The role of between- and within-occupation differences in wage inequality trends in Europe (2002-2018)

JRC Working Papers Series on
Labour, education and Technology
2024/01

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LABOUR EDUCATION TECHNOLOGY

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JRC137944

Seville: European Commission, 2024

How to cite this report: Orfao, G., Fernández-Macías, E. and Malo, M.A., *The Role of Between- and Within-Occupation Differences in Wage Inequality Trends in EU-28 Countries (2002-2018)*, JRC Working Papers on Labour, Education and Technology 2024/01, European Commission, Seville, 2024, JRC137944.

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Abstract

This working paper presents a comparative analysis of the role played by occupational changes in recent wage inequality trends in six European countries between 2002 and 2018. Using the European Union Structure of Earnings Survey, the analysis shows two patterns in the share of wage inequality explained by between-occupation differentials: while the relative importance of between-occupation trends has grown in Finland and the UK, it has diminished in Spain, France, Poland and Romania. Although between-occupation differentials account for a great share of total wages' variance, changes in the occupational structure (in particular, the patterns of job polarisation and upgrading widely discussed in the literature) have not driven recent wage inequality trends in Europe. Wage inequality, instead, has been mostly driven by changes in wage differentials within occupations. Finally, we found that occupations effectively account for the distribution of wages, yet their explanatory significance markedly declines at the highest wage tiers. This work contributes to a better understanding of how within- and between-occupation differences have influenced wage inequality trends in Europe. Consequently, our results add significant value to the debate about recent stratification theory, which has challenged the idea that occupations structure economic disparities and wage inequality as importantly as they once did.

Keywords: Europe, jobs, occupational structure, occupations, wage inequality.

Joint Research Centre reference number: JRC137944

Related publications and reports:

Mariscal-De-Gante, Á., Palencia Esteban, A., Grubanov-Boskovic, S. and Fernandez Macias, E., Feminization, ageing and occupational change in Europe in the last 25 years, JRC Working Papers Series on Labour, education and Technology 2023/04, European Commission, 2023, JRC132328. https://publications.jrc.ec.europa.eu/repository/handle/JRC132328

Torrejon Perez, S., Hurley, J., Fernandez Macias, E. and Staffa, E., Employment shifts in Europe from 1997 to 2021: from job upgrading to polarisation, JRC Working Papers Series on Labour, Education and Technology 2023/05, European Commission, 2023, JRC132678. https://publications.jrc.ec.europa.eu/repository/handle/JRC132678

Acknowledgements

This work has been supported by the Joint Research Center of the European Commission [JRC/SVQ/2023/VLPV/2903]; and the Junta de Castilla & León co-funded by the European Social Fund under grant [EDU/601/2020 to G.O.]. We also acknowledge Eurostat for the data provided to develop the research proposal RPP 328/2023-SES.

Executive summary

This working paper presents a comparative analysis of the role played by occupational changes in recent wage inequality trends in six European countries between 2002 and 2018. In particular, the analysis considers the changes in the occupational structure, the evolution of main inequality indices and the variations in the relative weight of both within- and between-job differentials in explaining wage inequality.

Policy context

European labour markets are continuously undergoing shifts in their occupational structures. Technological changes and international trade have driven a diversity of patterns of occupational change in Europe, including the polarisation, upgrading and downgrading processes. At the same time, wage inequality has grown in many of these economies, especially since the 1980s. This raises the question of whether the trend in wage inequality can be at least partly driven by occupational changes.

Key conclusions

There has been a decrease or stagnation of wage inequality in all European countries with the exception of Finland between 2002 and 2018. The role of occupations grew significantly in Finland and the UK, while their relative weight decreased in Spain, France, Poland and Romania. However, we conclude that, in general, occupational dynamics did not drive recent trends in wage inequality in Europe since within-job differentials overshadowed their effect. Our findings support the idea that occupations no longer structure economic disparities and wage inequality as importantly as they once did. Even considering that occupations have gained relatively more weight in wage inequality trends in some EU countries, such as Finland and the UK, our results are more in line with the argument that trends in wage inequality are mostly driven by differences within-occupation for the bulk of European countries followed by changes in the mean wages of occupations.

Main findings

The Theil decomposition results reveal that there are different patterns in the share of wage inequality explained by between-occupation differences. While the role of occupations grew significantly from 2002 to 2018 in Finland and the UK, their relative weight decreased in Spain, France, Poland and Romania. These findings confirm that there is no unique trend in terms of the role of occupations in the development of wage inequality in Europe. The evolution of both within and between components suggests that occupational change, which differs considerably across EU countries, had a positive effect on wage inequality trends. However, the negative effect of changes in within-occupation differentials and the mean wages of occupations were more substantial, and more relevant for explaining recent wage inequality trends.

Between-occupation differentials account for around 35-60 percent of total wages variance. However, significant differences are found by country. While in Spain and France occupations explain about a 35-40% of this variance, in Poland and Romania, they explain up to a 45-50%. Moreover, in Finland and the UK, the wage variance accounted for by occupations reaches values of up to 60%. Finally, occupations play a significant role in the distribution of the wages of most workers, but a marginal one in the distribution of very large wages.

1 Introduction

The aim of this paper is to analyse whether occupational changes have driven wage inequality trends over recent decades in Europe. European labour markets, like those of any other part of the world, are continuously undergoing shifts in their occupational structures. According to many US studies, technological changes and international trade have driven a polarisation of employment, or in other words, a relative increase in the demand for low- and high-skilled workers relative to those in the middle (Wright and Dwyer, 2003; Autor, 2015; Autor et al., 2006). This evidence is more mixed for Europe, where some studies find pervasive polarisation (Goos et al., 2009), some mostly upgrading (Oesch and Piccitto, 2019), and some a diversity of patterns of occupational change (Eurofound, 2017; Torrejón-Pérez et al., 2023). Outside Europe and the U.S., the pattern that predominates is one of occupational upgrading (Torrejón-Pérez et al., 2024). In parallel, wage inequality has grown in many of these economies, especially since the 1980s (OECD, 2011), although asymmetrically in European countries (Pereira and Galego, 2019). This raises the question of whether this steady increase of wage inequality can be at least partly driven by occupational changes.

In the debate on the factors that explain wage inequalities, some authors have highlighted the key role that occupations play above other elements such as education (Acemoglu and Autor, 2011; Williams, 2013). Nonetheless, there is no consensus on whether it is the differences between- or within-occupations, or the change in occupational shares, that drive wage inequality. While certain authors assign a predominant role to within-occupation differentials as a determinant of recent trends in wage inequality (Fernández-Macías and Arranz-Muñoz, 2020; Godechot, 2012; Kim and Sakamoto, 2008; Mishel et al., 2013), others argue instead that it is precisely the differences between occupations that drive this evolution (Acemoglu and Autor, 2011; Helland et al., 2017; Weeden et al., 2007; Williams, 2013). A striking fact is that although some of these studies use the same data, they often find different or even opposite results due to the different operationalisation. However, comparative studies are scarce, perhaps due to the lack of homogeneous and harmonized data to apply the same operationalisation across countries.

In a recent paper, Fernández-Macías and Arranz-Muñoz (2020) made a first approximation to measure the role of occupational differences in wage inequality evolution in five European countries for the period 2005-2014, using data from the European Survey on Income and Living Conditions (EU-SILC). However, these authors emphasize the limitations of the data used for their analysis, concerning the measure of wages (calculated as full-time equivalent rather than hourly, and estimated rather than measured directly) as well as the sample size, level of detail in the analysis and period covered (2005-2014). In the present article, we try to add to this literature by analysing the role of occupational change in wage inequality trends in Europe in recent years. We base our analysis on a wider timeframe (2002-2018) for a set of six EU countries with different economic structures and institutional contexts, using a direct measure of hourly wages as dependent variable and benefitting from the larger sample size and level of detail of the European Structure of Earnings Survey.

2 Literature Review

Taking the definition of income inequality proposed by the Organisation for Economic Co-operation and Development (OECD) as a reference (OECD, 2015), we define wage inequality as how unevenly wages are distributed within a population, in this particular case the work force. Wage inequality is a phenomenon that has been widely studied in the literature, especially in developed economies, such as the United States (Autor, 2014; Mouw and Kalleberg, 2010; Weeden et al., 2007) and European countries (Godechot, 2012; Helland et al., 2017; Williams, 2013). In this respect, sectors and occupations (Akerman et al., 2013), globalisation (Helpman, 2018), within-firms heterogeneity (Schaefer and Singleton, 2020; Song et al., 2019), trade unions (Card, 2001; Pontusson, 2013), or more recently robotisation (Barth et al., 2020), have been investigated as some of the possible drivers

of wage inequality trends. Moreover, Acemoglu and Autor (2011) and Williams (2013) argue that occupations may be more important than other factors, such as education, when explaining wage inequality trends in the U.S. and the UK respectively.

From a theorical point of view, we can identify four mechanisms by which changes in occupations relate to variations in overall wage inequality. The first two mechanisms would relate changes in wage inequality to variations in between-occupation differences, while the last two relate to changes in the differentials within-occupation. Firstly, wage inequality may rise due to an increase in the differences between the mean wages of occupations, even if the occupational structure itself does not change (Fernández-Macías and Arranz-Muñoz, 2020; Kim and Sakamoto, 2008). Secondly, changes in the structure of employment by occupation may affect wage inequality if there is relative growth of employment in low- and high-paid occupations (Goos and Manning, 2007). This way, the processes known as job polarisation or occupational upgrading could lead to an increase in wage inequality (by increasing the share of employment in the tails of the wage distribution). Thirdly, total wage inequality may also expand if employment increases relatively faster in those occupations with greater internal differences in terms of wages (Fernández-Macías and Arranz-Muñoz, 2020). Fourthly, wage inequality can rise if internal differences within-occupation increase, or in other words, if the distribution of wages within-group becomes more unequal (Mookherjee and Shorrocks, 1982).

There is abundant empirical research about the role of occupational wage differentials in explaining recent trends in wage inequality, usually focusing on one developed economy. However, their findings are often contradictory. On the one hand, Helland et al. (2017) for Norway, Williams (2013) for the UK, or Acemoglu and Autor (2011) and Weeden et al. (2007) for the U.S., amongst others, find that increasing wage inequality in these countries was mainly driven by between-occupation differences. These authors highlight that job polarisation and widening occupational wage differentials were driving wage inequality from the 70s to the first decade of the 21st century. In this line, Mouw and Kalleberg (2010) report similar findings for the U.S. from 1992 to 2008, where between-occupation differentials explain two-thirds of the increase in wage inequality. However, they also found that within-occupation differences were shoving the previous increase from 1983 to 1992.

On the other hand, and in line with this latest finding of Mouw and Kalleberg (2010), other authors state that the trends in wage inequality mostly reflect within-occupation variations. By contrast to the aforementioned studies focused on the U.S., Kim and Sakamoto (2008) emphasized the increasing role of within-occupation differences with respect to between-occupation ones from 1983 to 2002. This was partly supported by the evidence of Mishel et al. (2013), who using the same data as Acemoglu and Autor (2011), but with a distinct operationalisation, found that the weight of between-occupation differences raised until 1994, followed by a significant decline afterwards substituted by within-occupation differentials as the main driver of wage inequality trends. In Europe, and particularly in Finland, France, Germany, Spain and the Netherlands, Fernández-Macías and Arranz-Muñoz (2020) find that changes within-occupation were predominantly driving wage inequality from 2005 to 2014. Furthermore, Godechot (2012) shows that wage inequality grew in France due to the increase pay for top finance managers, which mostly affects within-occupation differentials.

There are a number of reasons that may explain the contradictory evidence on the role of occupations in explaining wage inequality trends in recent years, related to the methodological challenges of doing this kind of analysis (Fernández-Macías and Arranz-Muñoz, 2020). International occupational classifications have undergone several updates since their introduction in the 1970s, notably in the late 1990s and around 2010. These updates, necessary due to changes in the division of labour and technological advancements, aim to produce more consistent occupational categories. However, they complicate the long-term comparability of wage data. For instance, Mouw and Kalleberg (2010) attribute a third of the increase in wage variance explained by occupations in the 1990s to reclassification. In general, long-term comparisons of occupational trends are problematic due to the sensitivity of results to minor methodological choices in how occupational codes are treated for the analysis.

Another major issue is the growing influence of large outliers in the wage distribution. Studies suggest that recent inequality spikes largely stem from massive income increases for the top 1% or even 0.1% (OECD, 2011; Piketty, 2014). Standard surveys, like the U.S. Current Population Survey, often fail to accurately capture this trend due to underreporting, sparse data, non-contact or refusal of high earners. Increasingly, researchers have turned to administrative registers and tax return data to better understand trends in earnings inequality. This is important because most studies on occupational wage trends rely on surveys, potentially overlooking a key part of recent wage inequality growth. These problems can be compounded by the common practice of using log wages instead of monetary values for the analysis, which can obscure the interpretation, particularly if large outliers are a common feature of the wage distribution (Fernández-Macías et al., 2017: 39–40). For instance, Kim and Sakamoto (2008) found less evidence of growing between-occupational differentials when analysing dollar wages instead of log wages.

These methodological problems may partly explain the lack of comparative analyses across countries, although the most ostensible reason is the lack of databases that include a large number of countries and consistent information of wages and occupations over a long period of time. Nevertheless, the recent waves of the EU Structure of Earnings Survey (SES) give us an opportunity to empirically study the link between recent changes in the occupational structure and wage inequality trends in Europe, taking into account the methodological challenges just discussed. In particular, the Structure of Earnings Survey provides very precise information on individual hourly wages which is crucial when measuring their variance, especially in comparison to wages' information collected through surveys.[1] Probably, administrative records of employers and employees offer, in some countries, even more detailed information on wages. However, these administrative sources are not evenly available across European countries, and they are far from homogeneous. Therefore, the SES is the highest-quality statistical source for comparative analysis on wage evolution in the EU.

3 Data and methodology approach

3.1 Data

The data used comes from the European Structure of Earnings Survey, compiled by Eurostat for the period 2002-2018. It is a 4-yearly cross-sectional database on labour earnings, the individual characteristics of employees and those of their employer. It contains consistent information for the whole period analysed on occupation, sector and wages, the main variables necessary for our analysis. The sample is very big in all countries, which allows for a detailed breakdown of wages by occupations and sectors. Additionally, hourly wages are measured accurately and with a high degree of detail, which is one of the main advantages of this database in comparison to others previously used for similar analyses, such as the EU-SILC. Our sample includes all individuals in paid employment, covering six European countries characterised by having different welfare state models: Finland, France, Poland, Romania, Spain and the United Kingdom.[2] In particular, the sample only includes those individuals actively working, in other words, the unemployed and workers on leave are not analysed. This database´s main shortcoming is the lack of information on some sectors[3] and

[1] Alternatively, wages can be gathered from the EU-SILC, which is the database used in most recent studies. However, its information of wages is provided as monthly wages of previous year and the number of hours worked per week is not available. Therefore, some assumptions must be established, such as wages do not differ from previous year and individuals do not change from one occupation to another (these changes cannot be captured). Also, hourly wages of part-time employers in the EU-SILC are calculated as an approximation considering that they work the maximum number of hours allowed by regulation. Therefore, we can affirm that the Structure of Earnings Survey data is much more precise.

[2] Data on the UK is only available until 2014, therefore we have only analysed the period 2002-2014 for this country.

[3] Sectors A/A-B and L-to-Q/O-to-U (NACE Rev.1.1/NACE Rev.2) of agriculture, fishing and Public Administration, Education, Health, Household activities and extraterritorial activities were missing for some countries. Therefore, they have not been

firms[4], whereby the agriculture and public administration sectors and those firms of less than 50 workers have not been included in the analysis.

Following the approach by Fernández-Macías and Hurley (2016), Hauser and Warren (1997) and Kim and Sakamoto (2008), we define occupations as coherent bundles of tasks that entail specific skills, corresponding to different positions within the division of labour in society. According to this definition, occupations are structured by the division of labour, which involves the breakdown of economic processes into different tasks performed by specialized workers (Fernández-Macías and Arranz-Muñoz, 2020). This division is organised by two different mechanisms: hierarchies and markets. Hierarchies coordinate the division of labour within firms and markets between them. Likewise, occupations classify workers according to their position within the skill structure and hierarchy of organisations (vertical division of labour), while sectors classify organisations workers operating in different markets (horizontal division of labour).

The main unit of analysis in this paper will be defined by positions within the division of labour along the vertical and horizontal dimensions combined. In practical terms, we refer to this combination as "job" (an occupation-by-sector combination: for instance, commercial manager within the accommodation and food service sector). This concept of "jobs" is useful to avoid misunderstandings between detailed occupation as a combination of vertical and horizontal divisions of labour, and occupation as conventionally understood (reflecting only the vertical division of labour). This "jobs approach" has been previously used by Torrejón-Pérez et al. (2023), Eurofound (2017) and Wright and Dwyer (2003), amongst many others. Jobs are identified in the SES through the combination of occupation and sector according to ISCO-88 and NACE 1.1 (for the period 2002-2006) and ISCO-08 and NACE 2.0 (for the period 2010-2018) classifications at 2-digit and 1-digit level respectively.[5] In this case, we cannot strictly compare the periods 2002-2006 and 2010-2018 because information at a detailed level of ISCO-88 and ISCO-08 classifications (4-digit) is not available to apply correspondence tables that match occupations exactly.[6] However, this break has been taken into account when analysing occupational structure and wage inequality changes, as we will see later.

For wages, the other key variable, the Structure of Earnings Survey gathers information on the hourly wages of individuals. As already mentioned, this is one of the main advantages of using this database. It allows to precisely measure how between- and within-occupation dynamics influence wage inequality trends in recent decades. To avoid the problems related to large outliers while considering the increasing importance of very high wages in the distribution, we have carried out the analysis considering both nominal and log wages. In order to study the occupational structure change and some inequality measurements for each country, we have constructed a jobs matrix ranked by median hourly wage, to later classify each job in quintiles (weighted by the number of individuals in each job). This classification has been harmonised by matching each job in quintiles according to the mean value of their distribution interval.

Finally, it is worth mentioning the choice of the six European countries selected. Following Esping-Andersen (1990), EU member states can be grouped in six different groups due to their geographical location and welfare state model, as previously undertaken for EU-28 member states by Sapir (2006)

included in the analysis. However, some countries have this data available, so robustness checks have been carried out including all sectors and results almost do not vary.

[4] Some countries include firms of less than 10 workers for some years while others do not. However, we cannot identify these firms among those with less than 50 workers due to the data categorisation. Only firms of more than 50 workers have been therefore selected. Again, robustness checks have been carried out for the countries which include this information.

[5] Although beyond 3-digit level, the comparability of ISCO across countries is problematic (Elias, 1997), the flexibility in the definition of job is necessary to carry out the intended analysis. However, the results should be careful interpreted and discussed since some heterogeneity between jobs at this detailed level may appear as heterogeneity within jobs.

[6] The number of jobs increases considerably between 2006 and 2010 due to changes in ISCO and NACE classifications, as shown in tables 1, 2, 3 and 4.

and Orfao et al. (2021). These groups can be defined as follows: Continental (Austria, Belgium, France, Germany and Luxemburg), Nordic (Denmark, Finland, the Netherlands and Sweden), Anglo-Saxon (Ireland and the United Kingdom), Mediterranean (Greece, Italy, Portugal and Spain), Central European (Czech Republic, Croatia, Poland, Slovenia, Slovakia and Hungary), and Eastern European (Lithuania, Latvia, Estonia, Bulgaria and Romania).[7] Although each country has its own idiosyncrasies, the countries in each of these groups present some similarities, such as the state of the labour market, institutional context and the economy (Esping-Andersen, 1990; Sapir, 2006). Thus, we have included one country of each group to be able to relate occupational trends and wage inequality in countries within different economic, labour market and institutional contexts.

3.2 Methodology approach

This section describes the methodology used to analyse the role of jobs, or between- and within-job differentials, in explaining the evolution of wage inequality in Europe during the first decades of the 21st century. For this, two different approaches have been used. First, we have carried out the estimation of several ANOVA decompositions in order to analyse whether the explanatory power of between-job differentials with respect to wages has gained importance in recent years. In this approach, the total variance of wages by country can be split in two components grouping data by job: the between- and within-group variability. This methodology has been used before by Acemoglu and Autor (2011), Fernández-Macías and Arranz-Muñoz (2020) and Mouw and Kalleberg (2010) when analysing wage inequality trends. If jobs have gained relevance in structuring wage inequality, then between-job variance would be expected to grow over time.

Secondly, we have estimated a series of inequality indices, such as Gini and Theil, applied for wages. In this case, for each country and year we computed both indices. The Gini coefficient takes values between 0 and 1, where a higher value means greater wage inequality. A Gini index is calculated as the Gini coefficient multiplied by 100. The Theil also has a minimum threshold of 0 which reflects perfect equality, but it has no upper threshold (Allison, 1978). Although the Gini cannot be directly decomposed into between- and within-group components, this decomposition is available for the Theil in order to analyse the role of jobs for each country *i* and year *y*. Therefore, the Theil can be calculated as follows:

$$Theil_{iy} = \sum_{j=1}^{k} s_{jiy} T_{jiy} + \sum_{j=1}^{k} s_{jiy} ln \frac{\overline{w}_{jiy}}{\overline{w}_{iy}}$$

where, *k* refers to the total number of jobs, and s_{jiy}, T_{jiy} and $\overline{w}_{jiy}$ to the wage share, Theil index and mean wage of job *j* in country *i* and year *y* respectively. Thus, s_{jiy} can be defined as:

$$s_{jiy} = \frac{\overline{w}_{jiy}}{\overline{w}_{iy}} \times \frac{n_{jiy}}{N_{iy}}$$

being n_{jiy} the number of workers of occupation *j* in country *i* and year *y*, and N_{iy} the total workforce of country *i* in year *y*. The first right sided component of the Theil equation corresponds to the within-job inequality while the second one is the between-job inequality.

The Theil index is more sensitive to variations related to smaller values than from larger ones, while the Gini index to changes from the part of the distribution where the density is highest (around the middle for bell-shaped distributions). The estimation of these inequality indices for wages and the variance decomposition approach allow us to compare our results on the recent trends of wage inequality and the role of jobs with the previous studies on this matter, particularly those focused on

[7] The Continental group is defined by its focus on pensions and unemployment benefits. The Nordic countries, by contrast, focus on high social welfare and a reduction in unemployment. The Anglo-Saxon countries seek to reincorporate jobseekers into the labour market and reduce the salary gap through the use of active policies. In turn, the Mediterranean model focuses on pensions, with a weak redistribution of income. The countries in Central and Eastern Europe are defined by little employment flexibility.

European countries (Fernández-Macías and Arranz-Muñoz, 2020; Godechot, 2012; Williams, 2013). As a robustness check, the same analysis has been made for both wages and log wages, and also including all company sizes and activity sectors in those countries with information available.[8] Finally, the methodology used by Mookherjee and Shorrocks (1982) to decompose the trend in wage inequality has been applied to measure the relative contribution of changes in within-occupation inequality, population shares between- and within-occupation, and mean wages of occupations.[9]

4 Results

4.1 Wage inequality and occupational structure change in Europe

Before analysing whether between- and within-job differences have driven recent trends in wage inequality, we will look at the bigger picture of how wage inequality has evolved in European countries. Table 1 shows the evolution by country of the Gini index, Theil index and wage ratios by job-average wage quintiles, from 2002 to 2018. Regarding Gini and Theil indices, Finland records the lowest inequality levels for the complete period analysed (values under 23 and 10 points respectively), while the other European countries have higher values that exceed the 30 and 15 points, in Gini and Theil indices respectively. However, the evolution between 2002 and 2018 differs considerably across countries.

In general, our results reveal a decrease or stagnation of wage inequality during the past two decades in Europe, which contrasts with the recent narrative in this matter. In fact, we only find an increase of wage inequality in Finland, the most equitable country in terms of wages, where table 1 shows an expansion of wage inequality during the first decade of the 21st century with a subsequent stagnation in the next decade. By contrast, a consistent decline is observed in Poland, Romania and the UK for the whole period. In Spain and France, although there was a fall in the years preceding the Great Recession followed by a rise afterwards, the Gini and Theil values at the end of the period analysed were smaller in France and almost the same in Spain than the ones in 2002. It should be noted that focusing on the Spanish case, the Gini index decreased from 2002 (31.35) to 2018 (30.82) but the Theil index increased in the same period from 17.94 to 18.39. This is explained by the fact that Theil index is more sensitive to changes from smaller values than from larger ones, while the Gini index is more sensitive to changes from the part of the distribution where the density is highest. The idea that occupational trends such as job polarisation or even occupational upgrading would have driven an expansion of wage inequality in Europe in recent years, therefore, seems already implausible given that wage inequality did not increase across the board. However, if there has been polarisation or upgrading in some countries over the same period (Torrejón-Pérez et al., 2023), then a decrease in wage inequality reveals that there must be other components which are compensating the increase generated by occupational trends.

Interestingly, table 1 suggests a possible trend towards lower dispersion or convergence of wage inequality patterns across European countries, since the initially lower values (in Finland) increased the most and vice versa. Similar trends can be observed in the evolution of ratios between job-average wage quintiles in all countries, particularly when focusing on the rates between the middle (3) and lowest (1) quintiles. Nevertheless, we can observe a rise during the first part of the period analysed in the ratios between the upper and middle quintiles in two countries where overall inequality grew a little or remained stable, such as Romania and the UK. Although this trend implies an increase of job-average wages in the top half of the occupational distribution, it did not seem to affect overall wage inequality in these two countries as measured by the Gini and Theil indices.

[8] The results obtained in the robustness checks do not vary from those presented in the article.

[9] The methodology used to decompose the trend in wage inequality based on the approach by Mookherjee and Shorrocks (1982) is explained in the Appendix.

***Table 1**: Wage inequality across EU countries: Gini index, Theil index and wage ratios by job-average wage quintiles, 2002-2018.*

	Year	n	No. of jobs	Gini	Theil	Ratios between job-average wage quintiles: quintile 3 / quintile 1	Ratios between job-average wage quintiles: quintile 5 / quintile 3
Spain	2002	127,614	187	31.35	17.94	1.77	2.53
	2006	132,123	211	28.29	14.55	1.70	2.28
	2010	134,403	453	30.11	17.17	1.72	2.44
	2014	129,357	419	29.57	16.16	1.72	2.39
	2018	132,744	450	30.82	18.39	1.71	2.53
France	2002	94,233	188	35.34	28.04	1.82	2.90
	2006	67,012	195	28.2	16.81	1.73	2.26
	2010	114,523	439	27.15	16.29	1.65	2.22
	2014	141,169	426	30.66	20.25	1.77	2.46
	2018	147,300	417	31.41	21.58	1.81	2.51
Finland	2002	110,675	169	18.42	5.93	1.42	1.72
	2006	154,212	193	20.26	7.42	1.46	1.81
	2010	153,976	423	22.2	9.38	1.50	1.93
	2014	146,897	410	21.54	8.45	1.48	1.89
	2018	152,392	413	22.27	9.21	1.48	1.95
Poland	2002	355,732	205	32.62	20.65	1.96	2.54
	2006	346,495	199	34.08	23.51	1.96	2.68
	2010	347,044	463	33.09	22.16	1.85	2.64
	2014	391,579	456	33.71	22.75	1.84	2.73
	2018	426,895	461	31.51	19.79	1.73	2.58
Romania	2002	137,955	214	39.08	31.39	1.99	3.24
	2006	141,042	212	39.65	31.51	2.02	3.29
	2010	131,391	460	38.87	29.54	1.93	3.28
	2014	138,816	443	38.21	28.74	1.81	3.28
	2018	164,720	458	34.53	23.66	1.65	2.98
United Kingdom	2002	71,748	212	34.59	23.53	1.80	2.85
	2006	63,580	206	34.84	23.27	1.73	2.94
	2010	82,985	469	35.56	26.76	1.69	3.05
	2014	80,196	463	33.27	20.9	1.65	2.83
	2018	-	-	-	-	-	-

Source: Author's estimations based on SES data.

Table 2 shows wage ratios linked to gender, age and education categories of the working age population. Persistent wage differences are found by gender for the whole period, with women having significantly lower wages than men in all the European countries analysed. Amongst others, these inequalities could be associated with wage differences between- or within-jobs. It should however be noted that these differences have been considerably reduced from 2002 to 2018 in all countries, except in Poland. In particular changes in the distribution of men and women across occupations may have contributed to this evolution. Additionally, by level of education, we observe considerable differences. First, Spain and Finland record an increasing gap in the wage levels of those with tertiary and primary education. Secondly, the role of the level of education has remained stable in France and the UK during recent years. Thirdly, wage differentials according to level of education have been reduced in Poland and Romania, especially since 2010. Therefore, as we found for wage inequality, there is a trend towards lower dispersion of wages by education across European countries. Finally, wage ratios have changed little by age, with the exception of Romania, where the gap between young and adult people has been reduced.

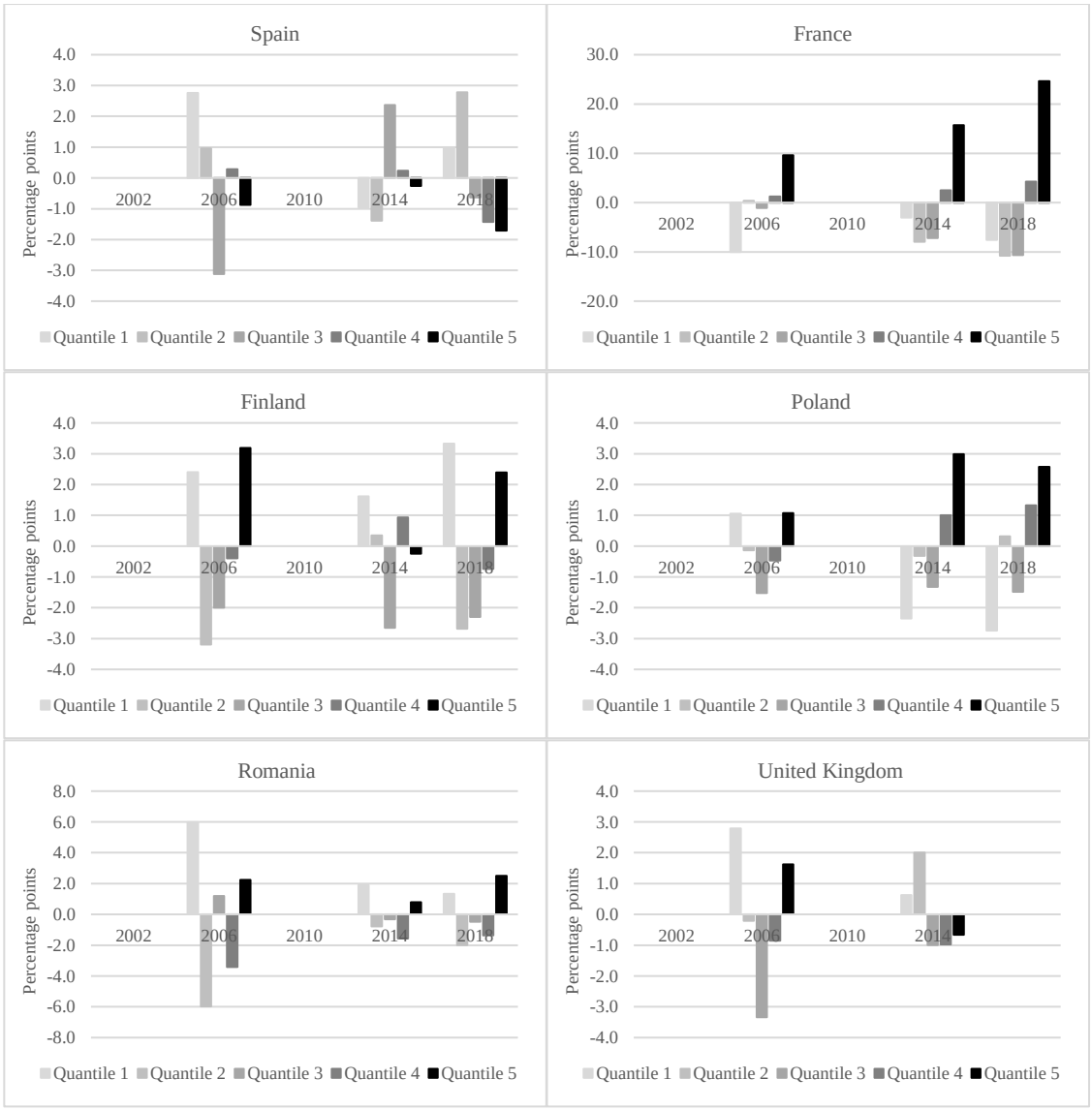
***Table 2**: Wage ratios by gender, level of education and age across EU countries, 2002-2018.*

	Year	n	No. of jobs	Wage ratios by gender: men / women	Wage ratios by education: high / low	Wage ratios by age: young (<30) / adult
Spain	2002	127,614	187	1.44	1.68	0.56
	2006	132,123	211	1.42	1.70	0.62
	2010	134,403	453	1.37	1.81	0.60
	2014	129,357	419	1.30	1.79	0.59
	2018	132,744	450	1.28	1.93	0.60
France	2002	94,233	188	1.32	1.97	0.59
	2006	67,012	195	1.25	1.79	0.61
	2010	114,523	439	1.20	1.76	0.62
	2014	141,169	426	1.21	1.73	0.55
	2018	147,300	417	1.19	1.74	0.57
Finland	2002	110,675	169	1.24	1.40	0.85
	2006	154,212	193	1.26	1.59	0.78
	2010	153,976	423	1.28	1.46	0.73
	2014	146,897	410	1.25	1.77	0.71
	2018	152,392	413	1.22	1.80	0.72
Poland	2002	355,732	205	1.18	2.38	0.72
	2006	346,495	199	1.25	2.44	0.72
	2010	347,044	463	1.21	2.51	0.82
	2014	391,579	456	1.24	2.00	0.79
	2018	426,895	461	1.20	1.94	0.88
Romania	2002	137,955	214	1.23	3.42	0.66
	2006	141,042	212	1.12	3.32	0.79
	2010	131,391	460	1.07	3.49	0.87
	2014	138,816	443	1.06	2.93	0.91
	2018	164,720	458	1.09	2.59	1.04
United Kingdom	2002	71,748	212	1.44	1.85	0.79
	2006	63,580	206	1.41	2.30	0.72
	2010	82,985	469	1.38	1.69	0.67
	2014	80,196	463	1.30	1.68	0.68
	2018	-	-	-	-	-

Source: Author's estimations based on SES data.

Simultaneously to the aforementioned changes, European labour markets have undergone important changes in their occupational structures, which have led to the processes commonly known as job upgrading, downgrading and polarisation (Torrejón-Pérez et al., 2023). Figure 1 shows the employment change in percentage points by job-wage quintile and country for the period 2002-2018, using a "jobs approach" similar to previous literature but with data from the EU Structure of Earnings Survey. This figure highlights the diverse patterns of change that European countries have experimented during this period, consistently with previous studies (Torrejón-Pérez et al., 2023; Eurofound, 2017).

***Figure 1**: Employment change (in percentage points) by job-wage quintile and by country, 2002-2018.*



(1) year 2002 has been used as reference for 2006 and variations for the period 2014-2018 are calculated based on the occupational structure of 2010 due to changes in ISCO-08 and NACE classifications.

Source: Author's estimations based on SES data.

Occupational change during the last two decades in France and Poland has been characterised by a relative growth of employment in highly paid occupations. We can therefore affirm that there has been job upgrading in these two countries. By contrast, Finland and Romania reveal patterns of job polarisation, with a downgrading skew in the first country from 2010 to 2014 and in the later from 2002 to 2014. These findings are in line with the results of Torrejón-Pérez et al. (2023), who found an upgrading process in the Czech Republic (a Central European country, as it is Poland) and in France notably after the Great Recession. In this same work, Torrejón-Pérez et al. (2023) revealed net employment loses in quintiles second, third and fourth in Romania, leading to job polarisation.

On the contrary, Spain and the UK record two different trends. On the one hand, figure 1 shows a downgrading process in Spain, especially before and after the financial economic crisis of 2008. This result contrasts with the job polarisation found by the Torrejón-Pérez et al. (2023), although this report also states that the polarisation found was biased towards low paid jobs, or, in other words, job downgrading. In fact, these small differences might be explained by the use of survey information instead of firm data by Torrejón-Pérez et al. (2023), and their inclusion of the public administration and agriculture sectors. On the other hand, we observe job polarisation in the UK from 2002 to 2006, with a subsequent downgrading afterwards for the period 2010-2014. These dissimilar dynamics

demonstrate the diversity of European labour markets and the idiosyncrasies that each country have and that should be considered when analysing wage inequality.

According to Torrejón-Pérez et al. (2023), in general, employment growth during the latest decades in Europe has been mainly driven by job creation in the private service sector although in a polarised way. However, employment in public services increased considerably in mid and high-paid jobs. Finally, the primary sector has been shrinking in the last decades by a reduction of the size of low- and mid-paid jobs from 1997 to 2010. The narrowing of the primary sector is other of the factors (apart from the dynamic of public services) that promoted a process of job upgrading before the Great Recession and job polarisation after it.

Our analysis of EU Structure of Earnings Survey data for Europe between 2002 and 2018, therefore, reveals significant changes both in terms of the occupational structure and wage inequality across different European countries, in line with previous literature. For both the U.S. and Europe, some authors have argued that technology-driven shifts in labour demand are behind the observed patterns of occupational change (Autor et al., 2003; Goos and Manning, 2007; Goos et al., 2014). However, it is not clear that these demand shifts have had an impact on wages or wage inequality (Böhm et al., 2024). On the one hand, occupational wage growth has been decoupled from occupational employment growth (Mishel et al., 2013; Roys and Taber, 2019; Hsieh et al., 2019). On the other hand, Autor (2019), Card et al. (2013) and Firpo et al. (2011) have argued that changes in labour demand across occupations had a small significance when explaining the increase in wage inequality of recent years.

In this respect, it is striking that the clearest cases of growth and reduction of wage inequality in our analysis, Finland and Romania respectively, show a similar trend of job polarisation. This on its own suggests that the observed patterns of occupational change are largely unrelated to wage inequality trends, since the same input (in this case job polarisation), can generate very different outputs (both an increase and a decline of wage inequality). By contrast, France and partially Poland experimented occupational upgrading and a decline in wage inequality, which may initially sound more plausible but is also problematic (because an expansion of high-paid jobs may reduce wage inequality compositionally, but it may also expand the distance -or inequality- between the average wages of high-paid jobs and the rest). Hence, the comparison of wage inequality trends and occupational changes already suggests a weak or non-existent relationship between these two phenomena.

Comparing the evolution of wage inequality indicators and occupational structure changes in the European countries, some questions arise about the importance of between and within-job wage differentials, if they have increased or decreased overtime, and if there are differences by country. Table 3 summarises the trends in the dispersion of individual and job-average wages within each quintile. From an individual worker perspective, Spain, Finland, Poland and Romania are characterised by a growth in the dispersion of wages within quintiles, remarkably in the last country. We might expect this tendency to lead to a growth in wage inequality due to a rise in within-job differences. In fact, a similar trend is observed in the UK until 2010, although the dispersion within each quintile is reduced afterwards. Finally, France is a unique case since the dispersion of individual wages has been consistently reduced in all quintiles during the period analysed.

Regarding between-job differentials, we detect similar trends in all European countries studied. In this sense, the dispersion of job-average wages within each quintile has continuously increased from 2002 to 2018. However, there are differences in the scale of this increase. In Spain and Finland, between-job differentials increased particularly in the medium and high paid quintiles. By contrast, in France, Poland and the UK, this growth was concentrated in middle-paid jobs. Last, Romania records the highest rise in these differences, which are mainly observed from 2002 to 2018 in low-paid jobs, with an increase of 17.32 and 10.69 percentage points in the first and second quintiles respectively.

These descriptive findings suggest that both within- and between-job wage differentials may have contributed to wage inequality trends in Europe, although this contribution was not strong enough to drive a generalised increase in wage inequality, as previously discussed. In any case, to discuss more precisely how occupational trends may have affected wage inequality in Europe, it is necessary to

carry out a variance and Theil decomposition analysis, distinguishing the particular role that between- and within-job differentials have had in this evolution.

***Table 3**: Indicators of within-quintile wage inequality (differences according to individual and between job average wages) by country, 2002-2018.*

				Between-individual differences				
	Year	**n**	**No. of jobs**	**Change in standard deviation Q1 (ref. 2002)**	**Change in standard deviation Q2 (ref. 2002)**	**Change in standard deviation Q3 (ref. 2002)**	**Change in standard deviation Q4 (ref. 2002)**	**Change in standard deviation Q5 (ref. 2002)**
Spain	2002	127,614	187	-	-	-	-	-
	2006	132,123	211	-0.04	0.21	0.20	0.00	-0.01
	2010	134,403	453	0.08	0.31	0.76	0.35	0.48
	2014	129,357	419	0.19	0.72	0.47	0.27	0.47
	2018	132,744	450	0.13	0.47	0.69	0.60	0.96
France	2002	94,233	188	-	-	-	-	-
	2006	67,012	195	-0.61	0.03	-0.62	-0.64	-0.24
	2010	114,523	439	1.68	-0.28	-0.62	-0.23	-0.35
	2014	141,169	426	-0.10	0.24	-0.45	-0.40	-0.07
	2018	147,300	417	-0.45	-0.05	-0.59	-0.36	-0.11
Finland	2002	110,675	169	-	-	-	-	-
	2006	154,212	193	0.06	0.19	0.25	0.25	0.44
	2010	153,976	423	0.28	0.35	0.34	0.56	1.16
	2014	146,897	410	0.04	0.40	0.30	0.64	1.07
	2018	152,392	413	0.17	0.38	0.27	0.80	1.34
Poland	2002	355,732	205	-	-	-	-	-
	2006	346,495	199	0.16	0.24	0.31	0.21	0.41
	2010	347,044	463	0.50	0.44	0.56	0.76	0.78
	2014	391,579	456	0.59	0.71	0.80	1.08	1.04
	2018	426,895	461	0.69	0.88	0.96	1.22	1.00
Romania	2002	137,955	214	-	-	-	-	-
	2006	141,042	212	1.24	0.98	0.99	0.86	1.10
	2010	131,391	460	1.63	1.80	2.18	1.68	2.15
	2014	138,816	443	2.08	2.42	2.70	2.29	2.30
	2018	164,720	458	4.46	4.11	5.06	5.33	4.06
United Kingdom	2002	71,748	212	-	-	-	-	-
	2006	63,580	206	-0.15	0.08	0.09	0.14	0.02
	2010	82,985	469	0.05	0.57	9.97	0.28	0.22
	2014	80,196	463	-0.13	0.62	0.24	0.05	0.11
	2018	-	-	-	-	-	-	-

(Continues)

Table 3 *(continued)*

	Year	n	No. of jobs	Between-job differences				
				Change in standard deviation Q1 (ref. 2002)	Change in standard deviation Q2 (ref. 2002)	Change in standard deviation Q3 (ref. 2002)	Change in standard deviation Q4 (ref. 2002)	Change in standard deviation Q5 (ref. 2002)
Spain	2002	127,614	187	-	-	-	-	-
	2006	132,123	211	0.88	1.04	1.64	0.68	0.21
	2010	134,403	453	-0.04	0.28	0.71	1.21	2.09
	2014	129,357	419	3.70	1.46	2.81	2.77	2.06
	2018	132,744	450	2.29	1.76	3.02	2.42	3.11
France	2002	94,233	188	-	-	-	-	-
	2006	67,012	195	0.09	0.78	0.46	-0.32	-0.23
	2010	114,523	439	-0.24	-0.26	0.15	-0.32	0.03
	2014	141,169	426	0.36	1.46	1.15	0.08	0.25
	2018	147,300	417	0.21	1.69	2.39	0.47	0.59
Finland	2002	110,675	169	-	-	-	-	-
	2006	154,212	193	0.23	1.18	0.92	1.20	0.58
	2010	153,976	423	0.45	0.98	0.73	1.06	3.15
	2014	146,897	410	1.10	4.71	4.00	2.12	3.94
	2018	152,392	413	1.71	3.29	3.31	7.72	4.63
Poland	2002	355,732	205	-	-	-	-	-
	2006	346,495	199	2.46	1.61	1.40	0.59	0.48
	2010	347,044	463	1.21	3.95	0.50	0.67	2.07
	2014	391,579	456	1.87	2.59	2.38	1.81	2.56
	2018	426,895	461	2.91	4.10	4.19	2.17	2.53
Romania	2002	137,955	214	-	-	-	-	-
	2006	141,042	212	1.03	3.77	2.72	1.76	1.24
	2010	131,391	460	2.32	2.23	1.85	1.78	0.83
	2014	138,816	443	4.13	5.09	5.43	4.74	1.08
	2018	164,720	458	17.32	10.69	6.83	8.32	2.06
United Kingdom	2002	71,748	212	-	-	-	-	-
	2006	63,580	206	0.63	1.65	1.89	0.63	-0.25
	2010	82,985	469	0.08	0.52	2.93	0.14	1.21
	2014	80,196	463	0.80	1.08	4.86	0.91	1.54
	2018	-	-	-	-	-	-	-

Source: Author's estimations based on SES data.

4.2 Wage inequality between- and within-jobs

Table 4 presents the percentage of variance in log wages explained by between-group differentials and decomposes the Theil index. The total variance of wages can be split into two factors when the data is grouped by jobs: the variance between- and within-job. According to this approach, between-job differences account for around 35-60 percent of total variance in log wages in the European context (Table 4). Similarly, Fernández-Macías and Arranz-Muñoz (2020) and Eurofound (2017) found that between-job inequalities explain around 25-40% and 40-50% of this variance respectively, using different data sources. However, significant differences can be observed by country. In Finland and the UK, the variance accounted for by jobs is comparatively large, reaching values of up to 60%. By contrast, in Poland and Romania, jobs explain around 45-50 percent of the variance of log wages, while in Spain and France the interaction of occupations and sectors only explain a 35-40%. In all

countries the most important component for the distribution of log wages using a jobs' approach is actually occupation as measured by the ISCO classification, which explains most of the variance shown by the full range of jobs (up to 30%). Nonetheless, sectors also add significantly to the explanation of log wages' variance, as well as its combination with occupations, especially in Finland and the UK (around 20-25%). For reference, table 4 also shows a column with the percentage of variance of log wages explained by a model with the usual socio-demographic variables: we can see that the model using jobs (ISCO x NACE) can explain in all cases a significantly larger percentage of variance than this reference socio-demographic model.

***Table 4**: ANOVA decompositions (percentage of variance in log wages explained by between-groups differentials) and inequality indices decompositions (wages not logged) by country, 2002-2018.*

				% of variance in log wages explained by between-groups differentials					
	Year	**n**	**No. of jobs**	**ISCO only (39 categories)**	**NACE only (18 categories)**	**ISCO + NACE, no interaction**	**Jobs (ISCO x NACE)**	**Jobs, wages not logged**	**Jobs, wages < top 1%**
Spain	2002	127,614	187	19.75	13.86	28.75	39.9	31.97	36.03
	2006	132,123	211	16.32	14.12	26.82	38.37	32.6	35.67
	2010	134,403	453	17.81	17.17	30.02	45.38	33.92	42.29
	2014	129,357	419	16.83	15.4	28.1	42.15	33.48	38.9
	2018	132,744	450	16.57	15.59	27.74	41.07	32.26	38.45
France	2002	94,233	188	31.12	3.73	34.72	46.56	10.7	43.39
	2006	67,012	195	25.32	4.1	28.41	36.85	10.29	31.11
	2010	114,523	439	25.01	6.17	28.12	39.04	12.16	36.36
	2014	141,169	426	24.19	6.54	26.34	35.63	11.39	28.02
	2018	147,300	417	23.11	4.56	24.68	33.41	13.28	25.03
Finland	2002	110,675	169	18.59	6.21	27.22	49.76	46.98	48.16
	2006	154,212	193	21.36	8.21	32.3	53.39	47.67	51.87
	2010	153,976	423	23.59	17.38	35.55	55.81	50.99	54.12
	2014	146,897	410	25.53	21.04	39.63	60.48	55.21	55.86
	2018	152,392	413	32.44	21.72	43.24	60.41	54.1	56.34
Poland	2002	355,732	205	18.67	11.65	29.23	45.24	29.91	40.52
	2006	346,495	199	18.76	10.95	29.37	44.92	27.66	38.97
	2010	347,044	463	21.4	19.12	35.36	49.51	36.77	43.52
	2014	391,579	456	20.87	15.27	32.85	48.18	35.35	42.04
	2018	426,895	461	22.09	15.8	32.18	46.91	36.95	41.75
Romania	2002	137,955	214	21.86	7.51	27.94	39.98	33.15	37.02
	2006	141,042	212	26.43	7.93	31.55	43.77	32.41	41.6
	2010	131,391	460	32.07	15.34	40.07	50.48	37.1	45.49
	2014	138,816	443	31.55	14.82	39.38	50.29	37.12	45.44
	2018	164,720	458	31.54	13.19	36.89	49.12	35.53	44.51
United Kingdom	2002	71,748	212	23.74	13.55	35.81	52.39	29.28	45.24
	2006	63,580	206	24.47	19.49	41	57.64	34.2	49.1
	2010	82,985	469	25.28	25.88	41.06	56.49	8.48	47.4
	2014	80,196	463	28.1	25.51	43.25	60.52	45.46	53.77
	2018	-	-	-	-	-	-	-	-

(Continues)

Table 4 *(continued)*

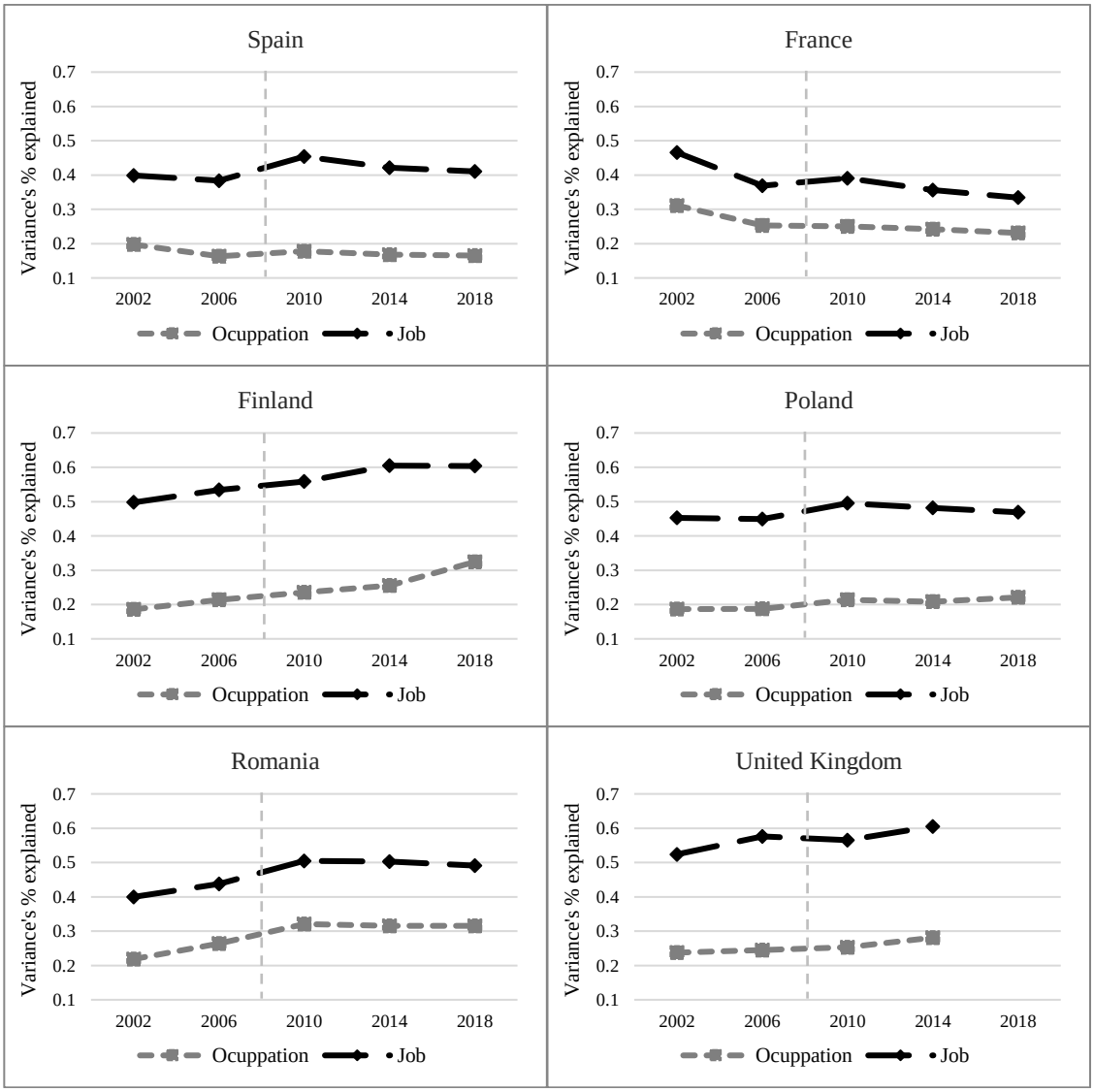
	Year	n	No. of jobs	% of variance explained by a model with socio-demographic characteristics	Inequality indices (wages not logged)				
					Gini	Theil	Theil between jobs	Theil within jobs	Between jobs/Total Theil
Spain	2002	127,614	187	34.49	31.35	17.94	7.31	10.63	40.75
	2006	132,123	211	34.05	28.29	14.55	5.77	8.78	39.66
	2010	134,403	453	35.11	30.11	17.17	7.83	9.34	45.60
	2014	129,357	419	32.18	29.57	16.16	6.94	9.22	42.95
	2018	132,744	450	32.47	30.82	18.39	8.04	10.35	43.72
France	2002	94,233	188	34.79	35.34	28.04	9.85	18.19	35.13
	2006	67,012	195	34.5	28.2	16.81	4.79	12.02	28.49
	2010	114,523	439	30.39	27.15	16.29	5.62	10.67	34.50
	2014	141,169	426	31.04	30.66	20.25	5.83	14.42	28.79
	2018	147,300	417	30.43	31.41	21.58	5.93	15.65	27.48
Finland	2002	110,675	169	32.44	18.42	5.93	3	2.93	50.59
	2006	154,212	193	35.45	20.26	7.42	3.99	3.42	53.77
	2010	153,976	423	32.12	22.2	9.38	5.44	3.94	58.00
	2014	146,897	410	39.71	21.54	8.45	5.17	3.28	61.18
	2018	152,392	413	39.56	22.27	9.21	5.64	3.57	61.24
Poland	2002	355,732	205	29.13	32.62	20.65	9.23	11.42	44.70
	2006	346,495	199	26.47	34.08	23.51	10.48	13.02	44.58
	2010	347,044	463	24.34	33.09	22.16	11.52	10.65	51.99
	2014	391,579	456	29.23	33.71	22.75	11.52	11.23	50.64
	2018	426,895	461	29.54	31.51	19.79	9.86	9.93	49.82
Romania	2002	137,955	214	29.12	39.08	31.39	14.71	16.68	46.86
	2006	141,042	212	31.14	39.65	31.51	15.44	16.07	49.00
	2010	131,391	460	32.82	38.87	29.54	15.65	13.88	52.98
	2014	138,816	443	35.43	38.21	28.74	15.07	13.67	52.44
	2018	164,720	458	34.72	34.53	23.66	12.04	11.62	50.89
United Kingdom	2002	71,748	212	28.88	34.59	23.53	11.33	12.19	48.15
	2006	63,580	206	31.11	34.84	23.27	12.22	11.06	52.51
	2010	82,985	469	24.69	35.56	26.76	12.87	13.9	48.09
	2014	80,196	463	24.69	33.27	20.9	12.33	8.57	59.00
	2018	-	-	-	-	-	-	-	-

Source: Author's estimations based on SES data.

It is crucial to keep in mind that wages are known to present a log-normal distribution, strongly asymmetric and right-side skewed due to a high concentration of observations below the mean, which is usually swelled by large outliers. We solved this problem by transforming wages into logarithms; however, this makes the distribution less unequal and can produce misleading results for our purposes. To evaluate this effect, we have also analysed the role of jobs when explaining the variance of wages using nominal wages (i.e., not logged), as well as all nominal wages except the top 1% of their distribution. In the first scenario, jobs lose part of their explanatory power, especially in France where the percentage of wages' variance explained falls down considerably. This means that there are very large values of wages whose occurrence cannot be linked to occupational differences. In the second situation, when not including the top 1% of nominal wages' distribution, the variance explained by jobs is similar to that of logged wages. Therefore, jobs play a significant role in the distribution of most wages, but a marginal one in the distribution of very large wages. In this sense, using nominal wages for the analysis clearly increases within-job inequality.

Our analysis not only reveals differences in the role of occupations when explaining the variance of wages by country, but also different evolutions across European countries. Figure 2 captures this evolution for both occupations and jobs by country from 2002 to 2018. As aforementioned, there are two periods strictly comparable that are 2002-2006 and 2010-2018. For this reason, we have added a vertical line to mark the breaks in ISCO and NACE classifications. In figure 2 we can distinguish two clear trends among European countries in the recent decades. On the one hand, in Spain, France and Poland, the variance explained by jobs clearly and significantly decreased over the period. This trend is also observed in Romania after the Great Recession, although a mild increase is seen before it. On the other hand, Finland and the UK show a clear and consistent growth in the share of log wage's variance explained by jobs.

***Figure 2**: ANOVA decompositions by country on the percentage of variance in log wages explained by occupation and job, 2002-2018.*

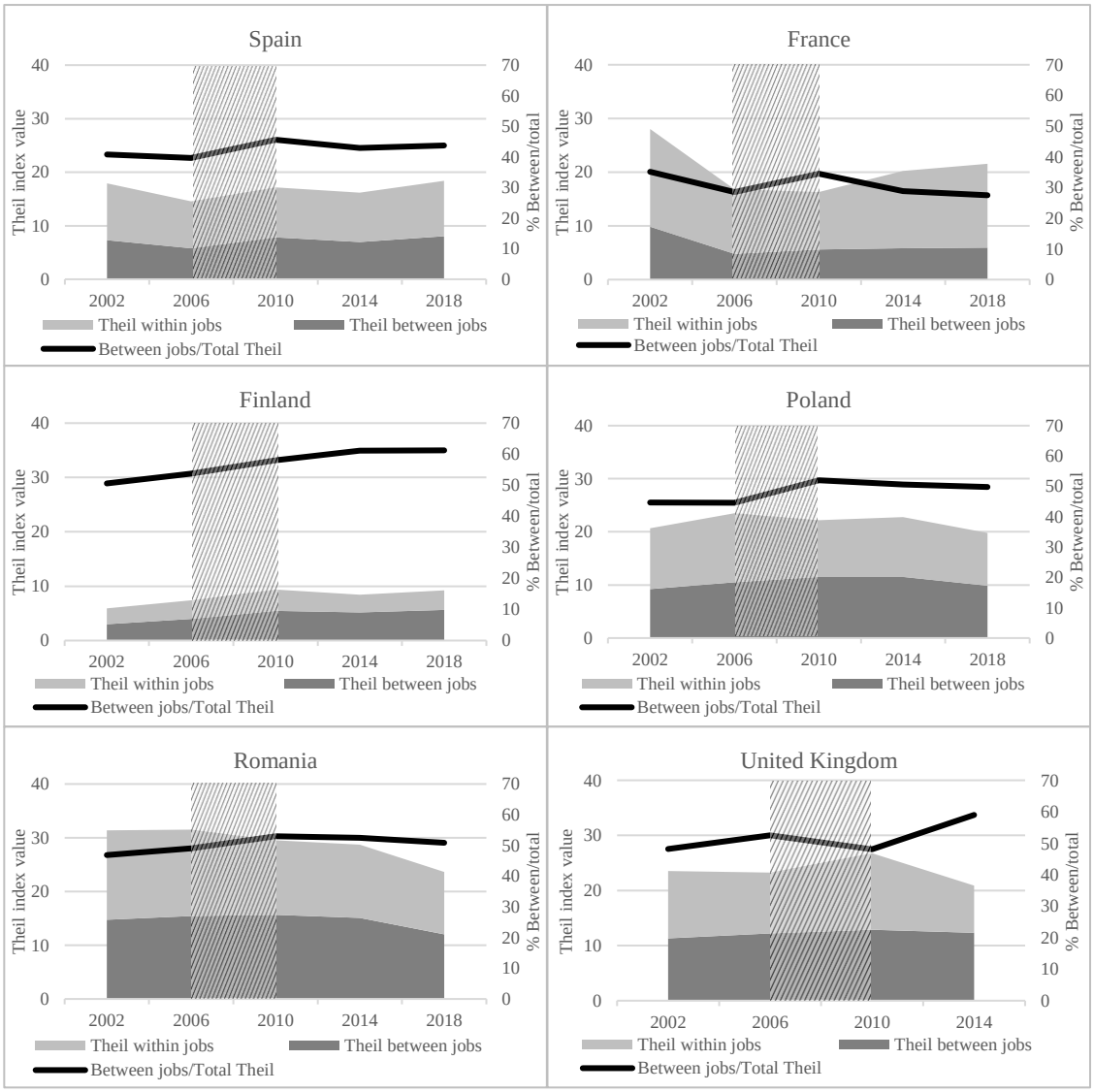


Source: Author's estimations based on SES data.

These findings suggest a decreasing role of jobs in a bulk group of European countries from 2002 to 2018. However, there are also some countries with an opposite trend. This contrasts with the results of Fernández-Macías and Arranz-Muñoz (2020), who, making use of the EU-SILC, found an increasing or stable role of jobs using the same approach. It should be noted that these authors found the increasing trend particularly around the period of the financial economic crisis of 2008. With our data, we see this increase from 2006 to 2010, although we cannot ensure that this growth is not a consequence, or at least in part, of the changes in the ISCO and NACE classifications. But most

importantly, the longer period covered, and the more precise data used here, reveal a more consistent and stable evolution of the role of jobs on wage inequality in all EU countries analysed. And in any case, it should be noted that the results for Finland and France are consistent with those of Fernández-Macías and Arranz (2020): only in Spain we find a different pattern when using SES (as we do here) and SILC (as done by Fernández-Macías and Arranz, 2020), and given the characteristics of both surveys we consider the results from SES to be more reliable. In terms of the power of explanation of occupation and job, we found a small gap in France. Being job the intersection of occupation and sector, this result reveals that sectors play little role in explaining wage inequalities in France, and wage inequality therefore lies in the side of occupation and other factors. This evidence is also supported by the results of the ANOVA analysis shown in Table 4. On the contrary, Finland has a high gap in the power of explanation between occupation and jobs, and hence a higher role of the sectors' capacity (see Figure 2).

***Figure 3**: Theil index decomposition by between and within job differences and percentage of overall Theil explained by between job differentials by country, 2002-2018.*



(1) Different scales have been applied for both axes in each country in order to accurately represent the evolution of Theil components.

Source: Author's estimations based on SES data.

In short, we observe two main dynamics in Europe: on the one hand, the predominant pattern is one of decreasing importance of occupations to explain overall wage inequality; on the other hand, we see an increasing importance of occupations in Finland and the UK. But from this we cannot conclude

yet whether occupational change contributed or not to the overall trends in wage inequality. In order to study this relationship, we have performed a Theil decomposition of between- and within-job differentials. Figure 3 decomposes the evolution of Theil, as a measure of the degree of inequality in the distribution of wages, into the between and within components for the analysed period. The sum of these two factors reflects the overall level of inequality in each country. We also present the share of the total Theil index that corresponds to between-job differences, which allows us to interpret if jobs have gained more relevance or not in explaining wage inequality over these last decades (this measure is equivalent to the variance decomposition approach discussed earlier).

In accordance with the previous findings on the variance analysis, but with some particularities, there are three patterns in the share of Theil explained by between-job differentials. First, there is again an increasing evolution from 2002 to 2018 in Finland, being the only country with a clear increase of wage inequality for the period analysed which is plainly linked to an expansion of wage inequality between occupations. Wage differentials between occupations grew strongly during the last two decades and explain most of the global Theil increase. In the Finnish case, it is therefore very plausible that the recent rise in wage inequality has been at least partly driven by occupational wage differentials.

Secondly, although the wage variance explained by jobs grew significantly in the UK and decreased in Romania and France, figure 3 shows that changes in Theil are in fact more associated to variations in the within component. This is because in this group of countries, the evolution of the between component has been more stable. In Romania and the UK there has been a reduction of wage inequality, which has been more intense in the within component than in the between one. In France, there has been a fall in overall inequality as captured by the Theil index, which is observed in both components, followed by a slight but consistent growth that has been mainly driven by the within component. However, and despite this growth, overall wage inequality did not reach the values found at the beginning of the period. This partially validates the results of Williams (2013) on the increasing role of jobs when explaining wage inequality in the UK. However, the development of between and within components suggest that it is the within component the one driving recent changes in wage inequality, which is in line with the findings for France of Godechot (2012) and was not reflected in the analysis of Williams (2013).

By contrast, in Spain and Poland, it is unclear if wage inequality changes are driven by the within or the between component. Comparing our results with those of Fernández-Macías and Arranz-Muñoz (2020), we find a much more stable evolution of both components.[10] It seems that both within and between components have evolved similarly to overall wage inequality, which has varied little. However, even in these countries the between component has been more stable, while the within component has changed more. In Spain, the global trend of wage inequality has been towards a small increase, while in Poland the opposite has been observed. However, these changes appear to be inconsistent and non-significant.

Based on approach by Mookherjee and Shorrocks (1982), table 5 shows the contribution to wage inequality trends of changes in within-occupation inequality, population shares between- and within-occupation and the mean wages of occupations. A first look into the results reveals that there are very different trends across countries and also between periods in each one of them. Nevertheless, in general terms, this approach supports more clearly the previous observation of a decreasing trend of wage inequality in most countries being mostly driven by differentials within-occupation. Additionally, changes in the mean wages of occupations also tend to contribute negatively to wage inequality, reducing it although in a softer way. The main exception is again Finland, where the

[10] As we have already noted, EU-SILC's information of wages is provided as monthly wages of previous year and the number of hours worked per week is not available. Therefore, hourly wages may not capture changes in the individuals' occupation and employment status affecting the income fluctuation component. Some adjustments can be done; however, any adjustment increases the statistical noise, which is especially important when measuring variance, in this particular case of wages.

opposite influence of changes in mean wages of occupations is found during the periods 2002-2006 and 2010-2018.

On the contrary, there is a positive effect on wage inequality trends of changes in the population shares of both between- and within-occupation components. Despite the positive contribution of these "composition effects", they are more volatile and smaller than the ones related to the other two components. According to the previous literature, changes in the population shares between-occupation component are the ones that could reflect the impact of occupational changes on wage inequality trends. Both polarisation and upgrading processes should lead to an increase in this component. The estimations carried out confirm that the "composition effect" tends to positively affect (expand) wage inequality, as we could expect according to the polarisation and upgrading found in some of the European countries analysed. However, in general, this effect did not drive wage inequality trends because the effects of the other components (especially the within-occupation and mean wages of occupations) compensate for it or even clearly dominate it. That said, we find again an exception in Finland, where wage inequality increased mainly due to changes in the population shares between-occupation component, or, in other words, due to occupational changes, which supports the findings of the Theil decomposition approach.

***Table 5**: Decomposition of the trend in aggregate inequality by country: Theil index I_0 (x10³).*

	Year	Change in aggregate inequality	Contribution to ΔI due to changes in			
			Within occupation inequality	Population shares		Mean occupation incomes
		ΔI	$\sum v_k \Delta I_0^k$	$\sum I_0^k \Delta v_k$	$\sum (\gamma_k - \ln \gamma_k) \Delta v_k$	$\sum (\theta_k - v_k) \Delta \ln \mu_k$
Spain	2002-06	-30.7	-14.9	0.2	3.3	-19.3
	2010-14	-6.0	-1.6	0.8	-0.3	-4.9
	2014-18	11.5	5.1	0.4	-0.4	6.5
France	2002-06	-100.9	-54.9	1.3	-8.6	-38.7
	2010-14	39.8	17.8	15.1	9.1	-2.1
	2014-18	9.2	-3.9	11.7	-8.4	9.7
Finland	2002-06	10.5	2.2	1.3	5.1	1.9
	2010-14	-6.8	-5.1	-0.9	-0.5	-0.2
	2014-18	4.6	2.1	0.1	0.9	1.6
Poland	2002-06	27.3	1.1	6.2	17.8	2.2
	2010-14	5.7	-1.4	6.1	2.7	-1.7
	2014-18	-24.4	-10.9	1.0	0.6	-15.0
Romania	2002-06	6.9	-25.7	19.8	27.3	-14.5
	2010-14	-7.3	-4.6	1.3	8.3	-12.3
	2014-18	-44.5	-22.1	5.1	5.8	-33.3
United Kingdom	2002-06	-0.7	-13.2	2.4	11.8	-1.7
	2010-14	-41.4	-29.1	-4.3	-1.7	-6.3
	2014-18	-	-	-	-	-

(1) equations' notation has been defined in the Appendix.
Source: Author's estimations based on SES data.

To summarise, using a more precise dataset on wages and a wider timeframe than previous studies, we found that, in both periods before and after the Great Recession, European countries present different patterns of association between occupational change and trends in wage inequality. The most common pattern is one in which occupational change, which differs considerably across countries, had a positive but smaller effect than within-job wage differentials on wage inequality tendencies during this period, particularly in some countries such as France and the UK. However, the

opposite pattern is clearly found in one of the countries analysed, Finland. Consequently, we cannot reject the possibility that in certain cases, occupational change may have had an important effect on the evolution of wage inequality. What we can reject is that, in general, occupational dynamics, due to changes in the occupational structure, explain recent wage inequality trends. Instead, our findings show that recent wage inequality trends were mainly driven by changes in within-occupation inequality and in the mean wages of occupations. Fernández-Macías and Arranz-Muñoz (2020) suggest that the within component may be more prone to drive wage inequality in the short run because it is more sensitive to cyclical effects. Our longer-term analysis suggests that there is not a uniform association between occupational change and trends in wage inequality in Europe, but instead there are some (few) countries in which occupational differentials became more important and contributed to growing wage inequality, and (more commonly) others in which they became less important and their positive effect on wage inequality trends were eclipsed by the negative trend on within-job wage differentials.

5 Conclusions

The objective of this work was to analyse whether occupational change has driven wage inequality in Europe during recent decades. To that end, a variance decomposition analysis, a Theil decomposition into between and within components, and a Mookherjee and Shorrocks (1982) decomposition of the trends in wage inequality approach have been estimated across six European countries through the use of data from the EU Structure of Earnings Survey. Considering the period 2002-2018, the analysis considered the changes in the occupational structure, the evolution of main inequality indices and the variations in the relative weight of both within- and between-job differentials in explaining wage inequality. Based on this analysis, we present the following conclusions regarding the role of jobs, understood as positions within the division of labour along the vertical and horizontal dimensions (occupation and sector), in wage inequality trends in Europe.

First, the Gini and Theil indices show a decrease or stagnation of wage inequality in all European countries with the exception of Finland in the period analysed. The Theil decomposition results reveal that there are different patterns in the share of wage inequality explained by between-occupation differences. While the role of occupations grew significantly from 2002 to 2018 in Finland and the UK, their relative weight decreased in Spain, France, Poland and Romania. These findings confirm that there is no unique trend in terms of the role of occupations in the development of wage inequality in Europe, but, on the contrary, they have gained more relevance in explaining wage inequality over the last two decades in the first group of countries and diminished it in the second group.

Secondly, the evolution of both within and between components suggests that occupational change, which differs considerably across EU countries, had a positive effect on wage inequality trends. However, the negative effect of changes in within-occupation differentials and the mean wages of occupations were more substantial, and more relevant for explaining recent wage inequality trends. In particular, occupational shifts contributed little to wage inequality trends in France, the UK and Romania in the period analysed, whereas within-occupation differentials played a much more important role. However, in Finland, there was a clear expansion of wage inequality which was clearly linked to changes in the occupational structure, in this case linked to a process of job polarisation according to our analysis. Moreover, in Spain and Poland, we cannot affirm if wage inequality changes were driven by the within or the between component since both elements' evolution was stable before and after the Great Recession.

Thirdly, between-occupation differentials account for around 35-60 percent of total wages variance, understanding occupations as the combination of vertical and horizontal dimensions of labour division. However, significant differences are found by country. While in Spain and France occupations explain about a 35-40% of this variance, in Poland and Romania, they explain up to a 45-50%. Moreover, in Finland and the UK, the wage variance accounted for by occupations reaches values of up to 60%. In all countries the most important component for the distribution of wages using the

jobs' approach (combination of vertical and horizontal dimensions of labour division) is actually the vertical dimension as measured by the ISCO classification, which explains most of the variance shown (up to 30% of the total). Nonetheless, the horizontal dimension, or sectors measured by the NACE classification, also add significantly to the explanation of wages' variance.

Finally, considering both log and nominal wages, we found that there are very large values of wages whose occurrence cannot be linked to occupational differences. By using nominal wages and when not including the top 1% of wages' distribution, occupations lose part of their explanatory power in explaining wages' variance. Therefore, occupations play a significant role in the distribution of the wages of most workers, but a marginal one in the distribution of very large wages.

These conclusions contrast with the ambiguous previous evidence on the role of occupations in wage inequality trends. As aforementioned, one of the main challenges was to apply a reasonably consistent and homogeneous operationalisation for all EU countries over the period 2002-2018, which in this case was achieved. In line with Fernández-Macías and Arranz-Muñoz (2020), we conclude that, in general, occupational dynamics did not drive recent trends in wage inequality in Europe since within-job differentials overshadowed their effect. Recent stratification theory has challenged the idea that occupations structure economic disparities and wage inequality as importantly as they once did (Williams, 2013). Even considering that occupations have gained relatively more weight in wage inequality trends in some EU countries, such as Finland and the UK, our results are more in line with the argument that trends in wage inequality are mostly driven by differences within-occupation for the bulk of European countries followed by changes in the mean wages of occupations, in the line of what Godechot (2012) shows for France, and Kim and Sakamoto (2008) and Mishel et al. (2013) for the U.S.

Although our conclusions are based on a 4-yearly cross-sectional database, our decomposition analysis provides useful evidence about the role of occupations in wage inequality trends in Europe, focusing on a wider timeframe and using more precise information on wages than previous studies. The main limitation here is the lack of more detailed information on ISCO and NACE classifications for the period analysed, which would have allowed us to carry out the subsequent correspondence tables for their reclassifications and compare both periods before and after the Great Recession. However, considering the scarce number of comparative studies on wage inequality and the particular role of occupations, our research opens the door to future analysis which may deepen on the drivers of both within- and between-occupation wage differentials. To extend this line of work, it would be useful to analyse a larger pool of countries and a wider timeframe, and to consider the role played, amongst others, by national institutions and regulations.

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List of abbreviations and definitions

EU	European Union
EU-SILC	European Survey on Income and Living Conditions
ISCO	International Standard Classification of Occupations
NACE	Statistical Classification of Economic Activities
OECD	Organisation for Economic Co-operation and Development
SES	Structure of Earnings Survey
UK	United Kingdom
U.S.	United States

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Appendix

Following the decomposition of the trend in wage inequality by groups proposed by Mookherjee and Shorrocks (1982), we can decompose the change in inequality measured as the Theil coefficient I_0 by occupations, as follows,

$$\Delta I_0 = \sum_k \bar{v}_k \, \Delta I_0^k + \sum_k \bar{I}_0^k \, \Delta v_k - \sum_k \overline{\ln \gamma_k} \, \Delta v_k - \sum_k \bar{v}_k \Delta \ln \gamma_k$$

with,

$$\gamma_k = \mu_k / \mu$$
$$\mu = \textstyle\sum_k v_k \mu_k$$
$$k = 1, \dots, n$$

where, v_k represents the population share and μ_k the mean wage, for each occupation k of a total of n occupations. Therefore, the change in inequality measured with the Theil index can be decomposed into four components: (i) the impact of intertemporal changes in within-occupation inequality, (ii) the effect of changes in the population share of the within-occupation component, (iii) the effect of changes in the population share of the between-occupation component, and (iv) the contribution to inequality changes attributable to relative changes in the mean wages of occupations. These four components can be calculated as:

$$\text{(i)}: \textstyle\sum_k \bar{v}_k \, \Delta I_0^k$$
$$\text{(ii)}: \textstyle\sum_k \bar{I}_0^k \, \Delta v_k$$
$$\text{(iii)}: \textstyle\sum_k (\bar{\gamma}_k - \overline{\ln \gamma_k}) \Delta v_k$$
$$\text{(iv)}: \textstyle\sum_k (\bar{\theta}_k - \bar{v}_k) \Delta \ln \mu_k$$

with,

$$\theta_k = v_k \gamma_k$$

Accordingly, ΔI_0 and the change in these four components can be calculated between any two years for each country. As well as with the between- and within-components of the Theil index, we can firmly compare only two separate periods due to the changes in both ISCO and NACE classifications (2002-2006 and 2010-2018).

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