an increase in numeracy test scores is associated with higher wages than in other countries. An increase of 100 numeracy score points is associated with a 30% increase in the

Table 6 Regression of log wages on numeracy test scores and years of schooling, employed persons

Model	Model 1		Model 2		Model 3		
Country	Scores	R^2	Schooling	R^2	Scores	Schooling	R^2
Denmark	0.22 (0.01)	0.34	0.06 (0.00)	0.44	0.09 (0.01)	0.06 (0.00)	0.45
Finland	0.24 (0.01)	0.25	0.06 (0.00)	0.38	0.11 (0.01)	0.06 (0.00)	0.40
France	0.30 (0.01)	0.23	0.06 (0.00)	0.32	0.14 (0.01)	0.05 (0.00)	0.34
Germany	0.39 (0.02)	0.28	0.10 (0.00)	0.37	0.18 (0.02)	0.09 (0.00)	0.39
Ireland	0.34 (0.02)	0.23	0.08 (0.00)	0.29	0.20 (0.02)	0.07 (0.00)	0.32
Italy	0.22 (0.02)	0.14	0.06 (0.00)	0.26	0.08 (0.02)	0.05 (0.00)	0.27
Japan	0.34 (0.02)	0.29	0.07 (0.01)	0.31	0.22 (0.02)	0.06 (0.01)	0.33
Netherlands	0.30 (0.02)	0.34	0.09 (0.00)	0.47	0.13 (0.02)	0.08 (0.00)	0.48
Flanders (Belgium)	0.28 (0.01)	0.25	0.07 (0.00)	0.34	0.14 (0.01)	0.06 (0.00)	0.36
Norway	0.21 (0.01)	0.31	0.06 (0.00)	0.39	0.11 (0.01)	0.05 (0.00)	0.41
Spain	0.35 (0.03)	0.18	0.08 (0.00)	0.33	0.15 (0.03)	0.07 (0.00)	0.34
England/N. Ireland	0.40 (0.02)	0.29	0.09 (0.00)	0.29	0.30 (0.02)	0.07 (0.00)	0.36
USA	0.48 (0.02)	0.28	0.11 (0.00)	0.39	0.22 (0.02)	0.09 (0.00)	0.42
Pooled	0.30 (0.01)	0.25	0.07 (0.00)	0.34	0.15 (0.01)	0.07 (0.00)	0.36

Source: calculations based on PIAAC
Note: Controls: experience, experience^2, gender, and immigration status. Tables are available upon request. For the purpose of easier interpretation, numeracy test scores are divided by 100

average wage in the pooled sample across countries. The highest coefficients are in the USA, the UK, Germany, and Spain, and the lowest are in Norway, Italy, and Denmark. If one interpreted these results by saying that skills affect wages significantly in the USA (coefficient = 0.48), one needs to be able to explain why the coefficient is only 0.21 in the case of Norway. Differences in dispersion of numeracy skills explain the differences in dispersion of earnings only partly. Model 2 shows that the coefficient of years of schooling on wages is the highest in the USA (11%), Germany (10%) and the UK, and the Netherlands (9%), whereas the lowest is in Italy, France, and Scandinavia (6%). On average, one extra year of schooling is associated with 7% higher earnings. Once we add both numeracy scores and years of schooling to the model, both coefficients are significant, although the size of the score coefficient drops significantly (from 0.30 to 0.15 in the pooled regression). This is due to the fact that numeracy skills and schooling are correlated (0.45 on average). However, big variation across countries is evident here as well; whereas in most of the countries the skill coefficient drops by around half, in the UK, Ireland, and Norway, it drops less. In this model, the coefficient of years of schooling remains stable at 7% on average. The 1% fall is observed in all countries, except for the UK and the USA, where the drop is equal to 2%. These findings are similar to those of Hanushek et al. (2014)[22].

Once controlled for all factors, why does return to skills vary so much across countries? Although the fact that the coefficients are highest in the first model could lead to the conclusion that the skill compression hypothesis holds, this notion is rejected. Especially in the model where both skills and years of schooling are included, the coefficient for skills drops by half. It might be that schooling affects wages independently from numeracy skills (possibly through the signaling effect). However, it all

leads to the conclusion that there must be something else (in addition to numeracy scores and years of schooling) that affects wage structure significantly and affects wage inequality as well.[23] As mentioned above, if the perfect market theory was correct, wages should be explained by the wage regression and residual should be equal to one. However, Mincer equations explain only 30% of the variation of wages; this either disproves the perfect market hypothesis or increases the relevance of immeasurable skills Schettkat (2008).

5 Dispersion within skill level

While it is often argued that high wage inequality fosters investment in human capital, Agell (1999) claimed that that could be true but only if the wage dispersion is between education levels. However, if there is high wage dispersion within the same education level, wage dispersion serves as a discouragement for educational attainment. Based on similar logic, as among the most convincing evidence that the skill hypothesis does not hold, Devroye and Freeman (2001) used the tables that show that dispersion of wages is much higher within skill levels than between skill levels. If skill determines wages, people at the same skill level should earn similar wages—the highest dispersion should be between different skill levels; within skill levels, there should barely be any significant dispersion. In their analysis based on the IALS data set and four OECD countries, Freeman and Devroye find that this was not the case. We perform the same calculations based on the PIAAC data set. Table 7 records the coefficient of the variation of log wages by six defined numeracy test score levels. The conclusion is the same—wage dispersion within skill levels differs significantly across countries. The highest

Table 7 Coefficient of variation of log wages by score and schooling level, employed persons

	Skill levels				Schooling levels					
Country	L0 + 1	L2	L3	L4 + 5	L1	L2	L3	L4	L5	L6
Canada										
Denmark	0.08	0.08	0.08	0.07	0.10	0.06	0.06	0.05	0.07	0.06
Finland	0.15	0.10	0.12	0.12	0.13	0.11	0.11	0.11	0.11	0.10
France	0.14	0.14	0.14	0.15	0.15	0.13		0.13	0.15	0.13
Germany	0.23	0.23	0.21	0.20	0.28	0.19	0.17	0.16	0.18	0.15
Ireland	0.26	0.18	0.18	0.18	0.20	0.19	0.16	0.18	0.17	0.15
Italy	0.18	0.20	0.17	0.17	0.17	0.17	0.17	0.12	0.18	0.16
Japan	0.06	0.07	0.07	0.07	0.07	0.07	0.06	0.07	0.07	0.07
Austria	0.19	0.19	0.19	0.17	0.22	0.17	0.16	0.14	0.16	0.14
Netherlands	0.15	0.16	0.17	0.17	0.20	0.15		0.11	0.13	0.13
Belgium	0.13	0.12	0.12	0.12	0.12	0.11	0.11	0.11	0.13	0.12
Norway	0.06	0.07	0.06	0.06	0.07	0.06	0.06	0.06	0.06	0.06
Spain	0.21	0.21	0.21	0.19	0.19	0.20	0.20	0.20	0.18	0.17
Sweden										
UK	0.17	0.18	0.19	0.19	0.18	0.19	0.15	0.19		
US	0.18	0.18	0.19	0.19	0.16	0.18	0.17	0.17	0.18	0.16

Source: calculations based on PIAAC

Notes: Schooling levels: 1—lower secondary or less (ISCED 1, 2, 3C short or less); 2—upper secondary (ISCED 3A-B, C long); 3—post-secondary, non-tertiary (ISCED 4A-B-C); 4—tertiary—professional degree (ISCED 5B); 5—tertiary—bachelor degree (ISCED 5A); 6—tertiary—master/research degree (ISCED 5A/6)

dispersions of earnings are in Germany, Ireland, Spain, and the USA for every score level. The smallest dispersions are in Japan, Denmark, and Norway. Countries that have the highest wage dispersion in the lowest skill levels have on average comparatively higher wage dispersions for all skill levels and vice versa. In the second part of Table 7, the same exercise is performed for six different schooling levels.[24] Schooling levels tell the same story. It is interesting to see how countries do not deviate at all in the coefficient of variation of wages. Countries that have among the highest within-skill-level wage dispersion also have the highest within-schooling-level dispersion of wages. The biggest variation is within different schooling levels and not between them, and it is astonishing how this pattern is repeated in every country and on every schooling level. Thus, variation in numeracy skills cannot fully explain the variation in wages. Some other factor (other than numeracy skills and schooling) in these countries and their institutional settings must create these differences.

High wage dispersion within skill and schooling levels is in stark contrast with the marginal productivity theory. Based on the theoretical perfect market model, the marginal productivity theory claims that everybody is paid according to their contribution—to their marginal productivity. The empirical implication of this theory shows that there is the same wage for the same work. Since productivity is difficult to measure, it is necessary to find different proxies that could account for it. The most obvious ones are skills. Stiglitz (2013) commented that he wishes bankers were paid according to their marginal productivity during crisis. Proponents of marginal productivity theory and perfect markets try to defend their theory by claiming that people with the same measurable skills might differ in their immeasurable skills and this is why their wages are different; yet explanations based on monopsonistic labor market seem more plausible (see Manning 2003).

6 Wage compression and unemployment

Since the variation in wage dispersion across countries cannot be fully explained by variation in skill dispersion and its theoretical foundations seem to be flawed, another set of explanations needs to be considered. Some economists stress the importance of variation in wage-setting institutions across countries, for example, minimum wages and unions (Freeman 1991; Freeman and Katz 1994; Blau and Kahn 1996) as the most plausible explanation for cross-country variation in wage dispersion. Before the link between wage dispersion and unemployment is explored, the relationship between wage-setting institutions and wage dispersion is examined. Table 8 shows a clear pattern—there is a significant negative correlation between various wage bargaining institutions and wage inequality. Countries with higher union density and union membership, stronger and more coordinated wage bargaining institutions, and higher minimum wages have lower wage inequality and vice versa. This is in line with other studies based on panel data analysis (Schettkat 2003; Freeman 2007; Salverda and Checchi 2014). It is interesting to observe that the correlation coefficient between wage dispersion and various institutions is much higher than the correlation coefficient between wages and skills (see Section 3). Regrettably, the PIAAC data set does not provide information on union membership of the employees, so more thorough analysis is not possible. However, this data set offers information on employment status which allows us to examine the wage compression hypothesis.

Table 8 Relationship between wage inequality and wage-setting institutions, employed persons, 2011

Institutions/inequality	Minimum wage	Union density	Union membership	Bargaining coordination	Comprehensiveness index[b]
COV	−0.65[a]	−0.78[a]	−0.63[a]	−0.84[a]	−0.78[a]
D9/D1	−0.70[a]	−0.85[a]	−0.61[a]	−0.71[a]	−0.62[a]
D9/D5	−0.72[a]	−0.71[a]	−0.61[a]	−0.86[a]	−0.76[a]
D5/D1	−0.43[a]	−0.67[a]	−0.38[a]	−0.37[a]	−0.32[a]
Gini	−0.66[a]	−0.87[a]	−0.69[a]	−0.78[a]	−0.72[a]

Source: institutions from Schumpeter School International Comparative Institutions Database, for details, see (Jovicic 2015). Wage Inequality from PIAAC

[a]Represents 1% significance level

[b]Comprehensiveness index corresponds to product of bargaining level and bargaining coverage (see Schettkat 2003)

As seen in the previous table, minimum wages and wage-setting institutions are negatively correlated with wage inequality. This is exactly why some economists (neoclassical school of thought) claim that strong institutions cause wage compression, which in turn causes high unemployment among the low skilled (Siebert 1997; Heckman and Jacobs 2010). Due to skill-biased technical change, the relative demand for low-skilled workers declined in the past three decades. In countries with flexible labor markets (and weaker institutions), workers' wages dropped but they remained employed. In countries with rigid markets, institutions prevented the wages of low-skilled workers from falling and therefore these workers lost their jobs. In the first group of countries, an increase in wage inequality contributed to comparatively higher employment. If the wage compression hypothesis was true and differences in wage inequalities across countries can explain differences in employment, we expect to find a positive relationship between wage inequality in the bottom half of the wage distribution and employment among low-skilled workers. This explanation is based on the marginal productivity hypothesis, according to which, wages always correspond to the marginal product of labor. If there is no institutional intervention, the free market leads to solutions in which people earn what they contribute. Setting a wage through various forms of labor market institutions will lead to a higher wage than marginal productivity and higher unemployment subsequently.

In order to get a complete measure of labor market performance, employment to population rates (e-pops), the unemployment rate, and average weekly hours worked per head were calculated from the PIAAC survey or were already available (weekly hours worked). Table 9 shows the correlation matrix for various measures of labor market performance and wage inequality (for all employed persons and all skill levels). The majority of correlation signs are statistically insignificant. No matter which measure of labor market performance is being used, the relationship between labor market performance and wage inequality is insignificant and flat. If we look at the whole sample (regardless of skill level), there seems to be no significant relationship between these measures. In the case of e-pops[25] and unemployment rates, the correlation sign actually contradicts the wage compression hypothesis, although it is insignificant. If skill levels are accounted for, most of the correlations still remain insignificant at a 10% significance level.[26] E-pops, average hours worked, and unemployment rates are not related to wage inequality, either at the top or at the bottom. According to Table 9, and

Table 9 Relationship between wage inequality and labor market performance, employed persons

Employment/wage inequality	D9/D1	D9/D5	D5/D1
E-pop	−0.0049	−0.2587	0.2418
Hours worked	0.3083	0.5045[a]	−0.0382
Unemployment rate	0.2307	0.3357	0.0454
E-pop, skill level 0 + 1	0.2674	0.1685	0.2407
E-pop, skill level 2	0.1263	−0.1451	0.3423
E-pop, skill level 3	0.1304	−0.2086	0.4092
E-pop, skill level 4 + 5	0.0877	−0.2269	0.3358
Hours worked, skill level 0 + 1	0.0772	0.3087	−0.2154
Hours worked, skill level 2	0.2545	0.4557	−0.0646
Hours worked, skill level 3	0.2903	0.5052[a]	−0.0700
Hours worked, skill level 4 + 5	0.4029	0.5713[a]	0.0411
Unemployment rate, skill level 0 + 1	0.2302	0.2940	0.1030
Unemployment rate, skill level 2	0.2364	0.3165	0.0699
Unemployment rate, skill level 3	0.1473	0.2802	−0.0268
Unemployment rate, skill level 4 + 5	−0.3019	−0.0389	−0.4536

Source: calculations based on PIAAC
[a]Represents 10% significance level

analysis based on the core OECD countries, there is no evidence for wage compression hypothesis.

Furthermore, Fig. 3 focuses only on the relationships between wage inequality (D5/D1) and employment for the low-skilled workers and allows additionally observing individual countries. The first diagram in the upper left corner shows a slightly positive (although insignificant) relationship between the D5/D1 wage ratio and e-pops in the lowest skill level. The USA is the country with high wage inequality (D5/D1) that simultaneously has a good performance in terms of employment. However, all three diagrams find no support for the wage compression hypothesis—countries' labor

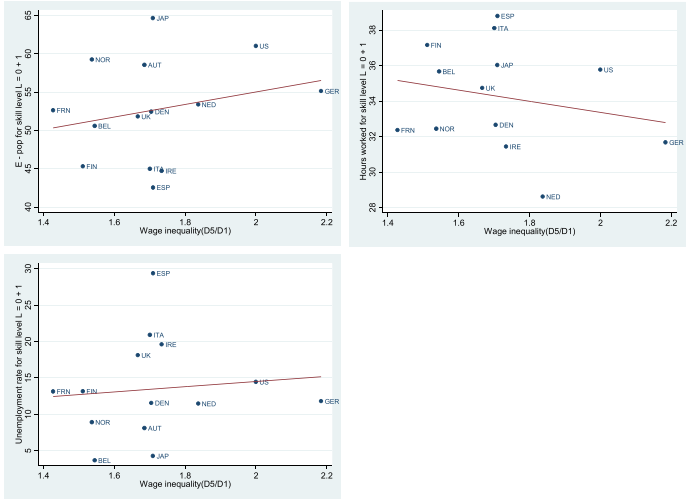

Fig. 3 Wage inequality (D5/D1) and employment for the low-skilled workers. Source: calculations based on PIAAC

market performance in the low-skill sector does not show a relation to wage inequality at the bottom half of the wage distribution; the pattern is rather mixed.

Why do some countries do so well in terms of low-skill employment, whereas others are much less successful in job creation? Can this cross-country variation in employment be explained by cross-country variation in wage inequality? Figure 4 presents e-pops/hours worked per head/unemployment rate for four different skill levels for eight selected countries. Countries are selected according to the lowest (highest) proportion of employed persons in the low-skill group. The diagram displays a very clear pattern. Employment to population rates are highest in high skill level groups, as expected. Countries that have comparatively higher employment

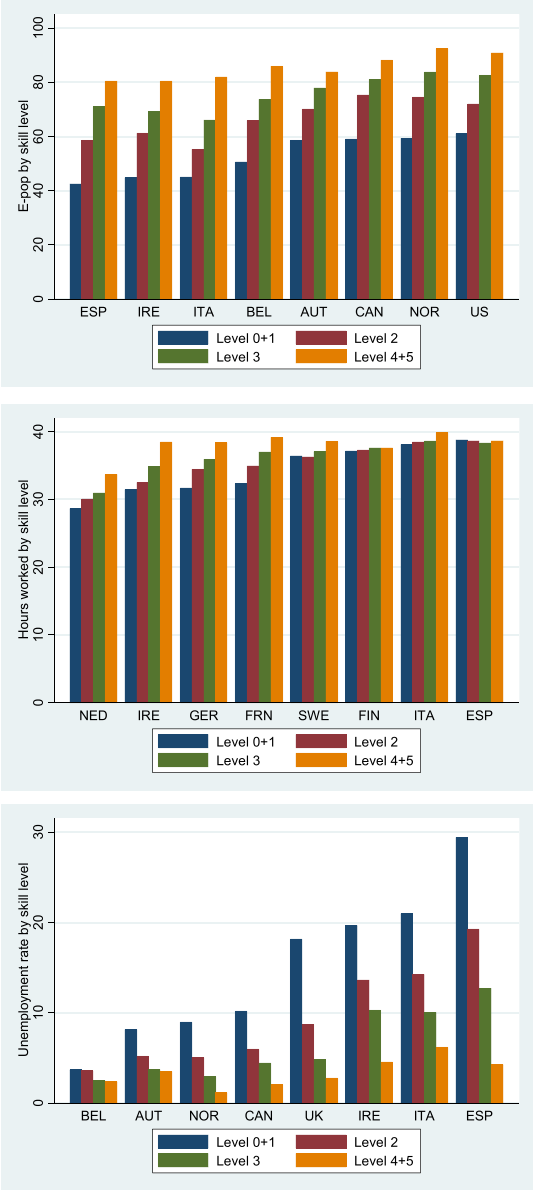

Fig. 4 Employment to population rate for four different skill levels, by country. Source: calculations based on PIAAC

among low-skilled workers (the USA, Norway, and Canada) also demonstrate higher employment in the other skill groups. Countries with the lowest employment among low-skilled workers (Spain, Ireland, and Italy) also have the lowest employment in other skill groups. When wage inequality among these countries is observed, the picture becomes mixed and there is no clear pattern. It rather seems more plausible that some countries are in general more successful in employment creation than others. It is not the low-skill sector and excessively high wages at the bottom of the wage distribution that make the whole difference in the employment performance of the countries but rather something else, e.g., economic policy-making. The only country that does not follow this general pattern is Japan. It has one of the highest e-pops in the lowest skill groups L0 and L1, whereas e-pops in other skill groups are significantly lower. The same story is true for unemployment rates. Only at the highest skill levels is unemployment low everywhere with no pattern across countries—high-skilled workers have low unemployment rates in all countries (under 6%). However, all other countries exhibit either high or low unemployment, regardless of the skill level. Average hours worked per head do not seem to vary much at different skill levels in Spain, Italy, Finland, and Sweden. In other countries, higher skills are related to higher number of hours worked and they are especially high for the highest skill workers. Even in countries with flexible wages in the bottom half of the wage distribution, average hours worked for low-skilled workers are lower than hours worked for high-skilled workers and well paid. Germany, the Netherlands, and Ireland have at the same time the highest wage dispersion in the bottom half of the wage distribution and the lowest average hours worked in the low-skill sector, which is not in line with theory. It is actually in Finland (low inequality country) in which there is no difference in the average weekly hours worked across skill groups.

Finally, in order to perform an additional check, the mean and median score results between the employed and unemployed across countries are compared. If the wage compression hypothesis was true, it would be expected that, in the countries with rigid labor markets and low inequality, the pool of unemployed consists mainly of low-skilled workers. At the same time, countries with flexible labor markets are expected to have much higher employment in the low-skilled sector[27] (and low skilled should not be unemployed).[28] Table 10 shows the mean, median, and standard deviation of numeracy skill scores by labor force status. Employed persons in the USA, the UK, Spain, and Italy have lower average scores than the unemployed in Japan, Belgium, Finland, Denmark, and the Netherlands. Since the latter countries (apart from Japan) have at the same time a more compressed wage structure, low-skilled people in these countries should be unemployed (on the basis that their wage is too high). Indeed, some of these less unequal countries do demonstrate low employment at the bottom. But these workers are not unskilled; their average score results are too high, as the data suggests. The data actually shows that the unemployed in these countries have higher average scores than the employed in some other countries. On the other hand, in the first group of countries, where wage flexibility is higher, the employment of low-skilled workers should be higher. However, the unemployed do have very low average skill scores, which is contradictory to the wage compression hypothesis. Furthermore, in Japan, there is almost no difference in the average score results between the employed

Table 10 Mean and standard deviation of numeracy skill scores by labor force status

	Employed			Unemployed			Out-of-labor force		
Country	Mean	Median	sd	Mean	Median	sd	Mean	Median	sd
Canada	271.66	275.03	52.77	249.22	253.41	54.96	244.41	249.26	60.18
Denmark	285.54	288.93	48.64	265.43	268.74	50.13	256.54	258.59	53.32
Finland	289.70	291.94	48.45	271.21	275.33	56.99	263.58	268.26	56.19
France	261.14	265.48	54.22	244.86	248.02	53.51	241.27	247.33	58.27
Germany	278.43	282.07	49.97	248.43	248.90	49.07	251.74	255.49	58.35
Ireland	264.35	266.99	50.17	246.98	250.29	50.12	240.18	246.60	57.65
Italy	255.00	257.20	49.31	236.38	241.41	50.62	237.33	239.22	48.62
Japan	291.03	293.52	43.99	285.69	285.76	43.80	280.17	283.01	43.01
Austria	279.78	282.81	47.53	265.33	269.37	51.86	261.41	264.63	51.58
Netherlands	286.86	291.30	47.38	264.84	270.00	56.89	258.45	264.04	56.41
Belgium (Flanders)	287.18	290.62	48.64	278.17	277.92	49.09	263.51	268.61	51.53
Norway	285.05	289.47	51.31	256.80	262.47	55.71	252.44	258.59	57.47
Spain	256.24	259.84	47.77	234.72	238.83	50.43	229.33	236.39	53.53
Sweden	287.22	290.41	50.26	255.12	263.08	59.44	256.62	264.86	60.57
England/N. Ireland (UK)	269.80	272.30	51.69	236.61	238.70	55.69	244.25	246.64	57.51
USA	260.04	264.03	55.95	235.63	236.30	46.89	232.21	235.90	58.14

Source: calculations based on PIAAC

and unemployed, which is again evidence against the wage compression hypothesis. The average score results of people out of the labor force are comparable to those of the unemployed people with a minor variation in the number of score points in both directions.

But then again, who are the employed, unemployed, and out-of-labor force? Are the subgroups of these three pools of people somehow different and can they reveal important insights? Data shows[29] that on average (in the pooled sample) there is no large difference between men and women—they are almost equally represented in both pools of the employed and unemployed. The share of men in the employed population is slightly higher than the share of women—their share varies between 52 and 54% in almost every country, with the notable exceptions of Italy and Japan where the share of men in the employed population is 60 and 58%, respectively. However, on average, the people who make up the out-of-labor force are more likely to be women (60%), compared to only 40% men in this group. This share is even higher in Japan, Italy, the Netherlands, the USA, and the UK, where women's participation in the labor market is lower than men's, possibly while they engage more in the household activities and parenthood and due to social norms. Only in the Scandinavian countries does there seem to be almost no gender difference in this regard. When it comes to immigration status, immigrants are only slightly more present in the pool of the unemployed compared to the pool of the employed and the out-of-labor force, relative to the non-immigrants. The main conclusion about the age subgroups is that unemployment is gradually decreasing with age across all countries. The pool of people out of the labor force is mainly represented by the lowest and highest age subgroups (age groups 1 and 5), and these two groups together account for around 60% of those out-of-labor forces on average.

Challenges to the validity of the wage compression hypothesis have been made in earlier cross-country empirical work (Glyn et al. 2006; Howell et al. 2007; Jovicic and Schettkat 2013), which found no evidence of a relation between wage compression (strong institutions) and unemployment. There are also a number of studies based on micro data that could not explain the high European unemployment rates with institutional rigidity (Card et al. 1996; Krueger and Pischke 1997). At the same time, some other economists were insisting on exploring the aggregate demand deficiency and macroeconomic policies as a potential explanation for employment differences across countries (see Solow 2008; Krugman 2009; Schettkat and Sun 2009; Wolf 2014). However, this evidence appears to have been ignored, and the deregulation of welfare-state institutions remained the main policy recommendations even today in Europe.

6.1 Share of low-paid jobs

It is doubtful that countries with rigid labor market institutions and rigid wages at the bottom of the distribution have low employment among the low-skilled workforce, as the previous analysis showed. What are the consequences of compressed wage structures? Figure 5 shows the share of low-paid jobs, where low pay is defined as 2/3 of the median wage in OECD countries. The countries with the highest share of low-paid jobs are Germany, the USA, Japan, and the UK. Not surprisingly, these are the countries where the dispersion of the wages in the bottom half of the wage distribution is relatively high. (Alternatively, the USA has a relatively high employment among low-skilled workers, but this is certainly not the case for the rest of the countries.) The high share of low-payed jobs was not enough to produce high employment in the low-skill sector in Japan, the UK, and Ireland. On the other hand, Norway managed to maintain well-paid jobs and high employment at the same time. The only certain result of the wage flexibility hypothesis is that there is a higher share of low-paid jobs. Proponents of the low-pay policy claim that this is still better than unemployment. This paper, however, finds no evidence for the wage compression hypothesis.

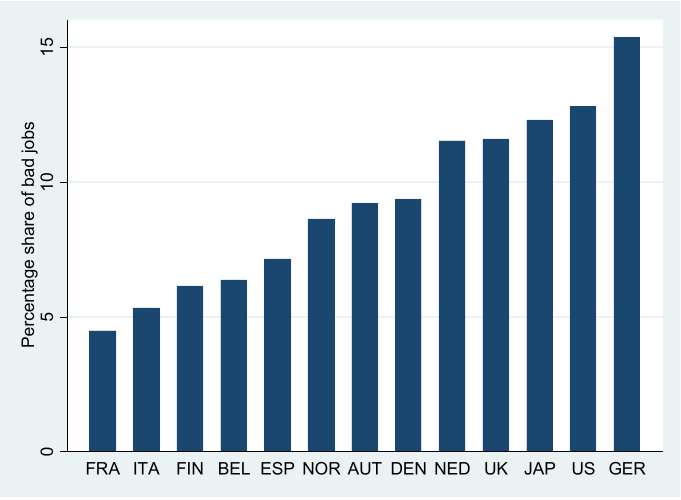

Fig. 5 Share of low-paid jobs measured as two thirds of median wage, employed persons. Source: calculations based on PIAAC

7 Conclusions

Based on the PIAAC adult skill survey, this paper examined international differences in wage inequality and skills and whether a compressed wage distribution is associated with high unemployment across core OECD countries. Although both the skill compression and wage compression hypotheses have strong theoretical backgrounds, none of them could be empirically verified based on this cross-country study. Firstly, there is a large variation in wage dispersion across countries, but its correlation to variation in skill dispersion is rather weak. Even when accounted for skills, some countries have a more compressed wage structure. Instead, it seems plausible that the other set of explanations in terms of institutions have more power in explaining these differences. According to this analysis, the correlation between various measures of institutions and wage inequality is significantly higher than the correlation between skill inequality and wage inequality. However, in order to confirm this finding, a more detailed analysis is required. Secondly, relative employment performance of low-skilled workers is not worse in countries where the wage premium for skill is more rigid (lower wage inequality). Countries that do well in this sector in terms of employment perform well in general (in all the other groups as well), which is independent from the level of wage inequality. On average, countries that have higher e-pops, higher hours worked, and a lower unemployment rate do not have high wage inequality, either at the top or at the bottom of the wage distribution. The only certain result of wage flexibility is that there is a higher share of low-paid jobs (but this high share of low-paid jobs does not appear to be related to high employment).

These results (although descriptive) have some important implications for policy-making. Based on the perfect market model, marginal productivity theory, skill compression and wage compression hypotheses, etc., institutional reform (which should lead to higher wage dispersion) was considered as the appropriate policy response to increase competitiveness, output, and employment (see OECD 1994; IMF 2003). When not distressed by regulation and public policy, markets should lead to wages that correspond to marginal productivity and full employment should follow. Compressed wages are seen as a likely cause of high unemployment, especially in the low-skill sector; consequently, permitting higher wage dispersion should stimulate employment. The same thinking, grounded on the equity-efficiency trade-off, is guiding austerity measures and reductions in public services in the EU today. This study challenges both hypotheses and the theoretical assumptions they are derived from; it calls for a revision of current policies. Rather than insisting on a deregulation of labor market institutions as the main policy recommendation to achieve higher employment (and higher wage inequality), policymakers should reconsider demand deficiency and macroeconomic policies as potential explanations for the employment differences across countries (see Solow 2008; Krugman 2009; Schettkat and Sun 2009; Wolf 2014). Consistent with this view, expansionary macroeconomic policies—stimulative demand policies—might be necessary in order to achieve high employment and low unemployment. Moreover, high inequality is correlated to major health and social problems, e.g., crime, violence, anxiety, mental illness, obesity, infant mortality, and imprisonment rates (see Wilkinson and Pickett 2009). The causation behind these correlations is subject to further scrutiny however (see Salverda et al. 2014). Not only do high wage

dispersions have negative consequences on societies, but this study also shows that wage dispersion is not vital for better labor market performance.

This study builds on the previous work of Devroye and Freeman (2001) and Freeman and Schettkat (2001), who performed similar analysis based on the IALS literacy survey from 1998 and two (four) countries. These findings, based on the more recent literacy survey (PIAAC) and core OECD countries, are in line with their findings and confirm their results. However, one must acknowledge that literacy surveys have their limitations; they capture a narrow measure of skills. Furthermore, the evidence presented here is rather descriptive. Yet, if the skill compression and wage compression hypotheses were true, even descriptive cross-country analysis would be expected to show that there are correlations and patterns between the variables of interest. The evidence presented herein illustrates that this is certainly not the case.

Endnotes

[1]In their paper, however, skills are measured by years of schooling and not by competency test scores.

[2]Problem solving is not measured in France, Italy, and Spain.

[3]Belgium is represented by its subunit Flanders. It is the most developed part of the country, with the lowest unemployment rate, and it cannot be considered as a representative for the whole country. It is important to keep this in mind when interpreting the study results.

[4]For Germany, the USA, and Austria, we obtained a Scientific-Use-File from their national centers (GESIS—Leibniz Institute for the Social Sciences, American Institutes for Research, and Statistics Austria, respectively). For Canada and Sweden, information about continuous earnings is not available.

[5]National samples are weighted to population in the relevant time period.

[6]The PIAAC sample design requires using plausible values of score technique which is used through the whole analysis.

[7]These are available on request.

[8]The OECD earnings database collects data on gross earnings of full-time dependent employees which are usually taken from household surveys.

[9]Skill levels are defined according to numeracy score results in the following way: L0 < 176; L1 = 176–226; L2 = 226–276; L3 = 276–326; L4 = 326–376; L5 > 376 points.

[10]The share of population in skill groups L0 and L5 is very low and not representative; that is why they are observed together with groups L1 and L4.

[11]Immigrants include first-generation immigrants. Quick tabulation shows that around 76% of the immigrants are not native speakers. Being a native speaker is highly correlated with higher scores in every country. On average, native speakers have 40 points higher scores than non-native speakers.

[12]The share of women in the employed population varies between 46 and 49% in almost all countries, with the notable exceptions of Italy and Japan where the share of women in employed population is relatively small—around 40%.

[13]The share of immigrants varies between less than 1% in Japan and 32% in Canada.

[14]Japan, Finland, and Sweden have the highest share of the oldest age group (more than 20%), but in these countries, the oldest age groups have relatively high

scores. On the other hand, Austria, Ireland, Italy, and France have small shares of the oldest age groups, but these countries do not have high average scores.

[15]Wage and salary earners could choose among reporting their earnings per hour, day, week, 2 weeks, month, or year or by piece rate. There was also an option for respondents to report their earnings in broad categories which was especially attractive for those who knew only roughly how much they earn. These novelties improved the data quality and willingness to report earnings (for more details, see OECD 2013a, b).

[16]Certainly the most widely used measure of skill in human capital literature is years of schooling. Years of schooling are easy to measure, and they are easily available for researchers. For a long time, this was probably the only measure of skills, since international comparative surveys of skills were first done in the 1990s.

[17]In the pooled sample, coefficient of variation does not seem to vary between men, women, immigrants, and non-immigrants. However, wage dispersion is the highest in the youngest and oldest age subgroup, and it is decreasing with the decrease of the age in the rest of the groups. The same is true for D9/D5 and D5/D1. Additionally, D5/D1 is slightly higher for men and immigrants than for women and non-immigrants.

[18]Additional analysis shows that there is no difference in the correlation coefficient between gender, age, and (non-) immigrant subgroups. The correlation coefficient in all the subgroups varies between 0.41 and 0.48 in the pooled sample.

[19]France, Italy, and Spain have the highest dispersion of years of schooling mainly due to the high dispersion in the bottom half of the distribution (comparative to the other countries). These three countries have the highest shares of employed persons with the lowest number of years of schooling (5 or 6) in the overall employed population—France (almost 14%), Italy (5%), and Spain (14%). Moreover, France and Italy are the only two countries in the sample in which there are people that acquired 5 years of schooling only.

[20]Decile is any of the nine values that divides the sorted data into ten equal parts so that each part represents 1/10 of the sample or population. The decile ratio is an indicator of dispersion; it is calculated by dividing the ratio of the 9/5th decile by the 5th/1st decile of skill scores and hourly earnings of an employed person.

[21]Wage and skill inequality measured by D9/D1, Gini coefficient, and Theil index also show that there is no strong relation. Their correlation coefficients are 0.09, 0.05, and 0.02, respectively.

[22]Hanushek et al. (2014) examined return to skills based on the PIAAC data set and found significant heterogeneity between the countries. Returns to skills (associated with a one-standard-deviation increase in measured numeracy test scores) vary between 12 and 15% in Nordic countries and 28% in the USA. Furthermore, returns to skill are lower in countries with higher union density, stricter employment protection, and a larger public sector.

[23]It could also be that schooling reflects wider range of skills, but this analysis is limited to numeracy skills only.

[24]L1—lower secondary or less; L2—upper secondary; L3—post-secondary, non-tertiary; L4—tertiary professional; L5—tertiary bachelor; L6—tertiary master degree

[25]The employment to population rate refers to the percentage share of employed persons in the total working age population.

[26]The only correlation that is of weak significance (at only a 10% significance level) is the one between hours worked per head and wage inequality at the upper part of the distribution. More hours worked are related to higher wage inequalities at the top.

[27]Analysis shows that there is no correlation between the relative deviation of scores between the employed and the unemployed and the wage dispersion in the low-skilled sector (D5/D1), which is not in line with the wage compression hypothesis.

[28]Surely, there will always be some frictional unemployment, but it exists in all skill groups.

[29]All tables and graphs are available upon request.

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The IZA Journal of European Labor Studies is committed to the IZA Guiding Principles of Research Integrity. The author declares that she has observed these principles.

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References

Acemoglu D, Autor D (2012) What does human capital do? A review of Goldin and Katz's the race between education and technology. J Econ Lit 50(2):426–463
Agell J (1999) On the benefits from rigid labour markets: norms, market failures, and social insurance. Econ J 109:F143–F164
Bach S, Corneo G, Steiner V (2007) From bottom to top: the entire distribution of market income in Germany, 1992–2001. DIW discussion paper 683. German Institute for Economic Research, Berlin
Blau F, Kahn L (1996) International differences in male wage inequality: institutions versus market forces. J Polit Econ 104(4):791–837
Broecke S, Quintini G, Vandeweyer M (2016) Wage inequality and cognitive skills: re-opening the debate. NBER working paper 21965. National Bureau of Economic Research, Cambridge
Card D, DiNardo J (2002) Skill-biased technological change and rising wage inequality: some problems and puzzles. J Labor Econ 20(4):733–783
Card D, Kramarz F, Lemieux T (1996) Changes in the relative structure of wages and employment: a comparison of the United States, Canada and France. NBER working paper 5487. National Bureau of Economic Research, Cambridge
Devroye D, Freeman RB (2001) Does inequality in skills explain inequality in earnings across advanced countries? NBER working paper 8140. National Bureau of Economic Research, Cambridge
Dew-Becker I, Gordon R (2005) Where did the productivity growth go? Inflation dynamics and the distribution of income. NBER working paper 11842. National Bureau of Economic Research, Cambridge
Dew-Becker I, Gordon R (2008) Controversies about the rise of American inequality: a survey. NBER working paper 13982. National Bureau of Economic Research, Cambridge
Freeman RB (1991) How much has de-unionization contributed to the rise in male earnings inequality? NBER working paper 3826. National Bureau of Economic Research, Cambridge
Freeman RB (2007) Labor market institutions around the world. NBER working paper 13242. National Bureau of Economic Research, Cambridge
Freeman RB, Katz LF (1994) Rising wage inequality: the United States vs. other advanced countries. In: Freeman R (ed) Working under different rules. Russell Sage, New York
Freeman RB, Schettkat R (2001) Skill compression, wage differentials and employment: Germany vs the US. Oxf Econ Pap 3:582–603
Glyn A, Howell D, Schmitt J (2006) Labor market reforms: the evidence does not tell the orthodox tale. Challenge 49(2):5–22
Goldin C, Katz LF (2008) The race between education and technology. Harvard University Press, Cambridge
Gottschalk P, Joyce M (1998) Cross-national differences in the rise in earnings inequality: market and institutional factors. Rev Econ Stat 80(4):489–502
Hanushek EA, Schwerdt G, Wiederhold S, Woessmann S (2014) Returns to skills around the world: evidence from PIAAC. OECD education working papers 101. OECD Publishing, Paris
Heckman J, Jacobs B (2010) Policies to create and destroy human capital in Europe. NBER working paper 15742. National Bureau of Economic Research, Cambridge
Heckman J, Lochner L, Taber C (1998) Explaining rising wage inequality: explorations with a dynamic general equilibrium model of labor earnings with heterogeneous agents. Rev Econ Dyn 1:1–58
Howell D, Baker D, Glyn A, Schmitt J (2007) Are protective labor market institutions at the root of unemployment? Crit Rev Evid Capital Soc 2:1–73
IMF (2003) World economic outlook. IMF
Jovicic S (2015) Schumpeter School International Comparative Institutions Database. Schumpeter discussion papers 2015-001. University of Wuppertal library, Wuppertal
Jovicic S, Schettkat R (2013) Does inequality promote employment? An international comparison. Schumpeter discussion papers 2013-010. University of Wuppertal library, Wuppertal
Juhn C, Murphy K, Pierce B (1993) Wage inequality and the rise in returns to skill. J Polit Econ 101(3):410–442

Katz L, Autor DH (1999) Changes in the wage structure and earnings inequality. In: Ashenfelter O, Card D (eds) Handbook of labor economics., pp 3A:1463–1555
Katz L, Murphy K (1992) Changes in relative wages, 1963–1987: supply and demand factors. Q J Econ 107(1):35–78
Krueger A, Pischke J (1997) Observations and conjectures on the US employment miracle. NBER working paper 6146. National Bureau of Economic Research, Cambridge
Krugman P (2009) How did economists get it so wrong?., Available via NY Times. http://www.nytimes.com/2009/09/06/magazine/06Economic-t.html?pagewanted=all Accessed Mar 2015
Lemieux T (2006) The "Mincer Equation" thirty years after schooling, experience, and earnings. In: Grossbard S (ed) Jacob Mincer a pioneer of modern labor economics. Springer US, New York
Leuven E, Oosterbeek H, Van Ophem H (2004) Explaining international differences in male wage inequality by differences in the demand and supply of skill. Econ J 114:466–486
Machin S (2016) Rising wage inequality, real wage stagnation and unions. In: Cappellari L, Polachek SW, Tatsiramos K (eds) Inequality: causes and consequences, research in labor economics, 43rd edn., pp 329–354
Manning A (2003) Monopsony in motion: imperfect competition in labor markets. Princeton University Press, Princeton
Mincer J (1958) Investment in human capital and personal income distribution. J Polit Econ 66(4):281–302
Mincer J (1974) Schooling, experience, and earnings. NBER, New York
Nickell S, Bell B (1995) The collapse in demand for the unskilled and unemployment across the OECD. Oxf Rev Econ Policy 11(1):40–62
OECD (1994) Jobs study. OECD, Paris
OECD (2011) Divided we stand: why inequality keeps rising. OECD Publishing, Paris
OECD (2013a) OECD skills outlook. OECD Publishing, Paris
OECD (2013b) Technical report of the survey of adult skills (PIAAC). OECD Publishing, Paris
Okun A (1975) Equality and efficiency: the big tradeoff. Brookings Institution, Washington
Paccagnella M (2015) Skills and wage inequality. Evidence from PIAAC. OECD education working papers No.114. Directorate for Education and Skills, OECD, Paris
Pena A (2016) PIAAC skills and economic inequality, Journal of Research and Practice for Adult Literacy, Secondary, and Basic Education 5(2):17–34
Salverda W, Checchi D (2014) Labour-market institutions and the dispersion of wage earnings. IZA discussion paper 8220. Institute for the Study of Labor, Bonn
Salverda W, Nolan B, Checchi D, Marx I, McKnight A, György Tóth I, Van de Werfhorst H (eds) (2014) Changing inequalities in rich countries: analytical and comparative perspectives. Oxford University Press, Oxford
Schettkat R (2003) Koordination von lohnverhandlungen. Mitt Arbeitsmarkt Berufsforsch 36(4):634–648
Schettkat R (2008) Lohnspreizung: Mythen und Fakten. Boekler Forschungsmonitoring 2, Hans Boeckler Stiftung
Schettkat R, Sun R (2009) Monetary policy and European unemployment. Oxf Rev Econ Policy 25(1):94–108
Siebert H (1997) Labor market rigidities: at the root of European unemployment in Europe. J Econ Perspect 11(3):37–54
Solow R (2008) Broadening the discussion of macroeconomic policy. In: Schettkat R, Langkau J (eds) Economic policy proposals for Germany and Europe. Routledge Taylor & Francis Group, London and New York
Stiglitz J (2013) How America as land of opportunity has vanished., INET video
Welch F, (2009) In Defense of Inequality. Am Econ Rev 89(2):1–17
Wilkinson R, Pickett K (2009) The spirit level: why more equal societies almost always do better. Allen Lane, London
Wolf M (2014) The curse of weak global demand., Available via Financial Times, https://www.ft.com/content/3e4be7f8-6e4b-11e4-afe5-00144feabdc0 Accessed Mar 2015