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Macroeconomic and institutional drivers in Europe

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Abstract

Rising wage inequality is disproportionately driven by widening differences in pay between firms. This can reflect that firms' workforces are increasingly homogenous but also that the pay of similar workers increasingly differs depending on firm productivity and the way that is shared with the workforce. This paper uses cross-nationally representative European data from the Structure of Earnings Survey to study the trends in earnings and wage inequality over time between and within firms, linking these to changes in macroeconomic and institutional factors. Earnings have converged between countries within Europe, hiding increasing inequality within countries, primarily driven by differences between firms. A substantial part of increased inequality is due to variation in working time and contracts. The remainder reflects both more sorting of workers into firms with other similar workers and a divergence in the premium firms pay. European economies face some common trends brought about by macroeconomic changes such as globalisation and digitalisation. Even in the light of these major trends, differences in wage inequality within and between firms seem mainly to reflect institutional changes, particularly the changing coverage of pay agreements and union strength which shape inequality within and between firms differently, as well as the presence and bite of minimum wages. While digitalisation and globalisation play a role in raising differences between firms, institutional factors seem to have a more substantial impact on the evolution of inequality within and between firms.

Introduction

Earnings inequality has increased in most developed nations in recent decades (Atkinson 2007; OECD 2015; Piketty et al. 2018). These changes are disproportionately driven by differences in pay between workplaces rather than differences between colleagues within a workplace (Criscuolo et al. 2020; Tomaskovic-Devey et al. 2020). This is the case both in countries where inequality is increasing such as the USA (Barth et al. 2016; Song et al. 2019) and Germany (Card et al. 2013) as well as in countries where inequality is declining such as Brazil (Alvarez et al. 2018).

This paper describes the trends in earnings inequality in Europe since the 2000s and – crucially – considers changes within and between firms separately. Key macroeconomic trends and institutional factors affect individual wages through firms, making their pay setting mechanisms increasingly important for the level of wages and for inequality (Criscuolo et al. 2020; Tomaskovic-Devey et al. 2020).

The widening of wage inequality between firms requires different policy interventions than inequality within firms. Inequality between firms can be addressed by closing the productivity gaps, increasing the bargaining power of workers overall and regulating certain aspects of wage setting (Criscuolo et al. 2020). Inequality within firms can reflect skill differences, different types of bonuses such as performance pay, rising rewards for managers and executives, and the use of more precarious working conditions (Alvaredo et al. 2013; Lin and Tomaskovic-Devey 2013; Zwysen 2021). Policy interventions would then mainly have to focus on the upskilling and training of workers and possibly setting minimum compensation at firm level.

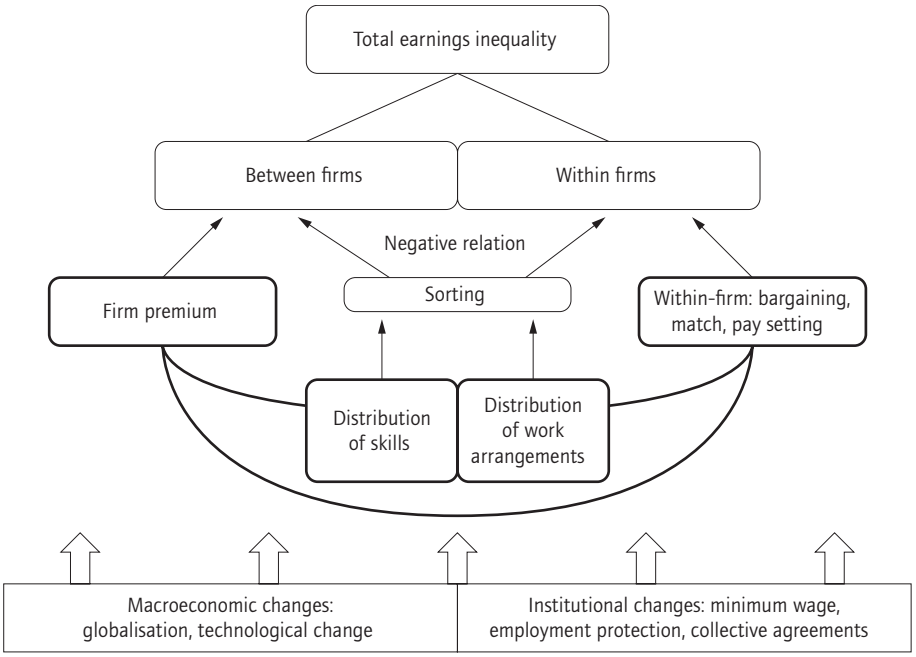
The paper first describes the evolution in wage inequality within and between firms in Europe since the early 2000s. It then links the different components – the composition of firms, differences in how firms reward similar workers and wage inequality within firms – to national and sectoral differences in institutions, globalisation and technological change. It goes on to provide an overview of the main lessons from the literature on the trends in and drivers of wage inequality between and within firms. Finally the paper uses cross-nationally comparable data on wages in Europe to describe the trends and explain the variation over time in the evolution of inequality.

1. Conceptual framework

1.1 Components of earnings inequality

This paper focuses on the distribution of earnings. In a perfectly competitive market, wages reflect differences in skills and productivity among workers. However, due to market imperfections such as search frictions and wage setting by employers in conditions of monopsony, earnings may differ depending on the match between employee and employer (Barth et al. 2016; Mortensen 2003; Song et al. 2019). Firms may also offer higher earnings to attract the best workers or as a way of sharing productivity rents with employees.

Figure 1 **Conceptual framework**



Source: adapted from Criscuolo et al. (2020)

The framework set out in Figure 1 points to three components that can drive the changes in earnings inequality within and between firms. These depend on the division of skills and work arrangements (the composition of workers) and how workers are divided among firms, particularly whether workers with

similar characteristics tend to work together or not (sorting). Between-firm earnings inequality further reflects the variation in the firm premium – i.e. the differences in how firms pay similar workers. Earnings also differ within firms through match-specific productivity complementarities, pay setting including bonuses and rewards to senior management and executives, and differences in bargaining power.

Differences in earnings between workers, depending on their skills and work arrangements, are likely to increase over time. Non-standard work patterns have become increasingly common with increasing numbers working in precarious jobs with generally lower wages (Eurofound 2007; Piasna 2018). Increased variation in the time spent at work also leads to widening differences in earnings. Second, the demand for and supply of skills both vary over time while technological innovations increase demand more rapidly than supply, thus raising the returns to skills (Goos et al. 2014).

Earnings inequality between and within firms reflects the extent to which workers are sorted into firms. Inequality between firms may increase where firms focus more on particular types of workers, for example as a result of concentrating on 'core' activities by removing 'peripheral' tasks such as cleaning, logistics or food services via outsourcing or offshoring. This process can be spurred on by a desire to maximise value for shareholders which has gained in importance (Goldschmidt and Schmieder 2017; Handwerker 2020; Kramarz 2017; Weil 2014). It may also reflect changes in the production process where new technologies can increase complementarities between workers (Håkanson et al. 2020; Iranzo et al. 2008). In that case overall wage inequality would not necessarily change as within-firm wage inequality would remain similar or even diminish but the differences between firms would become larger. However, most studies find that earnings increasingly vary within and between firms (Criscuolo et al. 2020; Tomaskovic-Devey et al. 2020).

An important question is whether higher-skilled workers also tend to work in the more productive and higher-paying firms. Such positive sorting has important consequences for wage inequality overall as well as for the persistence of inequality. If it becomes increasingly difficult to enter higher-wage firms, there will be an increasing divide between workers who are thus sorted into the better-paying firms with good conditions and those who are stuck in lower-paying firms in a secondary labour market.[1]

1. Sorting is not that straightforward to measure as the main method used in the literature to identify firm premia and workers' skills simultaneously – building on work by Abowd et al. (1999) – tends to bias downwardly the correlation between worker and firm pay. This results in many findings of negative or non-existent sorting (see e.g. Andrews et al. 2012; Borovičková and Shimer 2017). Papers that address these issues tend to find substantive sorting of high-wage workers to high-wage firms (Bagger and Lentz 2019; Borovičková and Shimer 2017; Lentz et al. 2018; Torres et al. 2018).

Earnings can also differ between similar workers depending on the firm for which they work – the so-called 'firm premium' (Barth et al. 2016; Card et al. 2017; Lopes de Melo 2017). These differences between firms partly reflect differences based on industry and firm size (Alvarez et al. 2018; Haltiwanger and Spletzer 2020). This means that changes in the composition of firms in terms of size or between industries may also contribute to any differences in earnings (Haltiwanger and Spletzer 2020; Lazear and Shaw 2009).

Even within industries there is substantial earnings variation between firms which is generally interpreted as being due to rent sharing (Criscuolo et al. 2020). Wage differences may reflect differences in firm productivity and revenue, leading to some of those rents being shared with workers in the form of wages (Alvarez et al. 2018; Barth et al. 2016; Card et al. 2017; Serafinelli 2019). Productivity differences increase over time and this is likely to influence some of the difference between firms (Berlingieri et al. 2017). The degree of rent sharing is not equal between firms and may also vary with time (Faggio et al. 2010). On average this depends on the relative bargaining power between workers and the firm, driven downwards by reduced union power and a decline in the role of internal labour markets for firms (Abowd et al. 2009; Guertzgen 2009; Hanley 2011).

Wage inequality within firms among otherwise similar workers could reflect differences in individual bargaining and firms' pay setting mechanisms, or possibly reflect 'fit' between the worker and firm. Wages and rewards for senior executives relative to the median worker within a firm have grown rapidly (Alvaredo et al. 2013; Song et al. 2019). One possible explanation is an increased reliance on returns on financial markets relative to product markets – the financialisation of companies – which limits the bargaining position of workers relative to executives (Godechot 2012; Lin and Tomaskovic-Devey 2013; Weil 2014). Relatedly, firms may also differ in how skills are rewarded and the ranking of wages within the firm. If more productive firms mainly share their profits with higher-skilled workers this would result in larger variation within the firm as well as larger variation between firms among similarly skilled workers (Hanley 2011). One particularly important point here is the growing use by firms of performance pay schemes, especially where bonuses are made relative to the performance of the firm (Eurofound 2016; Lemieux et al. 2009; Zwysen 2021). This is less clearly visible so it facilitates the varying of benefits and bonuses as opposed to wages without weakening social cohesion or feelings of fairness.

1.2 Cross-national evidence on earnings inequality within and between firms

On average, the majority of wage inequality occurs within firms but the proportion between firms differs from around one-fifth up to one-half and, on occasion, even more (Criscuolo et al. 2020; Lazear and Shaw 2009). However, changes in earnings inequality generally occur more between than

within firms. This means that the differences between firms – reflecting the sorting of workers and differences in firms' productivity – are increasing disproportionally (Card et al. 2017; Song et al. 2019).

Recently several studies have used cross-nationally comparative linked employer-employee data to study the role played by firms in wage inequality. The 2016/2017 Global Wage Report by the ILO (ILO 2016) included a focus on wage inequality in the workplace using the European Structure of Earnings Survey for 22 countries between 2002 and 2010. They find that wage inequality has declined over time across Europe with between-firm inequality accounting for slightly more of the change than that within firms.

An OECD project (Criscuolo et al. 2020) uses detailed longitudinal data from 14 OECD countries[2] to study wage inequality from the early 90s to the late 2010s. Longitudinal data allows them to account for worker skills in a more sophisticated way. In line with individual studies they show that dispersion between firms in their wages accounts for half of the change in overall wage inequality. Most of this change between firms is due to productivity-related premia while about one-third can be attributed to compositional changes. This study links productivity dispersion between firms – driven by a widening gap between 'superstar' firms and 'early adaptors' compared to 'laggards' in terms of technology – to widening wage inequality, although they do not yet link these changes directly to institutional factors.

A similar cross-national project (Tomaskovic-Devey et al. 2020) studies between-firm earnings inequality in 14 countries[3] and analyses what is driving the increase. They point to the importance of institutional factors rather than purely market-driven explanations. Where institutions are weakened, between-firm inequality tends to increase.

1.3 The macroeconomic and institutional drivers of inequality within and between firms

The overall rise in wage inequality is often attributed to macroeconomic factors affecting all developed countries. Technological change leads to a polarisation in earnings as some types of work are replaced while others become increasingly sought after. Increased trade and globalisation similarly change the demand for certain skills, at least in a majority of developed countries (Autor et al. 2003; Goos et al. 2014; Michaels et al. 2014). Both factors lead to a demand for high-skilled workers which typically outpaces supply.

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2. Canada, Estonia, France, Germany, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden and the United Kingdom; and published data from the United States.

3. Canada, Czechia, Denmark, France, Germany, Hungary, Israel, Japan, the Netherlands, Norway, Slovenia, South Korea, Sweden and the US.

However, several studies also point to institutional changes, in particular a declining rate of unionisation and, in the US, a decline in the real minimum wage, as the main drivers of growing wage inequality (Fortin et al. 2021; Kristal and Cohen 2017). Institutional factors play a clear role given the large variation in inequality levels and trends between countries (Tomaskovic-Devey et al. 2020). Countries and sectors differ strongly in the degree of regulation of the labour market, including through employment protection legislation, as well as through minimum wages and collective pay agreements. Despite these differences, there are some common trends such as labour market deregulation designed to encourage flexibility and a weakening of collective bargaining and worker representation (Alvaredo et al. 2013; Salverda and Checchi 2014).

The literature has shown that earnings inequality is growing disproportionally between firms and that, while this trend is present in many countries, there is substantial cross-national variation (Criscuolo et al. 2020; Tomaskovic-Devey et al. 2020). This paper uses a cross-nationally comparable European dataset to link this trend to changes in the contextual factors. I focus both on macroeconomic factors – namely globalisation and technological change –as well as institutional factors – minimum wages, employment protection and worker representation.

Globalisation – which entails greater interconnectedness between countries through trade – affects wage inequality in several ways. First, it may increase the returns to skills in richer nations as it becomes possible to offshore certain tasks, meaning the import of intermediate products that complement skilled workers but replace lower-skilled labour (Autor et al. 2016; Kramarz 2017; Michaels et al. 2014). This also weakens the bargaining position of lower-skilled workers. Second, trade openness provides greater opportunities for exporting firms who are able to pay more to screen applicants and hire the most skilled. As countries open up to trade, not all firms will participate in this and the ones that do will have a greater incentive to pay their workers more as the cost of a bad match increases (Davidson et al. 2014; Helpman et al. 2017). Greater trade openness would thus be expected to increase overall wage inequality through affecting the returns to skills, increasing the variation in firm premia and increasing the degree of the sorting of high-skilled workers into high-paying firms.

Technological change has also had several different effects which are likely to have increased inequality. First, by increasing the demand for high-skilled workers the pay difference between high-skilled and lower-skilled would have increased. A related explanation is that technological innovations can replace tasks that were generally more in the middle of the pay distribution, and so contribute to wage polarisation (Autor et al. 2003; Goos et al. 2014). As firms differ in their ability to take up new technologies the differences between firms in their productivity and revenue are widened – which, in turn, increases the differences in firm premia (Berlingieri et al. 2017; Faggio et al. 2010). Technological innovation may also change the optimal skill mix within a firm and increase the rewards for having a homogeneously high-skilled

labour force (Håkanson et al. 2020). Our expectation is that those sectors in which there is greater reliance on and investment in new technologies would have greater inequality, both through larger differences in workers' wages by skill and through greater differences in firm premia.

While these macroeconomic changes are likely to be important, the substantial variation in the levels of and trends in inequality between countries indicates that institutional factors also matter (Alvarez et al. 2018; Kristal and Cohen 2017; Tomaskovic-Devey et al. 2020). Institutional changes are important drivers of inequality in their own right (Fortin et al. 2021; Kristal and Cohen 2017).

First, countries and sectors differ in the strength of worker representation systems and the ways in which wage agreements are made. This affects the relative bargaining strengths of workers and firms. Stronger unions in a firm increase the rents that employers pay to workers (Dencker and Fang 2016; Hanley 2011; Kramarz 2017), thereby increasing earnings but possibly also increasing the extent to which productivity differences feed through to earnings differences. On the other hand, stronger unions also compress the within-firm wage distribution (Barth et al. 2012). Union strength does not only affect unionised workers but, through the threat of unionisation, there are important spillover effects that can affect the wage distribution more widely (Fortin et al. 2021).

The level of collective bargaining is also very important as a more coordinated system compresses the wage differences between firms and reduces the link between firm profitability and wages (Guertzgen 2009; Skans et al. 2009); in contrast, firm-level agreements increase the differences in pay between firms (Garnero et al. 2020; Ramos et al. 2018). Skans et al. (2009) show that earnings inequality in Sweden has increased rapidly since the 80s and 90s as a result of decentralised collective agreements with greater allowance for non-standard types of work such as temporary contracts. Declining trade union power would then be associated with higher wage inequality, definitely so within firms although the effect on inequality between firms is less clear-cut. More centralised wage negotiations would be associated with fewer differences between firms.

Second, the national institutional framework – particularly labour protection and minimum wages – shapes earnings inequality. Minimum wages of course affect the wage distribution both within and between firms (Alvarez et al. 2018; Redmond et al. 2020). Alvarez et al. (2018) attribute the decline in wage inequality, within but especially between firms, primarily to substantial increases in the level of the minimum wage. This mainly affects the bottom of the distribution but has substantial spillover effects to workers above the minimum wage. Fortin et al. (2021) show that, through such spillovers, the decline in minimum wages has had very large effects in terms of changes in wage inequality in the US between 1979 and 2017.

Deregulation and the liberalisation of the labour market affect the constraints firms face in their pay setting. More rigid employment protection legislation may also lead to higher differentiation through other means such as differences in the type of contracts offered or in pay.

2. Data and methodology

The data comes mainly from the Structure of Earnings Survey (SES) – a large cross-national European survey carried out every four years since 2002. It encompasses workplaces outside agriculture and the public sector which have at least ten employees and gathers detailed data on wages, annual earnings and working time from a sample of workers within those workplaces. The SES is restricted to establishments where the details of at least three workers are observed. This allows for the estimation of averages and spread within the establishment.[4] After data cleaning 20 countries are included from 2002[5]-2018[6].

Earnings are measured through log annual earnings, including all types of bonuses, adjusted to 2015 euros.[7] These earnings can be decomposed into three parts: predicted earnings based on observed characteristics;[8] the firm premium which is the wage effect of an establishment common to all its workers; and a residual which captures white noise, unobserved characteristics and the match between a person and firm. Out of these

4. As the sampling scheme varies between countries, the bias that is introduced by only retaining firms with at least three observed workers ranges widely. Bearing this in mind, the results are generalisable to larger firms in the countries included. Table A1 in Appendix B shows the distribution of firm size in 2018 per country (2014 in the UK): it is very low in the UK and the Netherlands where the median firm size was only one worker; and where only 9 per cent and 19 per cent of firms respectively were retained. A far larger proportion (82 per cent of firms on average) of the sample is retained in the other countries.
5. The 2002 wave differs slightly from the other waves in terms of which industries are included in each of the countries and, as the provided weights assume all industries are included, the weights have to be adjusted in order to be comparable.
6. Belgium, Bulgaria, Cyprus, Czechia, Germany, Estonia, Spain, France, Germany, Hungary, Italy, Lithuania, Latvia, the Netherlands, Poland, Portugal, Romania, Sweden, Slovakia and the United Kingdom. Germany and the United Kingdom are only available from 2006 onwards; and 2018 data is not available for the UK. Not all of these countries were members of the EU from the start; and several of the analyses are restricted to only those members in a given year.
7. Within each country-year, the bottom 1 per cent of earnings are dropped and the top 1 per cent are winsorised.
8. Observed characteristics consist of socio-demographic attributes (education (three categories), occupation (ten categories), gender, age (four categories) and the interaction between age and gender); and work arrangements (hours worked, weeks worked in the year and whether the individual works on a temporary contract).

components the full variance of earnings can be decomposed[9] (Barth et al. 2016; Criscuolo et al. 2020) into the part due to composition between firms, composition within firms, an unobserved part within firms and the firm premia. The decomposition method is explained more fully in Appendix A.

These variance components are then analysed at country-industry[10] - firm-size[11] - year level through variables capturing macroeconomic and institutional factors which vary between countries, industries and years. The regression includes controls for the socio-demographic and work arrangement variables aggregated to country-industry-firmsize-year level. The main explanatory variables are log transformed and, as the outcome is the log of the variance components, the coefficients can be interpreted as relative effects.

To capture the importance of trade in an industry I include trade openness – measured as imports plus exports over value added in an industry – as well as the direction of trade by including the share of imports in total trade (imports + exports). Trade data is taken from the OECD Trade in Value Added datasets.[12] I include three further indicators to capture digitalisation based on an OECD taxonomy paper (Calvino et al. 2018). First, a measure of investment both in information and communications technology (ICT) equipment (computer hardware and telecommunications equipment) and in software and databases, in each case as a share of non-residential gross fixed capital formation.[13] A second indicator is the purchase of ICT intermediates as a share of total sectoral output. These are the share of computer services (services offered by the sector 'computer and related activities') and the share of intermediate computer goods (produced by the 'computer and electronics' sector).[14] Finally I include an indicator of the digital-related human capital

9. The standard approach in decomposing wages is through using AKM (Abowd et al. 1999) on longitudinal data and isolating a worker effect which captures all observable and unobserved unchanging worker characteristics, a firm premium which then accounts for all worker characteristics and an error which captures only white noise and matching effects. Criscuolo et al. (2020) include a comparison of firm premia and their contribution to wage inequality in levels and changes when estimated through AKM or through observed characteristics. They show that accounting for unobserved characteristics reduces the contribution of firm premia at all levels but that the effect on overall change is very limited. This indicates that the bias is not likely to change much over time.

10. ISIC3 was used in the 2002 and 2006 waves of the SES; and ISIC4 in 2010 and 2014. These are combined into 20 categories as shown in Table A2. Agriculture, mining and the activities of households as employers are not included.

11. Firm size is included in three categories: 1-49; 50-249; 250+.

12. TiVa at ISIC3 from December 2016 and Trade in Value added Principal indicators (December 2018) at ISIC4 level. Imports, exports and value added per industry-country-year were linked to the SES at industry level.

13. The data is taken from national accounts on oecd.stat by sector (ISIC4) augmented with data from EU KLEMS where missing. It is available at country-industry-year level until 2016. For each year of the SES the average of the two preceding years is taken while the value for 2015-2016 is taken for 2018.

14. This data is taken from the OECD inter-country input-output database and national input-output tables. It is only available until 2015 and this value is used to merge with the 2018 SES.

of a sector measured by its proportion of IT workers[15] taken from the Labour Force Survey. Each indicator is the average of its components.

Union density is taken from the Database on Institutional Characteristics of Trade Unions, Wage Setting, State Intervention and Social Pacts (ICTWSS version 6.1) by country, sector[16] and year and differing between large and smaller firms.[17] To capture further the influence of collective bargaining I include indicators on the share of workers covered by different types of collective pay agreements (CPA): national level; sectoral level; firm or workplace level; other; or not covered. This question is available at firm level from the Structure of Earnings Survey (see e.g. OECD 2018). I include data from the Employment Protection Legislation Index which captures regulations on the dismissal of workers and varies at country-year level. I use the indicator for workers on regular contracts. The Index is based on statutory laws, collective bargaining agreements, case law and expert opinion. The higher the Index, the more regulated and difficult it is to fire workers, introducing greater rigidity to the labour market. To capture the effect of the minimum wage I include the ratio of the minimum wage to the median wage (the Kaitz index),[18] which varies over time and countries. Table A3 shows the level of and changes in these drivers per country.

Finally a more detailed analysis uses the SES aggregated to country-year-industry-firmsize-firm level to analyse the determinants of within-firm inequality and the spread between firms directly.[19] The log of variance at firm-level is regressed on aggregated compositional factors, firm characteristics such as size and type of collective pay agreement and contextual factors including country, year and industry fixed effects. Again country-industry and year fixed effects are included meaning the variation in drivers over time is used.

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15. IT specialists fall into four occupational codes: managers in IT; software developers and analysts; database and network specialists; and technicians in ICT and user support (ISCO 2008 133, 251, 252, 351; and ISCO-88 213 and 312).

16. The ICTWSS can be merged into 12 larger sectors: agriculture, hunting, forestry and fishing; mining and quarrying; manufacturing; electricity, gas and water supply; construction; wholesale and retail trade and repair; hotels and restaurants; transport and communications; financial intermediation; real estate and business activities; public administration; and other services.

17. Union density by sector was adjusted by average union density by firm size in a country. The adjustment factor is union density for large firms [100+] and smaller ones divided by overall union density.

18. The main dataset for minimum wages comes from OECD statistics on the minimum relative to the median wages of full-time workers. Where this is missing, data from Eurostat (earn_mw_cur) is used. In Bulgaria for 2002 and 2006, no information on the ratio of the minimum wage to the median was available. I developed data on this by adjusting the ratio of the minimum to the mean wage by the ratio of the minimum to the median wage in 2010.

19. This analysis is not representative of all firms within the country but, as an extension of the analysis on earnings variation between all workers included in the sample, it groups them into local units and analyses the variation of wages within and between firms.

The spread between firms is estimated through recentred influence functions (Firpo et al. 2009). These functions allow for an analysis of how independent variables shift the unconditional distribution; and, in this paper, are used to study the variance in log hourly wages, compositional factors and firm fixed effects. As a robustness test a second measure of inequality – the ratio between the 90^{th} and 10^{th} percentiles – is also estimated. The models include the same explanatory variables and fixed effects as the aggregate analyses.

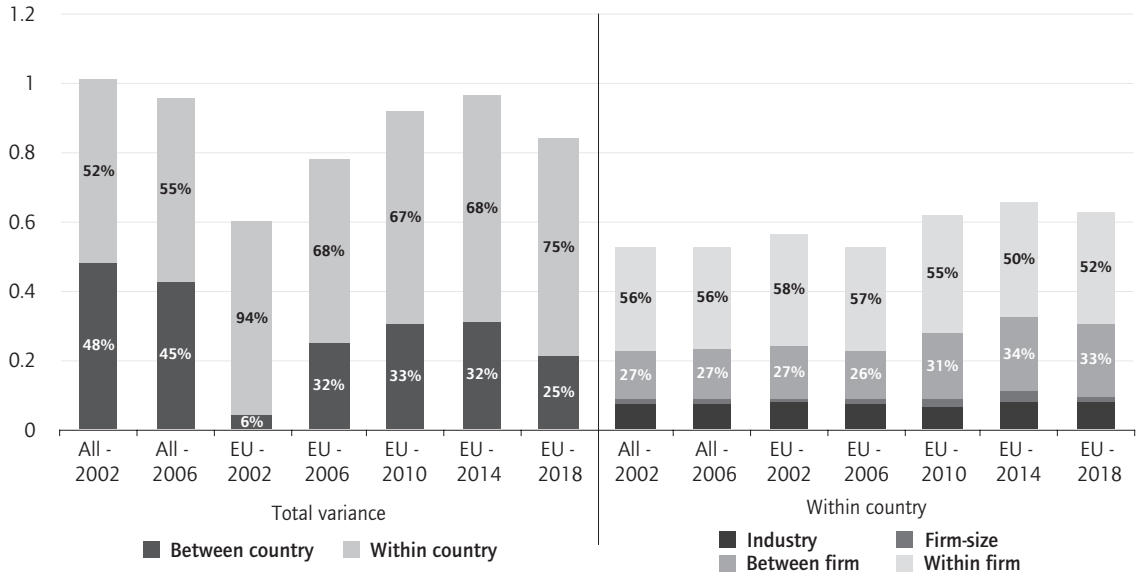
3. Findings

3.1 Earnings inequality across the EU

Earnings inequality within Europe follows two trends from 2002 to 2018: (1) an increase in the between-country variance in earnings as the EU expands in 2004 and again in 2007, followed by a convergence in earnings since then; and (2) an increase in inequality within countries driven by a large increase in inequality between firms, particularly in 2010 and 2014. As shown in Figure 2, looking across all current EU member states there is a clear convergence in variance between firms, making up 48 per cent of total variance in 2002 but falling to 25 per cent in 2018. Combined, earnings inequality rose sharply until 2014 and then dropped somewhat as average earnings in each country became more similar. In 2018 slightly over half of all the variance in earnings occurs within firms (52 per cent). Variance between firms occurs mainly between firms of the same broad sector and firm size (33 per cent) with a further 3 per cent occurring between firm size groups and 12 per cent between sectors. In line with the literature, the increase is disproportionately driven by rising variation between establishments (37 per cent). Differences also increased between firms of different sizes within the same industry (by 50 per cent). Inequality within firms grew very little.

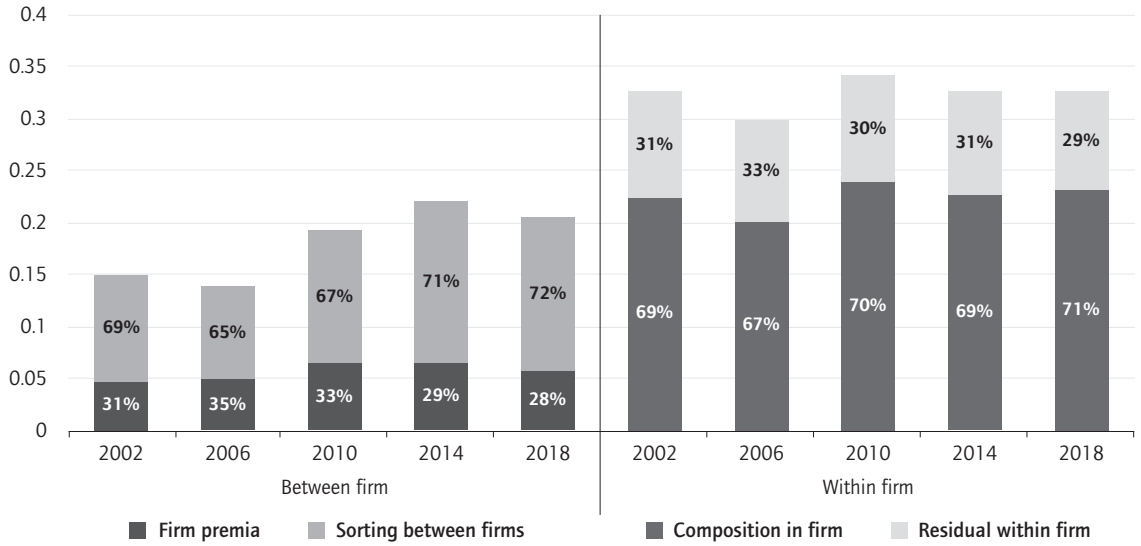
Rising earnings inequality between firms is mainly due to compositional changes, meaning firms hired more similar workers; while the differences in the premium paid by firms to similar workers increased less as shown in Figure 3. At the same time inequality within firms also increased due to worker characteristics, especially by 2010, while residual differences between workers within firms, which could reflect differences in match quality or bargaining, remained stable.

Figure 2 **Earnings converge between countries but inequality increases within countries**



Note: the left panel shows the decomposition of the total variance in annual earnings across 20 EU countries into between-country and within-country parts. The right panel decomposes the within-country variance into parts between industries, between firms within industries and within firms.
'EU' includes all EU member states at that time; while 'all' includes all countries in the sample currently in the EU. Countries included: before 2002: BE, DE, ES, FR, GR, IT, NL, PT, SE, UK; joined in 2004 and included from 2006: CY, CZ, EE, HU, LT, LV, PL, SK; joined in 2007 and included from 2010: BG, RO. UK and Germany were not observed in 2002 so values from 2006 are taken; and the UK is not observed in 2018 so values for 2014 are taken.
Source: SES 2002-2018

Figure 3 **Compositional differences drive the increase in earnings inequality between firms**



Note: the left panel shows the decomposition of earnings variance between firms in 20 EU countries (from their moment of entry) into parts due to variance in firm premia and compositional sorting; while the right panel decomposes the within-firm variance into parts due to worker characteristics and the residual.
Source: SES 2002-2018

Table 1 shows a decomposition of the variance in 2018 both of annual earnings and of hourly earnings as well as the changes in variance from 2002 to 2018 across the European Union. Almost three-quarters of the rise in inequality in annual earnings from 2002 to 2018 is due to greater differences between countries, reflecting the eastwards expansion of the European Union. Of the remainder, 87 per cent of the change occurred between firms within industry – firm-size groups and a further 11 per cent as larger, medium and small firms drifted further apart within industries. Rising differences between firms consist, for the most part, of increasing differences between workers in their observed characteristics – their skills and the way they are rewarded as well as work arrangements. There is a clear sorting between firms which hired similar workers under similar work arrangements but then drifted apart.

Table 1 **Variance decomposition into between- and within-firm components accounting for worker characteristics**

	Annual earnings				Hourly wage			
	2018		2002-2018		2018		2002-2018	
Total variance	**0.839**		**0.235**		**0.536**		**0.197**	
Between countries	0.210		0.172		0.272		0.213	
Within countries	**0.629**	**100%**	**0.063**	**100%**	**0.265**	**100%**	**-0.016**	**100%**
Between industries within country	0.077	12%	0.000	1%	0.031	12%	-0.007	44%
Between firms in similar size group in the same industry	0.021	3%	0.007	11%	0.009	4%	-0.003	21%
Between firms within industry-country	0.205	33%	0.055	87%	0.091	35%	0.004	-24%
Due to firm premia	*0.057*	9%	*0.011*	17%	*0.049*	19%	*0.004*	-25%
Due to worker characteristics	*0.148*	24%	*0.045*	70%	*0.042*	16%	*0.000*	1%
Within firms	0.326	52%	0.000	1%	0.133	50%	-0.010	59%
Due to worker characteristics	*0.230*	37%	*0.006*	10%	*0.055*	21%	*-0.005*	28%
Due to other factors	*0.096*	15%	*-0.006*	-9%	*0.078*	29%	*-0.005*	31%

Note: the table shows the variance of log annual earnings (left) and the variance of log hourly wages (right) aggregated over 20 EU countries (from their moment of entry) in 2018 and the change from 2002-2018. Total variance is decomposed into between-country and within-country parts. The within-country variance is further decomposed into the variance between industries within countries, between firms and within firms. The between-firm variance is decomposed into parts due to worker characteristics and due to firm premia; while the within-firm variance is decomposed into worker characteristics and other factors.
Source: SES 2002-2018

Most of the rising inequality due to work characteristics reflects greater variation in the time spent working. As a result, inequality in earnings grew much faster than inequality in terms of hourly wages which actually declined slightly within countries. The convergence in earnings is driven mainly by declining inequality in hourly wages within firms with the remainder due to a convergence between industries in terms of average pay. The one component that did increase over time on average is inequality in hourly wages between firms which is wholly due to an increase in the firm premia. This suggests that firms do indeed differ more over time in what they pay otherwise similar workers.

These results point to four main processes of earnings inequality in Europe in the 21st century:

- Earnings and wages have converged strongly over time between the countries that now make up the European Union.
- Within countries, inequality in earnings and, to a lesser extent, in wages between firms has mainly increased.
- Workers with similar skills increasingly work together within firms, resulting in more differences between firms and fewer differences within them.
- Non-standard forms of work have increased substantially – more temporary work, more interrupted careers and greater variation in hours worked. This has led to a large increase in the variation in annual earnings and the greatest part of this has occurred between firms. On the other hand the average variance in wages has remained quite stable.

3.2 Trends between countries

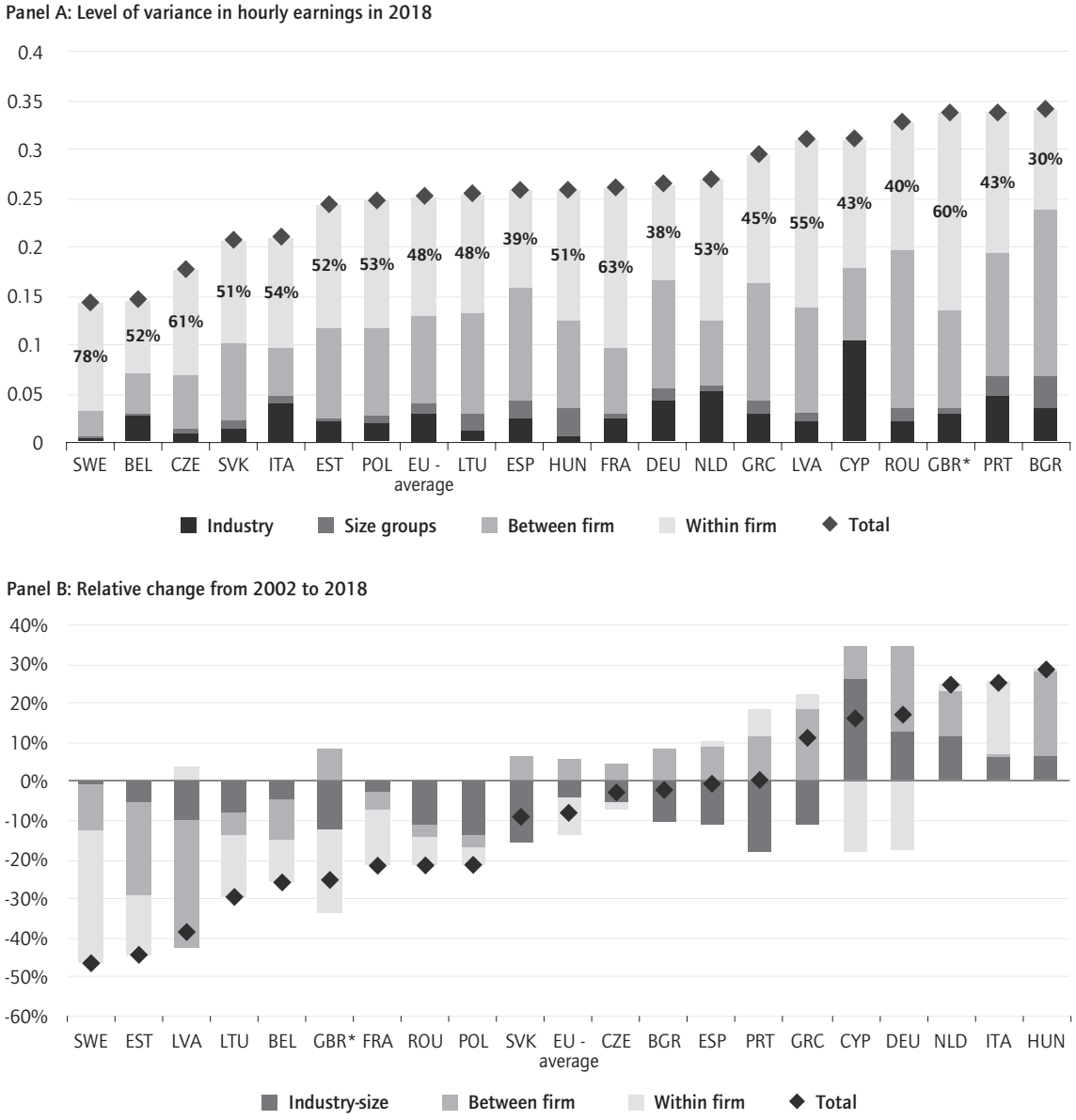
While earnings inequality has increased by around a quarter in the EU as a whole, it has decreased in six countries and grew widest on average in Hungary and Germany, as shown in Figure A1. These large increases in Germany, for instance, reflect rising diversity in work arrangements – wider variation in hours worked and weeks worked in the year and the greater use of temporary contracts. Where countries grew more equal this was mainly due to convergence in pay between firms and between industries. Rising inequality chiefly reflects increasing differences between workers and their sorting into firms. A similar pattern holds for hourly wages: decreasing inequality tends to reflect convergence between industries and, to a lesser extent, between firms; while increases mainly reflect the greater sorting of workers into firms and wider variation in worker characteristics within firms.

The remainder of this paper discusses trends in hourly wages, thereby abstracting from the growing diversity in time spent at work and focusing only on the issue of pay which is most directly linked to large economic and institutional factors. Figure 4 shows the average variance in log hourly wages in 2018 (Panel A) and the relative change (Panel B). The variance in wages declined somewhat on average. It increased most in Greece, Cyprus, Germany, the Netherlands, Italy and Hungary. The variance between firms rose more often, however, increasing in 12 of the 20 countries, and this rising difference is generally the motor behind the rising variance overall. The exception is Italy where wage inequality mainly increased within firms.

This country variation in earnings inequality can partly reflect institutional differences. Table 2 shows the correlation between the variance of log hourly wages at country level and institutional factors (left panel) as well as the relationship in terms of changes within a country (right panel). In general, the variance of wages is lower in countries which have greater union density and a higher number of workers covered by collective pay agreements. In

those countries the variance within and especially between firms tends to be lower. Within countries there is a strong relationship between changes in the minimum wage relative to the median, and changes in the variance of wages both between and within firms. The strictness of employment protection legislation shows little relation to wage inequality as measured in this paper.

Figure 4 **Variance in hourly wages**



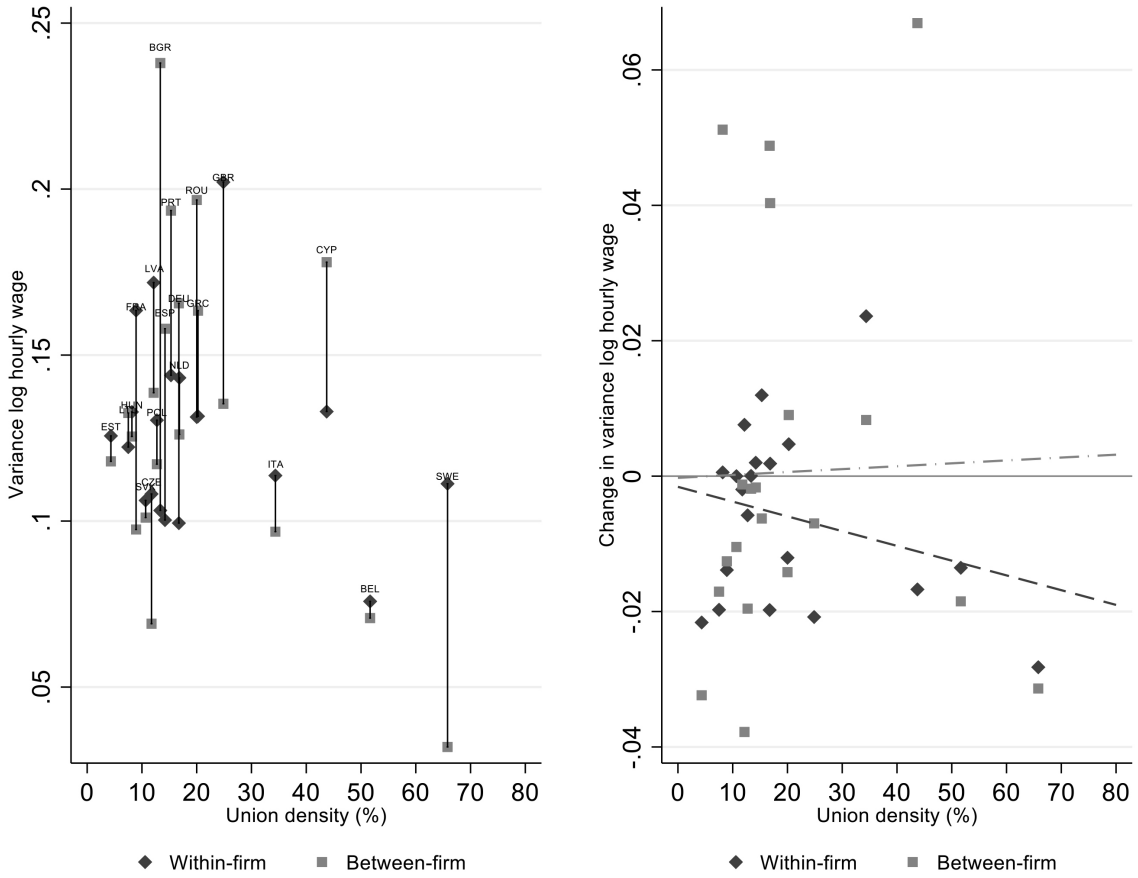
Note: the figure shows the level of the variance in the log hourly wage (A) and the relative change, as a percentage from the earliest level (B), decomposed into between-industry and firm size, between-firm and within-firm components.
* The start year is 2002 for all countries except for the UK and Germany where it is 2006. The end year is 2018 for all countries, except the UK where it is 2014.
Source: SES 2002-2018

Table 2 **Relationship between institutional factors and variance components of log hourly wages**

	Level			Change		
Variance	Total	Between	Within	Total	Between	Within
Union density	-0.32	-0.34	-0.10	0.02	-0.04	0.08
EPL	0.09	0.20	-0.08	0.08	0.11	0.05
Kaitz index	-0.07	-0.07	-0.03	-0.36	-0.29	-0.32
CPA coverage	-0.28	-0.21	-0.26	0.15	-0.03	0.33

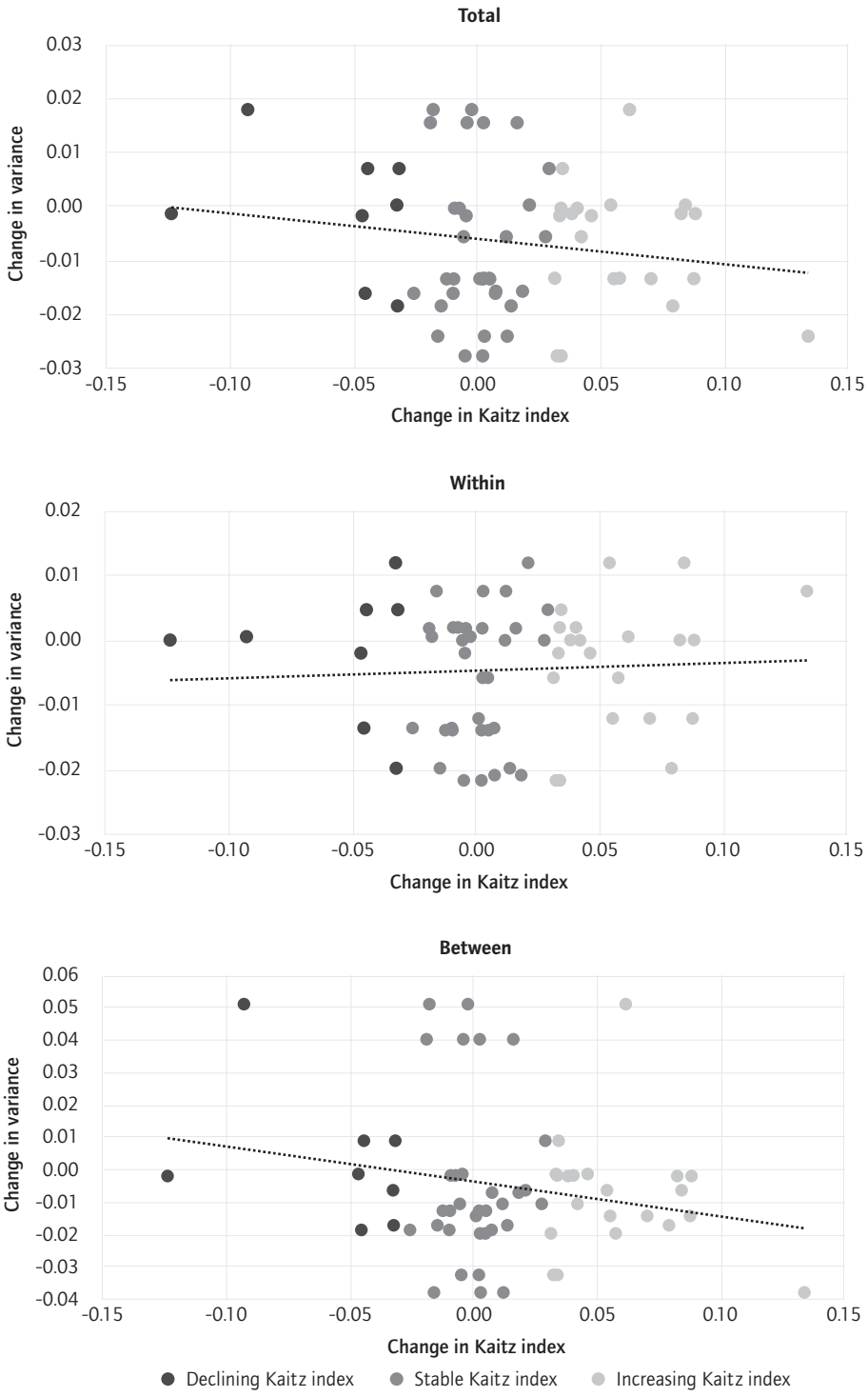
Note: the table shows the correlation between different institutional factors and the overall variance of earnings as well as the between- and within-establishment components. The left panel shows the cross-sectional correlation; the right shows the longitudinal correlation within countries by including country fixed effects.
Source: SES 2002-2018, external datasets (OECD statistics, Eurostat, ICTWSS) for institutional factors

Figure 5 **Variance of hourly wages is higher where union density is lower**



Note: the figure shows the variance in inequality decomposed into within- and between-firm components by union density. It shows the levels in 2018 (left panel) and the overall change from 2002 to 2018 (right panel).
Source: SES 2002-2018 and ICTWSS data on union density

Figure 6 **Changes in the minimum wage and the associated change in the variance of log hourly wages**



Note: the figure shows the changes in the Kaitz index and in the variance of log hourly wages from one wave to the next for those countries with a statutory minimum wage.
Source: SES 2002-2018; OECD statistics and Eurostat for the ratio of the minimum wage to the median

Figure 5 illustrates the relationship between wage inequality and union density. Wage inequality is on average lower in those countries where there is a high rate of union density (Italy, Sweden, Belgium) and higher where union density is quite low (the Baltic states). This overall negative correlation between union density and the variance of hourly wages (-0.3) is driven by the relation of between-firm variance rather than that of within-firm variance. Stronger unions seem to hold the amount of variation between firms mainly in check. As the right panel shows, it is also the case that, in those countries with higher union density, within-firm inequality tends to decline more.

A second important institutional factor affecting inequality is the minimum wage. Figure 6 shows the relationship between the change in the Kaitz index – capturing the bite of the minimum wage – and the change in the variance of wages. In particular, variance between firms tends to decrease in those countries where the minimum wage has had a relatively greater impact whereas it decreases where the minimum wage has had less relative impact. This is in line with a study on changing inequality in Brazil which finds a link between sizeable increases in the minimum wage and declining differences between firms as it changes the way rents are shared (Alvarez et al. 2018). The minimum wage increased by more than five percentage points from one wave of the SES to the next in seven countries (Bulgaria, Hungary, Lithuania, Latvia, Poland, Portugal and Romania) while a minimum wage was introduced in Germany. In seven of these eight countries the variance in wages declined upon the entry of the minimum wage. In the two countries (Bulgaria and Hungary) where the minimum wage declined substantially from one wave to the next the variance in wages increased.

In summary:

- Earnings inequality varies substantially across countries in the EU.
- The variance of wages actually decreased in most countries but, where it increased, differences between firms are a driving force.
- Institutional variation explains some of this country variation: wage variance is lower in countries with higher union density; while an increase in the bite of minimum wages tends to be related to declining wage inequality.

3.3 Variation between sectors and countries

Digitalisation and globalisation affect all countries but differ substantially between sectors. It is therefore important to consider sectoral trends in inequality. Table 3 shows the average change (in percentage points) over time for each industry, accounting for country or firm-size compositional factors. Some sectors have been heavily affected by digitalisation over time (machinery and equipment, transport equipment, other manufacture, transport and communications, financial intermediation and some parts of education in terms of IT specialists) while other sectors (health and social work, hotels and restaurants, construction, utilities) have been affected much less. Trade intensity generally increased from 2002 to 2018 in the countries studied here, particularly across the manufacturing sectors, especially textiles. Mostly,

Table 3 **Average changes from one wave to next by industry in technological change, trade and inequality in log hourly wages (%-points)**

	IT specialists	IT goods and services	IT capital	Trade intensity	Import ratio	Variance total	Within firms	Between firms
Hotels and restaurants	-0.00542	-0.0155	-0.237	1.52	1.6	-2.25	-1.65	-0.604
Real estate and business activities	-2.16	-0.0156	5.37	2.23	-1.35	-1.49	-0.892	-0.598
Food products, beverages and tobacco	0.124	-0.0201	1.15	4.65	-1.95	-1.33	-0.849	-0.482
Other community, social and personal services	0.0133	-0.0145	-0.908	-1.07	0.776	-1.28	-0.69	-0.588
Wholesale and retail trade, and repairs	0.119	-0.00308	1.17	2.3	-1.21	-1.24	-0.938	-0.303
Education	0.0793	0.0498	-0.594	1.96	-4.34	-1.24	-1.99	0.752
Wood and paper products	0.103	-0.00182	0.191	3.46	-2.65	-1.11	-0.689	-0.421
Public administration and defence	-0.0264	-0.0596	-0.966	1.91	-1.43	-0.916	-1.33	0.419
Construction	-0.0185	-0.0654	1.56	-0.425	2.02	-0.902	-0.698	-0.203
Textiles, textile products, leather	0.0803	0.000108	-0.512	7.55	2.58	-0.856	-0.356	-0.5
Basic metals	0.12	0.00256	0.773	3.57	-1.25	-0.818	-0.415	-0.403
Chemicals	0.141	-0.0348	1.04	4.97	-1.94	-0.596	-0.272	-0.324
Machinery and equipment	0.131	0.676	0.542	3.23	-1.91	-0.271	0.0382	-0.309
Transport equipment	0.154	0	0.742	-1.22	-3.15	-0.0534	0.194	-0.247
Health and social work	0.0637	-0.121	-0.885	0.629	-0.329	0.269	-0.0545	0.323
Electricity, gas, and water supply	-0.0239	0.00675	-1.03	0.331	0.835	0.508	-0.247	0.755
Financial intermediation	0.212	0.00413	-0.272	1.97	0.403	1.04	-0.607	1.65
Manufacture n.e.c	0.225	0.0843	1.28	12.6	5.09	1.22	0.592	0.626
Transportation and communications	3.7	0.0313	1.09	1.29	-0.111	1.69	0.203	1.49

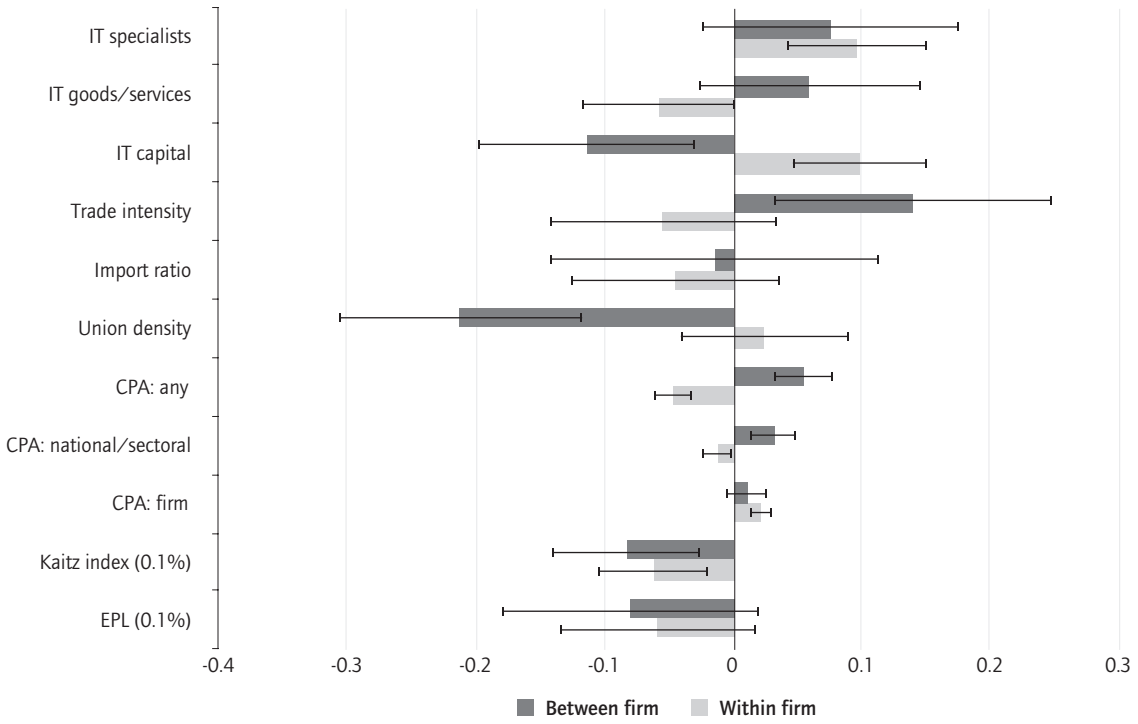
Note: estimated change over time by industry, controlling for firm size and country fixed effects and weighted to be representative. The coefficients show a change in percentage points from one wave to the next with colour codes showing the quartile of changes for each indicator.
Source: SES 2002-2018 and external data on technological change and trade (Eurostat, OECD statistics, EU KLEMS)

with the exception of textiles, other manufacturing and construction, there has been a switch towards exports. While wage inequality has decreased on average, as shown above, there have been sizeable increases in utilities, transport and communications, and financial intermediation.

3.3.1 Analysis at aggregate level

To explain how macroeconomic and institutional factors jointly affect earnings inequality I analyse how inequality has changed over time and whether this change differs between countries and sectors. Figure 7 shows the relationship between a change in the institutional and economic drivers and the variance of hourly wages as it occurs within and between firms. As both are in logs the coefficient can be interpreted as the percentage change in the variance for each 1 per cent change in the drivers (0.1 per cent change in EPL and the Kaitz index). Tables A4 and A5 show the coefficients for these models.

Figure 7 **How macroeconomic and institutional factors affect changes in wage inequality**



Note: the figure shows the estimated effect and 95 per cent confidence interval of a change in the drivers (all except for the CPA dummies in log form) on the log variance components. Each group of drivers (digitalisation, trade, union density, CPA, Kaitz index, EPL) is added separately. The regression includes country, industry, wave, firm size fixed effects and shares of age, educational groups, occupational groups, temporary workers and the proportion of women at the country-industry-firmsize-year level. Regressions are weighted. Standard errors are clustered at the level at which drivers vary (country-industry-year for technological change and trade; country – sector – firm-size - year for union density; and country-year for EPL and the Kaitz index) and are robust for CPA.
Source: SES 2002-2018 and external data on drivers (OECD, Eurostat, EU KLEMS, ICTWSS)

In line with expectations, the variance within and between firms is affected by digitalisation. An increase in the share of IT specialists within a sector is associated with greater differences both within and between firms. Greater consumption of IT goods and services is associated with wider variance in wages between firms while ICT capital is related positively to the variance within firms but negatively to that between them. This indicates that there is not a simple relationship between technological change and innovation and trends in wage inequality, but that both within and between firm variance are affected.

A greater involvement in trade of a sector is associated with greater variance between firms and greater differentiation which could indicate that not all firms profit equally quickly from greater trade. This is in line with export premia increasing the differences between firms in terms of rent sharing and in their desire to attract the best possible workers and pay more for this screening (Davidson et al. 2014; Helpman et al. 2017).

Increases in union density at sectoral level are associated with a substantial decline in wage inequality between firms meaning the steady decline of union density contributed to a drifting apart of firms. This decline in unions might mean that more firms do not have adequate protection and representation, and that these firms increasingly differ in the rents that workers are able to extract. Collective pay agreements, on the other hand, seem to limit the variation in wages within a firm, but not similarly between firms.

If a minimum wage has greater impact, wage inequality between and within firms drops substantially. Minimum wages thus seem to have a sizeable effect overall on the wage distribution and do not merely push all wages up as a form of compensation. This strong effect is in line with findings by Fortin et al. (2021) on how reductions in the minimum wage account for a large part of the increase in US wage inequality, i.e. through spillover effects on a much larger part of the labour market. Employment protection legislation has little association with wage inequality.

In summary, wage inequality seems to be influenced at aggregate level mostly by institutional factors such as changes in the bite of the minimum wage, union density and collective pay agreements. On the other hand macroeconomic factors do also play a role and seem, on the whole, to increase inequality – in terms mostly of within-firm inequality when looking at digitalisation and between firms when looking at trade.

These analyses are repeated when restricting the analysis to large firms of 250 or more employees and to EU member states in any given year (results shown in Table A6). The results are overall very similar in terms of the direction of the effect but, for large firms, the relationship between institutional factors (the Kaitz index and union density) and overall variance tends to be weaker than across all firms, although in the same direction and still remaining substantial.

3.3.2 Analysis at firm level

This final section looks at firms more directly firstly by estimating the variance among workers within each firm directly and secondly by modelling the differences between firms. This analysis is still weighted by the number of workers in each firm so that it is at the same level as the previous analysis and is therefore not representative of the population of firms. These models differ from the aggregate analysis, however, as they include controls for firm characteristics such as composition in terms of education, gender, occupation and size as well as the existence of a collective pay agreement at firm level.

Figure 8 shows the results of an analysis of the log variance of hourly wages within the firm and the log variance of worker characteristics which affect both the variance of wages and the variance of wages due to worker sorting within the firm. Tables A7 and A8 show the full coefficients.

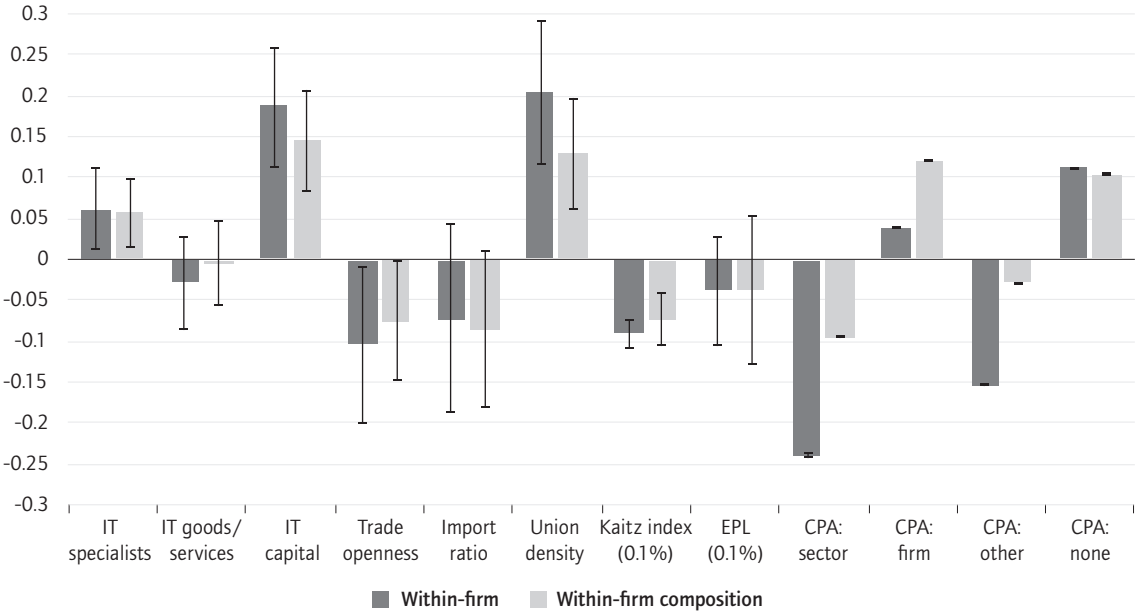
First, wage inequality within firms is larger in sectors with more IT specialists and more investment in ICT capital. This can reflect a production mode where there is a greater dispersion in skills resulting from the use of new technologies (Iranzo et al. 2008). Trade openness is related to a decrease in dispersion within firms and greater homogeneity within the firm. This role of technological change is in line with the aggregate findings above.

Firms that are covered by collective pay agreements of a national, sectoral or other type tend to be more equal in terms of wages than those that are covered by a firm-level agreement or none at all. This is in line with expectations. Wage inequality within firms tends to be lowest in those firms that are covered by sectoral agreements. On the other hand, union density in the country-sector seems positively associated with wage inequality within firms when accounting for other firm characteristics, due to greater compositional variation. This indicates there is less sorting and the firms in sectors with greater union coverage tend to be less homogeneous in terms of the workers they employ.

Minimum wage bite is strongly associated with lower wage inequality and with lower inequality by worker characteristics. Employment protection legislation does not have a statistically significant effect when accounting for more detailed controls at firm level.

This analysis shows that macroeconomic factors do play a role in wage inequality within firms but that there is also a very important role being played by institutional factors such as the coverage of pay agreements and the minimum wage.

Figure 8 **Drivers and institutional factors affecting within-firm wage inequality and worker sorting**

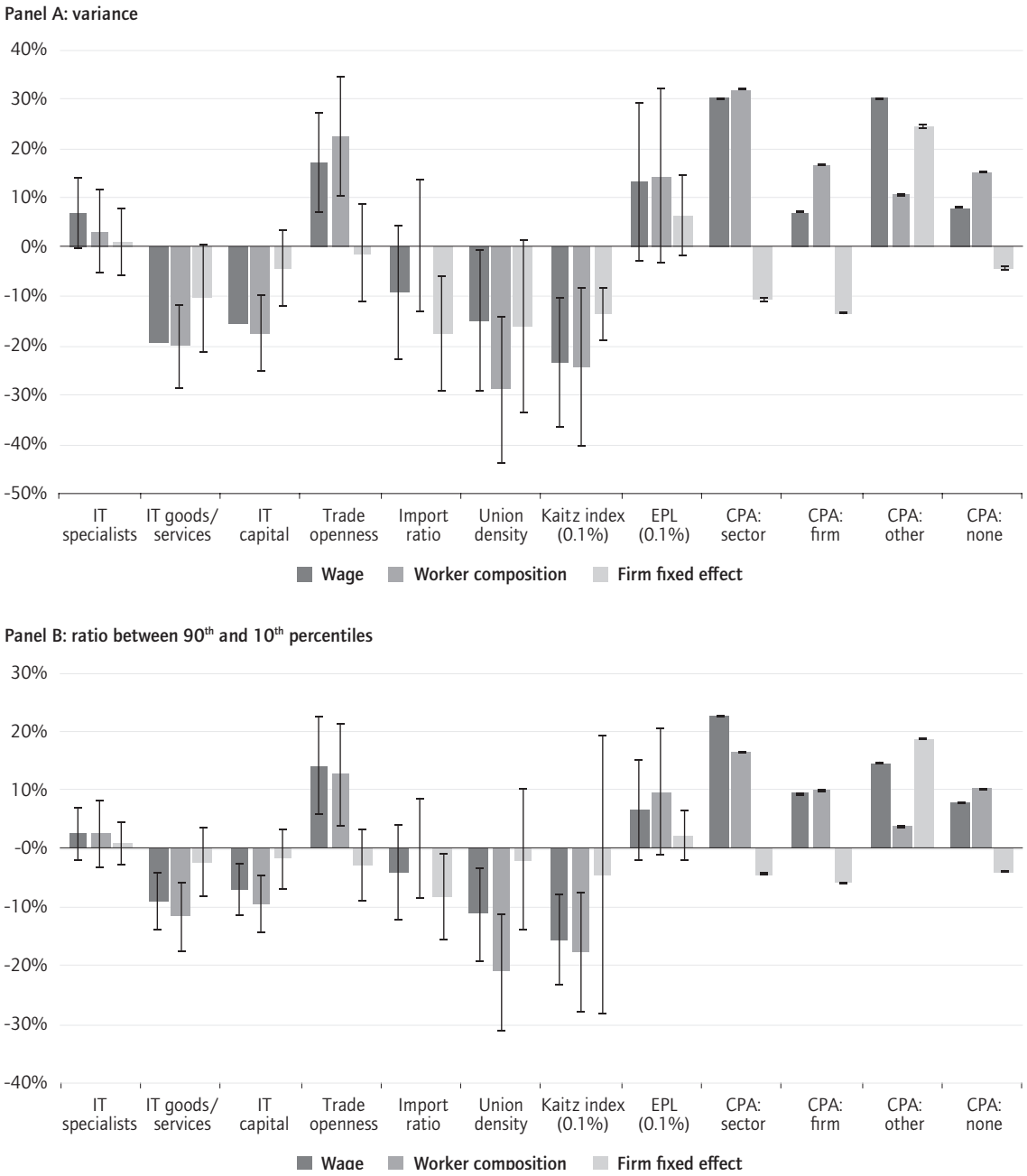


Note: the figure shows the estimated difference and 95 per cent confidence interval in the log variance of log hourly wages and worker characteristics within the firm. The figure shows the effect of a one percentage point change in the drivers (0.1 percentage point in Kaitz index and EPL) in the percentage change in the variance; or of being covered by another type of CPA agreement (sectoral, firm-level, other, or none) rather than a national agreement. Standard errors are clustered at the level at which the drivers vary (country-industry-year for technological change and trade; country-sector-firmsize-year for union density; and country-year for EPL and the Kaitz index) and are robust for CPA. Fixed effects for country, industry, firm size and year as well as controls for composition. Regressions are weighted for observed establishment size.
Source: SES 2002-2018 and external data on drivers (OECD, Eurostat, EU KLEMS, ICTWSS)

Inequality between firms is estimated through recentred influenced functions (Firpo et al. 2009) which allow for an estimation of the effect of independent variables on the distribution of an outcome variable. Panel A of Figure 9 shows the estimated effect of each of the drivers on the variance of log hourly wages between firms, on the component due to sorting between firms and on the firm premia. Panel B shows the same analysis but on the ratio between the 90th and 10th percentiles, which is a different measure of inequality. Full coefficients for the model on variance are shown in tables A9 and A10.

In line with the aggregate analysis and the results within firms, wage dispersion between firms tends to be somewhat smaller in sectors that are more affected by digitalisation. This is due to a reduced sorting of workers. Greater trade, however, is associated with the increased sorting of workers into firms and with greater homogeneity in firms in terms of their workforce. In line with the literature on export premia there is also an association between the import ratio and the dispersion in firm premia which suggests that, where there is an increase in exports, the dispersion in firm premia also increases (Helpman et al. 2017). This can reflect greater rents that then spill over into wages as well as greater competition for workers. The dispersion between firms in wages is lowest where workers are covered by national collective pay agreements but are quite high where they are covered by sectoral agreements.

Figure 9 **Effect of large change in variance between firms**



Note: the figure shows the estimated difference and 95 per cent confidence interval as estimated from a recentred influence function on the variance (panel A) and inter-percentile ratio (p90/p10; panel B) of log hourly wages, worker composition and firm fixed effects between firms. The effect is shown relative to average variance or ratio. Standard errors are clustered at the level at which the drivers vary (country-industry-year for technological change and trade; country-sector-firmsize-year for union density; and country-year for EPL and the Kaitz index) and are robust for CPA. Fixed effects for country, industry, firm size and year as well as controls for composition. Regressions are weighted for observed establishment size.
Source: SES 2002-2018 and external data on drivers (OECD, Eurostat, EU KLEMS, ICTWSS)

As with the aggregate analysis, the impact of institutional factors seems greater than that of macroeconomic changes. Union density at sectoral level is associated with reduced inequality between firms, particularly due to a lower degree of sorting. Inequality between firms tends to be lowest among those that are covered by a national collective pay agreement. In the presence of sectoral agreements there is greater inequality between firms due to compositional differences between workers, but importantly the inequality in firm premia is smaller. These premia vary most among firms covered by other types of collective pay agreement. Changes in the bite of the minimum wage are associated with a reduction in wage inequality.

In summary, the firm-level results highlight the importance of institutional factors besides macroeconomic changes.

- Increasing digitalisation is associated with greater inequality within firms and less inequality between them. This reflects a greater heterogeneity in the workforce of firms in those sectors most affected by technological change.
- The reverse is true with regards to trade: firms in sectors where trade is relatively more important tend to be more homogeneous in their workforce, meaning that workers are more sorted into specific firms which leads to pay differences, and they differ more in the premia they give to workers. This is especially true in sectors that export relatively more.
- Union density at sectoral level is associated with lower inequality between firms but somewhat greater dispersion within them (albeit not statistically significantly so). It is also associated with greater variation between firms especially in the premia.
- Inequality within firms is largest in those that are covered by no agreement or by firm-level agreements. Inequality between firms is lowest when firms are covered by national collective pay agreements.
- Changes in the minimum wage have a profound effect on inequality both within and between firms. They do this mainly via the wage differences associated with worker characteristics rather than through firm premia.

Conclusion

This paper uses comparable cross-national EU data to detail the sources of earnings inequality and the way it has changed over time. The passing of time demonstrates a clear convergence in earnings and wages between European countries. This in itself is already important as it shows the positive effects of European unification and the diminishing of regional inequality.

However, earnings inequality within member states has increased on average. In line with the literature, I show that this increase mainly occurs between firms rather than within them. The most important driver of rising earnings inequality is the increasing variation in work arrangements – as the standard of full-time employment and indefinite contracts becomes less and less the norm, the variation in earnings increases substantially. The variance in hourly wages does not increase on average but, even accounting for work types, the pay differences between firms do increase.

There are several plausible reasons that could lead to rising inequality between firms: technological change and increasing global trade, on the one hand; and institutional changes in terms of worker representation and state regulation on the other.

This paper shows that macroeconomic trends have relatively modest effects relative to the institutional factors. Wage inequality does tend to increase in sectors that experience technological change the most while trade is also associated with rising wage inequality both within and between firms. This is in line with expectations and with the literature showing that these drivers affect both the sorting of workers into firms and – through firm performance – greater variation due to firm premia.

However, institutional factors tend to be substantially more important. Here there is clearly a very strong association with the minimum wage: inequality between and within firms tends to decline as the bite of the minimum wage – where it is present – increases. This offers descriptive evidence that an increase in the minimum wage to 60 per cent of the gross median wage across Europe – which is everywhere higher than its current level – would be likely to reduce wage inequality both within and between firms (Müller and Schulten 2020).

Worker representation also has a clear descriptive relationship with wage inequality within and between firms. Collective pay agreements have the

clearest effect on inequality within firms. However they may also increase differences due to the extraction of rents which then translates firm differences in performance to the level of workers' wages. This paper shows that a reduction in the strength of trade unions is associated with increasing wage inequality, particularly between firms. This is problematic since, over the EU as a whole, the percentage of workers not covered by any collective pay agreement has increased from 11 per cent in 2002 to 30 per cent in 2018 while union density has dropped from 25 per cent to 19 per cent. The strengthening of rights to collective bargaining could, therefore, be one way to help reduce the widening gaps in pay between firms and will themselves have repercussions for the opportunities for everyone to have access to good jobs.

This importance of institutions is in line with recent work by Fortin et al. (2021), but also Kristal and Cohen (2017), pointing to the importance of institutional factors in wage inequality even beyond the often-studied macroeconomic trends. A previous study on earnings inequality using administrative cross-national data also points to this importance of institutions (Tomaskovic-Devey et al. 2020).

This paper shows that, even in the face of large economic changes that affect all countries, there is a very important role to be played by the government and by the institutions which govern pay within each country. The great variation between countries in the extent to which inequality increases – where it does increase – is a clear indication of the importance of institutional factors. If the aim is to diminish inequality, it is important to limit the differentiation between firms in their pay setting mechanisms. This can be done most straightforwardly by setting robust minimum standards, providing support for different forms of worker representation that increase the bargaining power of workers and – especially in the face of technological change or trade opportunities – by helping less productive employers to catch up.

References

Abowd J., Haltiwanger J. and Lane J. (2009) Wage structure and labor mobility in the United States, in Lazear E.P. and Shaw K.L. (eds.) The structure of wages: an international comparison, Chicago, University of Chicago Press, 81-100.

Abowd J.M., Kramarz F. and Margolis D.N. (1999) High wage workers and high wage firms, Econometrica, 67 (2), 251–333.

Alvaredo F., Atkinson A.B., Piketty T. and Saez E. (2013) The top 1 percent in international and historical perspective, Journal of Economic Perspectives, 27 (3), 3–20.

Alvarez J., Benguria F., Engbom N. and Moser C. (2018) Firms and the decline in earnings inequality in Brazil, American Economic Journal: Macroeconomics, 10 (1), 149–189.

Andrews M.J., Gill L., Schank T. and Upward R. (2012) High wage workers match with high wage firms: Clear evidence of the effects of limited mobility bias, Economics Letters, 117 (3), 824–827.

Atkinson A.B. (2007) The distribution of earnings in OECD countries, International Labour Review, 146 (1-2), 41–60.

Autor D.H., Dorn D. and Hanson G.H. (2016) The China shock: learning from labor-market adjustment to large changes in trade, Annual Review of Economics, 8, 205–240.

Autor D.H., Levy F. and Murnane R.J. (2003) The skill content of recent technological change: an empirical exploration, The Quarterly Journal of Economics, 118 (4), 1279–1333.

Bagger J. and Lentz R. (2019) An empirical model of wage dispersion with sorting, The Review of Economic Studies, 86 (1), 153–190.

Barth E., Bratsberg B., Hægeland T. and Raaum O. (2012) Performance pay, union bargaining and within-firm wage inequality, Oxford Bulletin of Economics and Statistics, 74 (3), 327–362.

Barth E., Bryson A., Davis J.C. and Freeman R. (2016) It's where you work: increases in the dispersion of earnings across establishments and individuals in the United States, Journal of Labor Economics, 34 (52), S67–S97.

Berlingieri G., Blanchenay P. and Criscuolo C. (2017) The great divergence(s), OECD Science, Technology and Industry Policy Papers 39, Paris, OECD Publishing.

Borovičková K. and Shimer R. (2017) High wage workers work for high wage firms, Working paper 24074, Cambridge, MA, National Bureau of Economic Research.

Calvino F., Criscuolo C., Marcolin L. and Squicciarini M. (2018) A taxonomy of digital intensive sectors, OECD Science, Technology and Industry Working Papers 2018/14, Paris, OECD Publishing.

Card D., Cardoso A.R., Heining J. and Kline P. (2017) Firms and labor market inequality: evidence and some theory, Journal of Labor Economics, 36, S13–S70.

Card D., Heining J. and Kline P. (2013) Workplace heterogeneity and the rise of West German wage inequality, The Quarterly Journal of Economics, 128 (3), 967–1015.

Criscuolo C. et al. (2020) Workforce composition, productivity and pay: the role of firms in wage inequality, OECD Economics Department Working Papers 1603, Paris, OECD Publishing.

Davidson C., Heyman F., Matusz S., Sjöholm F. and Zu S. C. (2014) Globalization and imperfect labor market sorting, Journal of International Economics, 94 (2), 177–194.

Dencker J.C. and Fang C. (2016) Rent seeking and the transformation of employment relationships: the effect of corporate restructuring on wage patterns, determinants, and inequality, American Sociological Review, 81 (3), 467–487.
Eurofound (2016) Changes in remuneration and reward systems, Luxembourg, Publications Office of the European Union.
Eurofound (2007) Part-time work in European companies, Luxembourg, Office for Official Publications of the European Communities.
Faggio G., Salvanes K.G. and Van Reenen J. (2010) The evolution of inequality in productivity and wages: panel data evidence, Industrial and Corporate Change, 19 (6), 1919–1951.
Firpo S., Fortin N.M. and Lemieux T. (2009) Unconditional quantile regressions, Econometrica, 77 (3), 953–973.
Fortin N.M., Lemieux T. and Lloyd N. (2021) Labor market institutions and the distribution of wages: The role of spillover effects, Working paper 28375, Cambridge, MA, National Bureau of Economic Research.
Garnero A., Rycx F. and Terraz I. (2020) Productivity and wage effects of firm-level collective agreements: evidence from Belgian linked panel data, British Journal of Industrial Relations, 58 (4), 936–972.
Godechot O. (2012) Is finance responsible for the rise in wage inequality in France?, Socio-Economic Review, 10 (3), 447–470.
Goldschmidt D. and Schmieder J.F. (2017) The rise of domestic outsourcing and the evolution of the German wage structure, The Quarterly Journal of Economics, 132 (3), 1165–1217.
Goos M., Manning A. and Salomons A. (2014) Explaining job polarization: routine-biased technological change and offshoring, American Economic Review, 104 (8), 2509–2526.
Guertzgen N. (2009) Rent-sharing and collective bargaining coverage: evidence from linked employer–employee data, The Scandinavian Journal of Economics, 111 (2), 323–349.
Håkanson C., Lindqvist E. and Vlachos J. (2020) Firms and skills: the evolution of worker sorting, Journal of Human Resources, 56 (2), 1-46.
Haltiwanger J.C. and Spletzer J.R. (2020) Between firm changes in earnings inequality: the dominant role of industry effects, Discussion Paper 12990, Bonn, Institute of Labor Economics.
Handwerker E.W. (2020) Outsourcing, occupationally homogeneous employers, and growing wage inequality in the United States, Working paper 522, Washington DC, U.S. Bureau of Labor Statistics.
Hanley C. (2011) Investigating the organization sources of high-wage earnings growth and rising inequality, Social Science Research, 40 (3), 902–916.
Helpman E., Itskhoki O., Muendler M.-A. and Redding S.J. (2017) Trade and inequality: from theory to estimation, Review of Economic Studies, 84 (1), 357–405.
ILO (2016) Global wage report 2016/17: Wage inequality in the workplace, Geneva, ILO.
Iranzo S., Schivardi F. and Tosetti E. (2008) Skill dispersion and firm productivity: an analysis with employerčemployee matched data, Journal of Labor Economics, 26 (2), 247–285.
Kramarz F. (2017) Offshoring, wages, and employment: evidence from data matching imports, firms, and workers, in Fontagné L. and Harrison A. (eds.) The factory-free economy: outsourcing, servitization, and the future of industry, Oxford, Oxford University Press, 257-301.

Kristal T. and Cohen Y. (2017) The causes of rising wage inequality: the race between institutions and technology, Socio-Economic Review, 15 (1), 187–212.
Lazear E.P. and Shaw K.L. (2009) Wage structure, raises and mobility: an introduction to international comparisons of the structure of wages within and across firms, in Lazear E.P. and Shaw K.L. (eds.) The structure of wages: an international comparison, Chicago, University of Chicago Press, 1–57.
Lemieux T., MacLeod W.B. and Parent D. (2009) Performance pay and wage inequality, The Quarterly Journal of Economics, 124 (1), 1–49.
Lentz R., Piyapromdee S. and Robin J.-M. (2018) On worker and firm heterogeneity in wages and employment mobility: evidence from Danish register data, Discussion paper 91, Bangkok, Puey Ungphakorn Institute for Economic Research.
Lin K.-H. and Tomaskovic-Devey D. (2013) Financialization and U.S. income inequality, 1970-2008, American Journal of Sociology, 118 (5), 1284–1329.
Lopes de Melo R. (2017) Firm wage differentials and labor market sorting: reconciling theory and evidence, Journal of Political Economy, 126 (1), 313–346.
Michaels G., Natraj A. and Van Reenen J. (2014) Has ICT polarized skill demand? Evidence from eleven countries over twenty-five years, The Review of Economics and Statistics, 96 (1), 60–77.
Mortensen D.T. (2003) Wage dispersion: why are similar workers paid differently?, Cambridge, MA, MIT Press.
Müller T. and Schulten T. (2020) The European minimum wage on the doorstep, Policy Brief 1/2020, Brussels, ETUI.
OECD (2018) The role of collective bargaining systems for good labour market performance, in OECD Employment Outlook 2018, Paris, OECD Publishing, 73-122.
OECD (2015) In it together: why less inequality benefits all, Paris, OECD Publishing.
Piasna A. (2018) Scheduled to work hard: The relationship between non-standard working hours and work intensity among European workers (2005–2015), Human Resource Management Journal, 28 (1), 167–181.
Piketty T., Saez E. and Zucman G. (2018) Distributional national accounts: methods and estimates for the United States, The Quarterly Journal of Economics, 133 (2), 553–609.
Ramos, R., Sanroma E. and Simon H. (2018) Wage differentials by bargaining regime in Spain (2002-2014): An analysis using matched employer-employee data, Discussion paper 12013, Bonn, Institute of Labor Economics.
Redmond P., Doorley K. and McGuinness S. (2020) The impact of a minimum wage change on the distribution of wages and household income, Discussion paper 12914, Bonn, Institute of Labor Economics.
Salverda W. and Checchi D. (2014) Labour-market institutions and the dispersion of wage earnings, Discussion paper 8220, Bonn, Institute of Labor Economics.
Serafinelli M. (2019) "Good" firms, worker flows, and local productivity, Journal of Labor Economics, 37 (3), 747–792.
Skans O.N., Edin P.-A. and Holmlund B. (2009) Wage dispersion between and within plants: Sweden 1985-2000, in Lazear E.P. and Shaw K.L. (eds.) The structure of wages: an international comparison, Chicago, University of Chicago Press, 217-260.
Song J., Price D.J., Guvenen F., Bloom N. and von Wachter T. (2019) Firming up inequality, The Quarterly Journal of Economics, 134 (1), 1–50.
Tomaskovic-Devey D. et al. (2020) Rising between-workplace inequalities in high-income countries, Proceedings of the National Academy of Sciences of the United States of America, 117 (17), 9277-9283.

Torres S., Portugal P., Addison J.T. and Guimarães P. (2018) The sources of wage variation and the direction of assortative matching: Evidence from a three-way high-dimensional fixed effects regression model, Labour Economics, 54, 47–60.
Weil D. (2014) The fissured workplace: why work became so bad for so many and what can be done to improve it, Cambridge, MA, Harvard University Press.
Zwysen W. (2021) Performance pay across Europe: drivers of the increase and the link with wage inequality, Working paper 2021.06, Brussels, ETUI.

Appendix

Appendix A: Decomposition of variance

Log earnings can be decomposed into three parts, as shown in equation 1, for individuals i in firm j. The first part is the predicted wage based on observed characteristics X_{ij} – consisting of individual socio-demographic characteristics (S) containing education (3 categories), occupation (10 categories), gender, age (4 categories) and the interaction between age and gender; and work arrangements (W) containing hours worked, weeks worked in the year and whether the individual works on a temporary contract. The second part is a firm premium φj which is the premium paid to all workers in the firm, accounting for the composition of observed characteristics. Finally there is the residual wage ε_{ij} which captures white noise but also further unobserved characteristics such as motivation, a matching effect or complementarity between the worker and the firm affecting wages and within-firm differences in pay setting.

Equation 1a: $\ln(y_{ij}) = \alpha + \beta X_{ij} + \varphi_j + \varepsilon_{ij}$

Equation 1b: $\beta X_{ij} = \beta_1 S_{ij} + \beta_2 W_{ij}$

Following the work by Barth et al. (2016) this decomposition allows for a decomposition of variance. I first decompose the total variance of earnings into its component parts: worker composition $[Var(\beta X_{ij})]$ (itself composed of worker socio-demographics $[Var(\beta_1 S_{ij})]$, work arrangements $[Var(\beta_2 W_{ij})]$ and the association between them $[2Cov(\beta_1 S_{ij}, \beta_2 W_{ij})]$); firm premia $[Var(\varphi_j)]$; and residual variance $[Var(\varepsilon_{ij})]$.

Equation 2a: $Var(\ln(y_{ij})) = Var(\beta X_{ij}) + Var(\varphi_j) + 2 * Cov(\beta X_{ij}, \varphi_j) + Var(\varepsilon_{ij})$

Equation 2b: $Var(\beta X_{ij}) = Var(\beta_1 S_{ij}) + Var(\beta_2 W_{ij}) + 2 * Cov(\beta_1 Sij, \beta_2 W_{ij})$

Total variance can also be decomposed into the variance within and between firms. Following Barth et al. (2016) the within- and between-firm variance can be decomposed using the components of equation 1. This requires the calculation of two associated components: segregation, as the relationship between worker skills and average skills within the firm $\rho_{seg} = \frac{Cov(\beta X_{ij}, \overline{\beta X_j})}{Var(\beta X_{ij})}$; and sorting, as the relationship between worker skills and the average firm premium $\rho_{sort} = \frac{Cov(\beta X_{ij}, \varphi_j)}{Var(\beta X_{ij})}$.

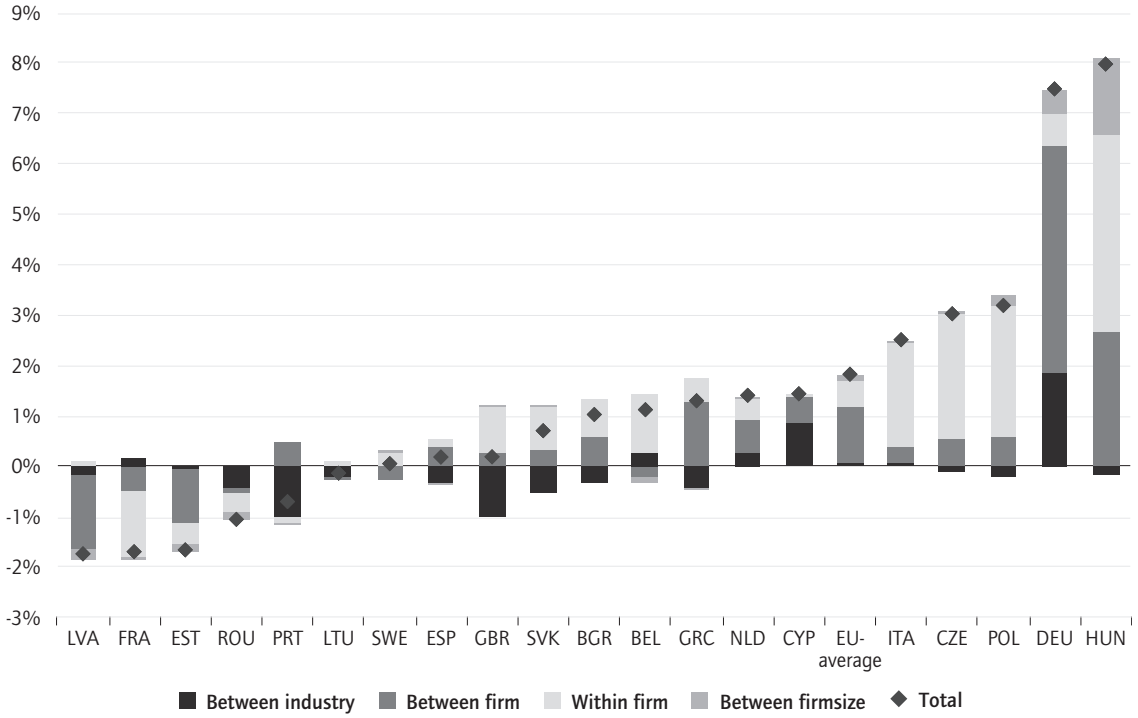
Equation 3a: $Var_{between} = Var(\beta X_{ij}) * (\rho_{seg} + 2 * \rho_{sort}) + Var(\varphi_j)$

Equation 3b: $Var_{within} = Var(\beta X_{ij}) * (1 - \rho_{seg}) + Var(\varepsilon_{ij})$

Not all workers within a firm are observed in the SES, so the share of within-firm variance is biased downwards while that of between-firm variance is biased upwards. To account for this I apply corrections to the within- and between-firm variance when analysing its evolution over time, following work by Hakanson et al. (2020). The within- firm variance of earnings y for individual i in firm j, where there are N_j workers in the firm and n_j are observed, is then estimated as: $\frac{N_j - n_j}{N_j n_j} * (\frac{1}{n_j - 1}) \sum_i (y_{ij} - \bar{y}_j)^2$ and the between-firm variance as $\frac{1}{n} \sum_j n_j \left[(\bar{y}_j - \bar{y})^2 - \frac{N_j - n_j}{N_j n_j} * (\frac{1}{n_j - 1}) \sum_i (y_{ij} - \bar{y}_j)^2 \right]$. The SES does not record total firm size for all countries, but it does include categories of size. For those countries where firm size is not included, this was imputed based on regressing the number of employees on firm size categories and industry. If the imputation fell below the firm size range, it was recoded to the lowest boundary and, if it fell above, it was recoded to the upper boundary.

Appendix B: Tables and figures

Figure A1 **Relative change from 2002 to 2018**



Note: relative yearly change in total variance in log earnings decomposed into between industry, within industry between firmsize, between firm and within firm components.
Source: SES 2002-2018

Table A1 **Distribution of firms and workers within firms in 2018**

country_num	No. of firms	Establishment size	Median establishment size	Median observed in establishment	Share with at least 3 workers
BE	8,043	783	110	17	97%
BG	17,331	156	21	3	57%
CY	1,372	510	613	3	58%
CZ	19,106	234	21	18	90%
DE	68,553	163	13	7	79%
DK	58,309	913	109	17	89%
EE	6,308	441	20	10	70%
ES	25,679	163	18	5	79%
FI	1	1,969	1,969	315,934	100%
FR	39,163	189	51	3	53%
GR	5,560	79	23	4	59%
HR	2,535	419	100	31	100%
HU	24,428	687	97	10	84%
IT	38,619	583	100	4	74%
LT	4,445	112	20	5	99%
LU	1	607	607	57,389	100%
LV	8,274	45	9	8	75%
MT	1,775	517	509	3	52%
NL	51,863	157	20	1	19%
PL	23,707	147	26	21	94%
PT	9,454	66	16	7	85%
RO	19,972	549	100	15	81%
SE	4,691	652	106	18	99%
SI	1	107	107	311,187	100%
SK	8,357	305	95	35	94%
UK	107,734	988	466	1	9%
Total	38,238	367	23	7	72%

Note: the number of firms per country, with their average share of observed workers, the median and the percentage of firms with three or more workers.
Source: SES 2018 (2014 for the UK)

Table A2 **Industry classification based on ISIC3 and ISIC4**

Industry classification	ISIC3	ISIC4
Food products, beverages and tobacco	15 to 16	10 to 12
Textiles, textile products, leather and footwear	17 to 19	13 to 15
Wood, paper, pulp, printing	20 to 22	16 to 18
Chemical, rubber, plastics, fuel, other non-metallics	23 to 26	19 to 23
Basic metals and fabricated metal products	27 to 28	24 to 25
Machinery and equipment	29 to 33	26 to 28
Transport equipment	34 to 35	29 to 30
Manufacture n.e.c.	36 to 37	31 to 33
Electricity, gas, water supply	40 to 41	35 to 39
Construction	45	41 to 43
Wholesale and retail trade; repairs	50 to 52	45 to 47
Hotels and restaurants	55	55 to 56
Transport, storage and communications	60 to 64	49 to 53, 58 to 63
Financial intermediation	65 to 67	64 to 66
Real estate, renting and business activities	70 to 74	68 to 75
Education	80	85
Health and social work	85	86 to 88
Other community, social and personal services	90 to 93	90 to 96
Extra-territorial organisations and bodies	99	99
Public administration and defence; compulsory social security	75	84

Table A3 **Level of and change in drivers per country**

Country	Level or change	Digita-lisation	Trade intensity	Import ratio	Union density	CPA: national	CPA: industry	CPA: firm	CPA: other	CPA: none	Kaitz index	EPL
BE	level	0.12	0.41	0.47	54.13	0.00	0.70	0.20	0.00	0.10	0.43	2.07
BE	change	0.26	0.16	0.01	-9.85	-0.25	0.17	0.06	0.00	0.02	-0.07	0.38
BG	level	1.22	0.49	0.43		0.00	0.11	0.19	0.00	0.70	0.63	
BG	change	0.35	-0.14	-0.13		0.00	-0.07	-0.09	0.00	0.15	0.08	
CY	level	0.26	0.57	0.53		0.00	0.39	0.12	0.00	0.49		
CY	change	0.35	-0.15	0.15		-0.07	-0.38	0.06	-0.03	0.42		
CZ	level	0.04	0.48	0.46	14.50	0.00	0.09	0.42	0.00	0.49	0.42	3.26
CZ	change	0.13	0.09	-0.03	-8.99	0.00	0.04	-0.18	0.00	0.14	0.03	-0.38
DE	level	0.31	0.28	0.53	20.24	0.00	0.31	0.04	0.13	0.52	0.48	2.60
DE	change	0.18	0.05	-0.04	-5.75	0.00	-0.05	-0.05	0.05	0.04		0.00
EE	level	0.25	0.52	0.46	11.40	0.01	0.00	0.03	0.00	0.96	0.43	1.81
EE	change	0.67	0.06	-0.01	4.15	0.00	-0.03	-0.07	0.00	0.10	0.06	
ES	level	0.01	0.23	0.37	17.59	0.00	0.67	0.21	0.00	0.13	0.41	1.96
ES	change	0.24	0.01	-0.08	-4.92	0.00	-0.04	0.01	-0.04	0.08	0.06	-0.39
FR	level	0.13	0.28	0.48	12.19	0.03	0.81	0.02	0.14	0.00	0.62	2.56
FR	change	0.15	0.12	0.07	0.45	-0.93	0.95	0.01	0.03	-0.06	-0.02	-0.02
GR	level	0.24	0.40	0.37		0.58	0.12	0.18	0.05	0.07	0.46	2.45
GR	change	-0.13	0.09	-0.09		0.23	-0.38	0.11	0.00	0.03	-0.01	-0.68
HU	level	-0.08	0.50	0.51	12.24	0.00	0.04	0.09	0.00	0.86	0.52	1.59
HU	change	0.14	0.08	-0.09	-9.93	0.00	0.02	-0.12	0.00	0.11	-0.05	-0.42
IT	level	0.00	0.22	0.44	33.99	1.00	0.00	0.00	0.00	0.00		2.47
IT	change	0.14	0.04	-0.04	5.18	0.06	0.00	0.00	0.00	-0.06		-0.54
LT	level	-0.08	0.51	0.51	11.49	0.00	0.07	0.16	0.00	0.78	0.50	2.13
LT	change	0.13	0.13	0.00	-7.71	0.00	0.05	-0.02	0.00	-0.04	0.04	
LV	level	-0.18	0.37	0.49	16.11	0.00	0.04	0.30	0.00	0.66	0.50	3.02
LV	change	0.24	0.00	-0.07		0.00	0.01	-0.01	0.00	0.00	0.13	
NL	level	0.46	0.32	0.45	21.46	0.00	0.74	0.12	0.00	0.15	0.47	3.44
NL	change	0.22	0.09	0.03	-9.58	0.00	0.70	0.06	-1.00	0.24	-0.01	0.14
PL	level	0.26	0.38	0.47	16.07	0.02	0.00	0.31	0.00	0.67	0.51	2.33
PL	change	0.43	0.08	-0.10	-8.96						0.10	0.00
PT	level	-0.15	0.37	0.43	38.25	0.35	0.06	0.22	0.26	0.12	0.63	3.14
PT	change	-0.64	0.09	-0.04		0.12	-0.24	-0.03	0.08	0.07	0.13	-1.45
RO	level	-0.13	0.32	0.60		0.14	0.05	0.75	0.00	0.05	0.58	
RO	change	0.08	-0.01	-0.02		0.00	-0.07	0.01	0.00	0.06	0.21	
SE	level	0.79	0.26	0.45	71.68	0.00	0.93	0.00	0.00	0.07		2.45
SE	change	0.79	0.01	-0.02	-2.03							0.00
SK	level	-0.04	0.52	0.48	10.72	0.00	0.36	0.29	0.00	0.35	0.49	2.51
SK	change	0.11	0.03	-0.02	-20.06	0.00	0.18	-0.17	-0.04	0.04	0.07	-0.63
UK	level	0.58	0.20	0.48	28.34	0.00	0.38	0.22	0.03	0.37	0.48	1.35
UK	change	0.23	0.03	-0.03	-2.01	0.00	-0.03	-0.07	0.00	0.10	0.03	-0.17

Note: the table shows the average level of each driver in the most recent available year (2018 everywhere except for UK where it is 2014) and the change from the first year (2006 in Germany and the UK, 2002 elsewhere) to the most recent year.
Source: SES 2002-2018

Table A4 **Coefficients on variance of log hourly wages at country-sector-firmsize-year level**

	1 Digitali-sation	2 Trade	3 Union density	4 CPA: any	5 CPA: national	6 CPA: firm	7 Kaitz	8 EPL
Age (ref = 20-29)								
30-39	-0.651**	-0.649***	-0.599**	-0.524***	-0.319***	-0.375***	-0.584**	-0.797**
	(0.279)	(0.232)	(0.297)	(0.107)	(0.122)	(0.116)	(0.244)	(0.360)
40-49	0.364	0.249	0.615*	0.525***	0.614***	0.415***	-0.238	0.0613
	(0.294)	(0.244)	(0.316)	(0.113)	(0.126)	(0.118)	(0.371)	(0.373)
50-59	-1.061***	-1.012***	-1.304***	-0.931***	-0.673***	-1.106***	-0.790**	-1.078***
	(0.347)	(0.275)	(0.378)	(0.129)	(0.147)	(0.137)	(0.326)	(0.296)
Education (ref = low)								
Middle	0.580***	0.247**	0.607***	0.241***	0.339***	0.0199	0.128	0.405*
	(0.130)	(0.112)	(0.143)	(0.0490)	(0.0543)	(0.0530)	(0.218)	(0.212)
High	1.121***	0.985***	0.886***	1.015***	1.141***	1.160***	0.880***	1.102***
	(0.194)	(0.174)	(0.183)	(0.0655)	(0.0714)	(0.0678)	(0.275)	(0.232)
Occupation (ref = low)								
Middle	-0.0758	-0.151	-0.0729	0.00350	0.00871	0.177***	0.000524	-0.224
	(0.152)	(0.140)	(0.149)	(0.0583)	(0.0634)	(0.0593)	(0.160)	(0.210)
High	-0.0993	-0.111	-0.123	-0.0176	-0.0215	-0.128**	-0.102	-0.207
	(0.197)	(0.184)	(0.180)	(0.0630)	(0.0680)	(0.0647)	(0.244)	(0.249)
Temporary contract	0.0126	0.00481	0.372***	0.145***	0.183***	0.0393	-0.00582	0.00453
	(0.00837)	(0.00637)	(0.104)	(0.0341)	(0.0438)	(0.0358)	(0.0139)	(0.0117)
IT specialists	0.0786**							
	(0.0326)							
IT goods and services	0.0101							
	(0.0244)							
IT capital investment	0.0300*							
	(0.0179)							
Trade intensity		0.0146						
		(0.0290)						
Import ratio		-0.0349						
		(0.0303)						
Union density			-0.0732***					
			(0.0266)					
CPA: any				-0.00935				
				(0.00596)				
CPA: national/sectoral					-0.00187			
					(0.00466)			
CPA: firm/establishment						0.0334***		
						(0.00389)		
Kaitz index							-0.583***	
							(0.193)	

	1 Digitali-sation	2 Trade	3 Union density	4 CPA: any	5 CPA: national	6 CPA: firm	7 Kaitz	8 EPL
Occupation (ref = low)								
EPL								-0.650*
								(0.336)
Constant	-1.362***	-1.542***	-1.642***	-1.788***	-1.995***	-1.578***	-1.914***	-0.923**
	(0.271)	(0.188)	(0.250)	(0.0716)	(0.0809)	(0.0770)	(0.285)	(0.462)
Observations	3,663	5,046	2,138	4,687	3,767	3,719	4,327	4,053
R-squared	0.637	0.612	0.696	0.623	0.632	0.667	0.627	0.608

Note: log of variance of hourly wages, within and between firms at country-sector-year level, controlling for country, sector, firm size and year fixed effects and compositional controls weighted by number of employees.
* p<0.1, ** p<0.05, *** p<0.01
Source: SES 2002-2018 and external data (Eurostat, OECD, EU KLEMS, ICTWSS)

Table A5 **Coefficients of drivers on variance overall, within and between firms**

	Variance total wage	Variance within firm	Variance between firms
IT specialists	0.0786**	0.187***	0.0503
	(0.0326)	(0.0445)	(0.0807)
IT goods and services	0.0101	-0.0766**	0.108**
	(0.0244)	(0.0321)	(0.0471)
IT capital investment	0.0300*	0.0934***	-0.0944**
	(0.0179)	(0.0237)	(0.0406)
Trade intensity	0.0146	-0.0405	0.0939
	(0.0290)	(0.0408)	(0.0582)
Import ratio	-0.0349	-0.0474	-0.0317
	(0.0303)	(0.0405)	(0.0628)
Union density	-0.0732***	0.0412	-0.183***
	(0.0266)	(0.0367)	(0.0535)
CPA: any	-0.00935	-0.0527***	0.0519***
	(0.00596)	(0.00710)	(0.0113)
CPA: national/sectoral	-0.00187	-0.0148***	0.0272***
	(0.00466)	(0.00564)	(0.00884)
CPA: firm/establishment	0.0334***	0.0230***	0.101***
	(0.00389)	(0.00445)	(0.00759)
Kaitz index	-0.583***	-0.599***	-0.842***
	(0.193)	(0.205)	(0.287)
EPL	-0.650*	-0.593	-0.607
	(0.336)	(0.371)	(0.472)

Note: log of variance of hourly wages, within and between firms at country-sector-year level, controlling for country, sector, firm size and year fixed effects and compositional controls weighted by number of employees.
* p<0.1, ** p<0.05, *** p<0.01
Source: SES 2002-2018 and external data (Eurostat, OECD, EU KLEMS, ICTWSS)

Table A6 **Robustness test of aggregate analysis: by large firms and EU member states**

	Large firms only (250+)			EU member states only		
	Variance Total	Within-firm	Between-firm	Variance Total	Within-firm	Between-firm
IT specialists	0.0944***	0.149***	0.109	0.0643***	0.0968***	0.0847
	(0.0276)	(0.0350)	(0.0719)	(0.0220)	(0.0280)	(0.0532)
IT goods and services	-0.0204	-0.0981**	0.0652	0.00134	-0.0716**	0.0733
	(0.0273)	(0.0431)	(0.0602)	(0.0215)	(0.0327)	(0.0471)
IT capital investment	0.0193	0.0985***	-0.159**	0.0259	0.0909***	-0.102**
	(0.0245)	(0.0378)	(0.0665)	(0.0188)	(0.0260)	(0.0460)
Trade intensity	0.0125	-0.0924	0.183***	0.0236	-0.0487	0.134**
	(0.0295)	(0.0581)	(0.0623)	(0.0317)	(0.0512)	(0.0613)
Import ratio	-0.0530	-0.108*	0.0127	-0.0391	-0.0609	-0.0275
	(0.0342)	(0.0563)	(0.0885)	(0.0325)	(0.0457)	(0.0705)
Union density	-0.0396	0.0853	-0.166*	-0.0873***	0.0250	-0.213***
	(0.0453)	(0.0542)	(0.0874)	(0.0253)	(0.0334)	(0.0481)
CPA: any	0.00838	-0.0330*	0.0591**	-0.0156**	-0.0575***	0.0415***
	(0.0138)	(0.0181)	(0.0286)	(0.00652)	(0.00785)	(0.0125)
CPA: national/sectoral	0.000177	-0.00107	0.0238	-0.00317	-0.0204***	0.0319***
	(0.00797)	(0.0107)	(0.0166)	(0.00483)	(0.00589)	(0.00924)
CPA: firm/establishment	0.0444***	0.0482***	0.113***	0.0310***	0.0207***	0.101***
	(0.00664)	(0.00863)	(0.0144)	(0.00416)	(0.00488)	(0.00813)
Kaitz index	-0.334*	-0.353	-0.504*	-0.757***	-0.807**	-0.989**
	(0.192)	(0.219)	(0.284)	(0.265)	(0.329)	(0.386)
EPL	-0.313	-0.264	-0.504	-0.600*	-0.507	-0.654
	(0.390)	(0.449)	(0.525)	(0.335)	(0.391)	(0.491)

Note: log of variance of hourly wages, within and between firms at country-sector-year level, controlling for country, sector, firm size and year fixed effects and compositional controls weighted by number of employees.
* p<0.1, ** p<0.05, *** p<0.01
Source: SES 2002-2018 and external data (Eurostat, OECD, EU KLEMS, ICTWSS)

Table A7 **Coefficients on variance components (log) within firms**

	Within-firm variance	Within-firm skills
Education (ref = low)		
Middle	0.0412	0.115*
	(0.112)	(0.0586)
High	0.350***	0.308**
	(0.127)	(0.136)
Share of women	-0.0547	0.0484
	(0.0716)	(0.0534)
Temporary contract	0.00945	-0.00118
	(0.0119)	(0.00967)
Occupation (ref = low)		
Middle	-0.189	-0.210***
	(0.139)	(0.0639)
High	0.324	0.0990
	(0.272)	(0.139)
Establishment size (ref = 50-249)		
<50	-0.266***	-0.101***
	(0.0205)	(0.0152)
250+	-0.0657***	-0.124***
	(0.0226)	(0.0172)
Observations	24,829,666	24,734,231
R-squared	0.153	0.237

Note: includes country, industry, firm size, wave fixed effects and compositional controls, weighted for firm size, standard errors clustered at country-sector-year level.
* p<0.1, ** p<0.05, *** p<0.01
Source: SES 2002-2018 and external data (Eurostat, OECD, EU KLEMS, ICTWSS)

Table A8 **Coefficients of drivers within firms**

	Variance of log wages	Variance of skills
IT specialists	0.0616**	0.0579***
	(0.0256)	(0.0220)
IT goods and services	-0.0290	-0.00450
	(0.0289)	(0.0262)
IT capital investment	0.186***	0.145***
	(0.0380)	(0.0319)
Trade intensity	-0.104**	-0.0757**
	(0.0491)	(0.0374)
Import ratio	-0.0720	-0.0847*
	(0.0589)	(0.0488)
Union density	0.204***	0.128***
	(0.0446)	(0.0352)
Kaitz index	-0.906***	-0.728***
	(0.0874)	(0.162)
EPL	-0.381	-0.378
	(0.339)	(0.466)
CPA (ref = national)		
Sectoral	-0.239***	-0.0952***
	(0.000995)	(0.000830)
Firm	0.0386***	0.119***
	(0.00102)	(0.000835)
Other	-0.153***	-0.0288***
	(0.00139)	(0.00118)
None	0.111***	0.104***
	(0.00103)	(0.000853)

Note: includes country, industry, firm size, and wave fixed effects and compositional controls, weighted for firm size, standard errors clustered at country-sector-year level.
* p<0.1, ** p<0.05, *** p<0.01
Source: SES 2002-2018 and external data (Eurostat, OECD, EU KLEMS, ICTWSS)

Table A9 **Coefficients on the variance of earnings components between firms (RIF)**

	Log wages	Composition	Firm fixed effects
Education (ref = low)			
Middle	0.139	0.152*	-0.00104
	(0.120)	(0.0811)	(0.00931)
High	-0.00128	-0.00477	0.0547***
	(0.180)	(0.112)	(0.0123)
Share of women	-0.0907**	-0.0956**	-0.0264***
	(0.0442)	(0.0389)	(0.00512)
Temporary contract	-0.0263**	-0.0254***	-0.00199
	(0.0113)	(0.00896)	(0.00160)
Occupation (ref = low)			
Middle	-0.0586	-0.0933**	0.00130
	(0.0773)	(0.0416)	(0.00757)
High	0.0982	0.0218	0.0125
	(0.0874)	(0.0513)	(0.00893)
Establishment size (ref = 50-249)			
<50	0.0868***	0.0203	0.0152***
	(0.0208)	(0.0135)	(0.00220)
250+	0.00197	0.0504**	0.00207
	(0.0289)	(0.0238)	(0.00333)
Observations	24,896,844	24,751,730	24,709,068
R-squared	0.288	0.483	0.140

Note: RIF regressions on variance of log hourly wage, composition and firm fixed effects. Weighted for firm size; controlling for industry, country, firm size and wave fixed effects.
* p<0.1, ** p<0.05, *** p<0.01
Source: SES 2002-2018 and external data (Eurostat, OECD, EU KLEMS, ICTWSS)

Table A10 **Coefficients of drivers of between-firm components**

	Log wages	Composition	Firm fixed effects
IT specialists	0.0446*	0.0180	0.000791
	(0.0247)	(0.0244)	(0.00239)
IT goods and services	-0.126***	-0.114***	-0.00700*
	(0.0293)	(0.0249)	(0.00379)
IT capital investment	-0.100***	-0.0989***	-0.00289
	(0.0231)	(0.0230)	(0.00267)
Trade intensity	0.105***	0.119***	-0.000771
	(0.0317)	(0.0333)	(0.00351)
Import ratio	-0.0563	0.00128	-0.0119***
	(0.0429)	(0.0362)	(0.00410)
Union density	-0.0820**	-0.139***	-0.01000*
	(0.0404)	(0.0365)	(0.00563)
Kaitz index	-1.021***	-0.860***	-0.101***
	(0.297)	(0.289)	(0.0201)
EPL	0.680	0.641	0.0380
	(0.415)	(0.403)	(0.0249)
CPA (ref = national)			
Sectoral	0.180***	0.163***	-0.00747***
	(0.000592)	(0.000346)	(0.000126)
Firm	0.0419***	0.0851***	-0.00938***
	(0.000604)	(0.000352)	(0.000128)
Other	0.180***	0.0545***	0.0171***
	(0.000768)	(0.000449)	(0.000164)
None	0.0477***	0.0777***	-0.00306***
	(0.000611)	(0.000357)	(0.000130)

Note: RIF regressions on variance of log hourly wage, composition and firm fixed effects. Weighted for firm size; controlling for country, industry, firm size and wave fixed effects as well as compositional controls.
* p<0.1, ** p<0.05, *** p<0.01
Source: SES 2002-2018 and external data (Eurostat, OECD, EU KLEMS, ICTWSS)

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