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RESEARCH REPORT

Eurofound

Occupational change and wage inequality: European Jobs Monitor 2017

Occupational change and wage inequality: European Jobs Monitor 2017

Eurofound

European Foundation for the Improvement of Living and Working Conditions

When citing this report, please use the following wording:
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Research manager: Enrique Fernández-Macías

Eurofound project: European Jobs Monitor

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Contents

Country codes

AT	Austria	**FI**	Finland	**NL**	Netherlands
BE	Belgium	**FR**	France	**PL**	Poland
BG	Bulgaria	**HR**	Croatia	**PT**	Portugal
CY	Cyprus	**HU**	Hungary	**RO**	Romania
CZ	Czech Republic	**IE**	Ireland	**SE**	Sweden
DE	Germany	**IT**	Italy	**SI**	Slovenia
DK	Denmark	**LU**	Luxembourg	**SK**	Slovakia
EE	Estonia	**LT**	Lithuania	**UK**	United Kingdom
EL	Greece	**LV**	Latvia		
ES	Spain	**MT**	Malta		

Executive summary

Introduction

During 2016, employment in the EU finally returned to the same level as before the global financial crisis. The recovery that began in 2013 has resulted in the net creation of eight million new jobs. Most of this net new employment has been created in services, but there has also been a marked rebound in manufacturing employment, with around 1.5 million new jobs.

This, the sixth annual European Jobs Monitor report, looks in more detail at recent shifts (from the second quarter (Q2) of 2011 to 2016 Q2) in employment at Member State and aggregate EU levels. Part 1 of the report applies a 'jobs-based approach' to describe employment shifts quantitatively (how many jobs were created or destroyed and in what sectors) and qualitatively (what kinds of jobs they were, primarily in terms of average hourly pay). Part 2, a more analytical section, discusses the role that occupations play in structuring European wage inequality, and to what extent the observed patterns of job polarisation and upgrading have contributed to wage inequality trends in the last decade.

Policy context

The EU's Europe 2020 strategy for smart, sustainable and inclusive growth includes a commitment to fostering high levels of employment and productivity. This implies a renewed focus on the goals of the earlier Lisbon Agenda, 'more and better jobs'. More jobs are needed to address the problem of unacceptably high unemployment rates. But Europe also needs better and more productive jobs if it is to succeed once again in improving living standards for its citizens in an expanding, integrated global economy. The European Commission's 2012 Employment Package ('Towards a job-rich recovery') identifies some sectors in which employment growth is considered most likely: health services, information and communications technology, and personal and household services, as well as the promising if hard-to-define category of 'green jobs'. The jobs-based approach adopted in this report provides up-to-date data about employment levels and job quality in growing and declining sectors and occupations.

The jobs-based approach was pioneered in the 1990s in the USA by Nobel Laureate Joseph Stiglitz and then refined by Erik Olin Wright and Rachel Dwyer. The particular question that this earlier American work addressed – was job growth being achieved at the expense of job quality? – has become more nuanced over time. The jobs-based approach has, in particular, been used to assess the extent to which employment structures in developed economies are polarising, leading to a 'shrinking' of mid-paid jobs, or upgrading as the supply of highly qualified workers increases. To the extent that employment in some labour markets appears to be polarising, this research also connects with broader concerns about increasing inequality.

Key findings

Shifts in employment, 2011–2016

- There were eight million more people at work in 2016 Q2 in the EU compared with three years previously. Employment growth since 2013 has been only modestly skewed towards well-paid jobs. There has been robust growth in low-paid and mid-paid jobs as well, consistent with a consumption-led recovery.
- Over a longer time frame (going back to the late 1990s), higher-paid jobs have continued to grow faster relative to those in the rest of the wage distribution. This has been the case in recessionary and non-recessionary periods alike.
- More than 7 out of 10 jobs in the EU are now in services, a sector that alone has added over 8 million jobs in the EU since 2011. Recent service sector employment growth has been asymmetrically polarised, with greater gains in jobs at the top and bottom of the wage distribution.
- There has also been an increase of 1.5 million in the manufacturing employment headcount since 2013. Most of this increase has been in engineering, professional and management jobs in the top wage quintile and not in more traditional, blue collar production roles. Proportionately, the EU13 countries (those that have joined the EU since 2004) have been the main beneficiaries of net new manufacturing employment.

- In many of the faster-growing large jobs, the share of older workers has increased significantly, suggesting that extended working lives and later retirement are as important in explaining recent employment growth as any resurgence of labour market dynamism.

Occupational change and wage inequality

- Occupations play an important role in the structuring of wage inequality in Europe. This is partly because occupations mediate the effect on wage inequality of other factors such as human capital, social class and segregation by gender or age. But occupations have their own effect on wage inequality, too, probably as a result of specific mechanisms such as occupational licensing, credentialing or apprenticeship systems.
- Although there are wide differences across Europe in the levels of wage inequality, occupations provide a remarkably similar backbone to the distribution of wages in all countries. The distribution of variance in wages between and within occupations and the hierarchy of occupational wages (which occupations pay more and which pay less) are essentially the same across all countries. The actual differences between the wages paid by occupations and the extent to which they are grouped in broad classes or linked to differences in human capital are aspects that do vary across countries.
- Despite the deepening and generalisation of job polarisation in Europe in the aftermath of the Great Recession, occupational dynamics did not drive wage inequality developments in the last decade. Changes in the distribution of wages within occupations were much more consequential for overall wage inequality trends than changes in the wages paid by the different occupations or changes in the occupational structure.

Part 1:
Shifts in the employment structure

1 Labour market context

In 2016, somewhat later than in other developed economies, employment levels in the EU recovered all the net losses experienced since the global financial crisis. Just over 223 million people were in work in the EU in 2008; 223.6 million were in work in 2016.[1] At the post-crisis trough in 2013, the number was just over 215.5 million.

Recessions based on banking crises are steeper, and recovery from them takes longer. Reinhart and Rogoff (2009) estimated that recovery – measured as the restoration of gross domestic product (GDP) per head to pre-crisis levels – takes over 7 years following a financial crisis, compared with 4.5 years after a 'normal' recession. GDP per head in the EU as a whole had returned to 2008 levels in 2015.[2] Using aggregate EU employment headcount as a labour market indicator leads to broadly similar conclusions. It has taken 7–8 years to get back to a pre-crisis level.

There has nonetheless been sustained employment growth since the second quarter (Q2) of 2013, which has been broadly shared across Member States. The EU added some 8 million net new jobs between 2013 Q2 and 2016 Q2, of which 3.8 million were created between 2015 Q2 and 2016 Q2. Even though the aggregate employment headcount in the EU has been restored to the pre-crisis level, the composition of employment has altered significantly over the last eight years. This report seeks to describe these changes and then to use the 'jobs-based approach' to add further detail on how shifts in employment (for example, by country, sector, gender, working time or contractual status) are shared across the wage or job quality distribution.

In some respects, the gathering momentum of job creation in recent years is unexpected; net employment expansion of 1.7% per annum – as recorded between 2015 Q2 and 2016 Q2 – results normally from above-par output growth. But real EU output growth has only intermittently, and then very marginally, passed above 2% over a long period, going back to 2008. Why has employment growth surpassed output growth? Two possible explanations can be advanced. Firstly, just as employers hoard labour at the onset of a recession, they may hesitate to hire at the onset of a recovery until such time as they consider it established. From this perspective, much of the recent job growth arises, for example, from deferred hiring decisions or from delayed recovery in cyclical sectors strongly affected by the particularly steep contraction of 2008–2013. Secondly, the recovery has, as recent Commission analysis indicates, been strongly consumption-led rather than fuelled by export or investment. This has led to 'stronger job creation in the services sector, which is more labour intensive and more reactive to the dynamics of consumption' (European Commission, 2016, p. 1). Such employment growth is also likely to have been less productivity-enhancing, which would, in part, explain relatively tepid output growth. It is important in this regard to highlight that the analysis in this report is based on a headcount approach; given declines in average hours worked and the increasing share of part-time employment, the total number of hours worked by EU workers was still nearly 2% lower in 2016 Q2 compared to 2008 Q2.

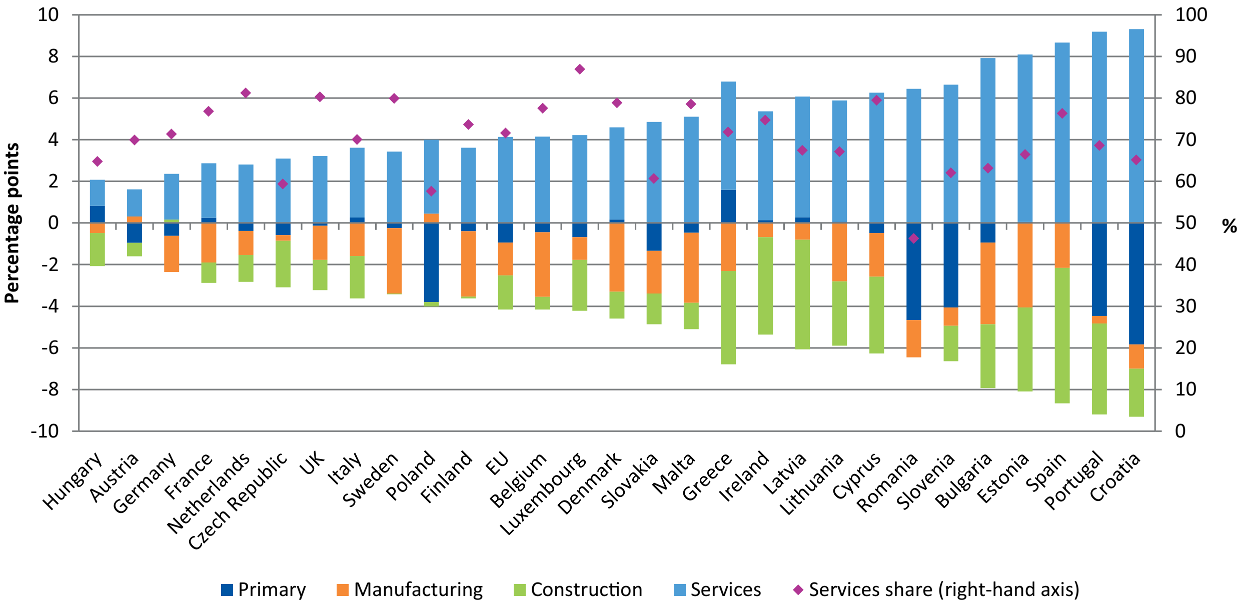
The recent boost in employment levels is reflected in higher levels of labour market participation, higher employment rates and declining unemployment rates. Demographic factors, however, no longer offer the boost to employment levels that they once did. Since 2010, the working age population in the EU has begun to contract at an annual average of 0.15% after rising at an annual average of 0.32% between 2000 and 2010. In Germany, the combination of sustained labour demand and contracting supply has contributed to a very tight labour market (the unemployment rate fell to 4% in 2016 Q3).

Given a very similar stock of EU employment headcount in 2008 and 2016, it is an obvious but nonetheless interesting exercise to compare what has changed over the crisis and post-crisis periods. Periods of crisis in particular are associated with rapid shifts in employment composition as some sectors and occupations are disproportionately impacted by the selective nature of job destruction during downturns. This was clearly the case in 2008–2010 when the manufacturing and construction sectors together accounted for all the net employment declines suffered in the earliest and severest years of the crisis. As Figure 1 confirms, the employment shares of construction and manufacturing remain much reduced in nearly every Member State, notwithstanding three years of employment growth. The primary sector (agriculture and mining principally) also represents a declining share of employment in most countries – rapidly declining in the case of Croatia, Poland, Portugal, Romania and Slovenia.

1 EU-LFS data for France since 2014 include employment in overseas departments (départements d'outre-mer, DOM), amounting to over 500,000 people. To ensure compatibility over time, DOM employment has been excluded in all analysis in this report.

2 In the 19 Member States of the euro zone (EA19) and the 15 Member States that joined before 2004 (EU15), the recovery has taken even longer; 2016 data should, when available, indicate full recovery.

Figure 1: Percentage point change in composition of employment, by Member State and main sector (2008 Q2–2016 Q2), and service sector employment share, by Member State (2016 Q2)



Note: *The percentage point change in composition of employment is plotted on the left-hand axis, and the percentage of service sector employment is plotted on the right-hand axis.*
Source: *EU-LFS (authors' calculations)*

The counterpart of these declines has been the increased share of service sector employment in all Member States. Services now account for 71% of EU employment. In some Member States (Austria, Germany and Hungary), the shift to services has been quite modest (less than 2.25 percentage points), but in 13 Member States, the shift has been notably sharper (more than 5 percentage points). These can be roughly divided into two groups. In the first group are those Member States, already indicated above, where the main recomposition of employment has been away from the relatively large primary sector to the service sector. In the second group – which includes the Baltic states, Cyprus, Ireland and Spain – sharp employment falls in the manufacturing and construction sectors explain in large part the increasing services share of employment.

Manufacturing employment has been in secular decline in advanced economies for over 40 years as a result of the twin influences of technological innovation (capital replacing labour) and trade (globalisation and the replacement of domestic labour by foreign labour). This secular decline has tended to manifest itself as stable employment levels in periods of economic growth, followed by sharp contractions in downturns. That historical pattern has been repeated, to some extent, over the last eight years. The manufacturing sector in the EU employed 41.1 million people in 2008 Q2, 36.2 million in 2013 Q2 and 37.7 million in 2016 Q2; so while there has been some recovery of lost manufacturing jobs in recent years, employment remains 8% below its pre-crisis level.

The construction sector is one that is typically considered more cyclically sensitive – employment tends to grow in upturns and decline in downturns – and more labour intensive, but the evidence of recent years is surprising for different reasons. Firstly, the contracting employment share of construction appears to be a common pattern across nearly all Member States, notwithstanding how differently the crisis affected individual Member States, in terms of both the severity of output declines and the core role played by construction in these declines in some countries such as Ireland, Latvia and Spain. Secondly, employment in the sector has recovered even more slowly post-2013 than has been the case in manufacturing. The resumption of economic growth has not, so far, been accompanied by the rebound in construction sector employment that might have been expected. There were nearly 20% fewer (3.7 million) construction sector jobs in the EU in 2016 compared to 2008. What explains this contraction? Clearly one factor was the over-exuberant and, in retrospect, unsustainable growth of the sector in the pre-crisis years in some countries. The construction employment share rose to nearly double its long-term average in countries such as Ireland and Spain. Much of the subsequent job loss was a reversion to the mean.

Table 1: Labour market indicators, EU

EU	2016 (%)	Change 2008–2016 (percentage points)
Employment rate (20–64-year-olds)	71.1	0.6
Gender employment gap	8.1	-2.5
Part-time share of employment	20.5	2.3
Older worker (55+ years) share of employment	18.6	4.6
High-skilled white collar worker share of employment*	41.0	1.8

** 'High-skilled white collar worker' refers to International Standard Classification of Occupations (ISCO) main groups 1, 2 and 3 (managers, professionals and associate professionals). Change data for this indicator are for 2011–2016 only due to a classification break.*
Note: *For full national data, see Annex 1.*
Source: *EU-LFS (authors' calculations)*

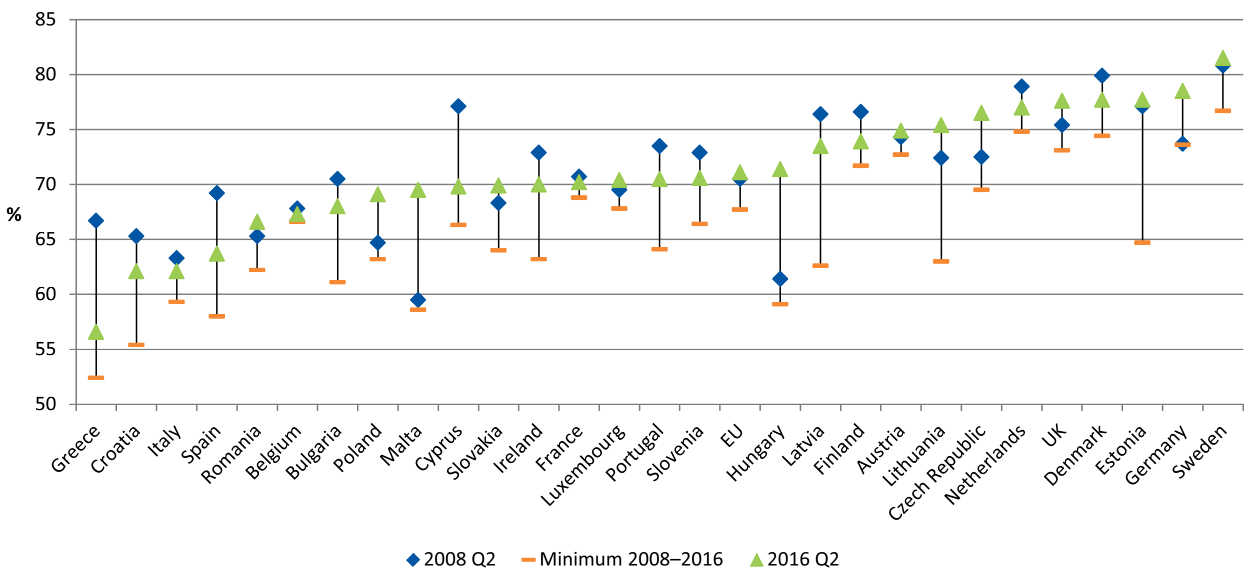
But the generality of the decline in construction employment across countries also suggests other factors may be in play. Perhaps there is a more technological explanation, based on increasing capital investment and decreasing labour intensiveness in the sector. Other possible factors include: demographic trends, notably declining rates of population growth; decreasing levels of public investment, including expenditure on public housing; and the declining affordability of housing for the cohort of household-forming age.

The workforce has changed across a number of other dimensions as well. Table 1 presents the most important shifts in workforce composition – in the sense that similar changes are likely to have occurred in all, or a very large majority, of Member States.

In addition to the already noted increasing share of employment in the service sector, the main changes identified are:

- an increasing share of older workers, arising from the compound effects of declining youth participation and employment, reduced early withdrawal possibilities and later retirement;
- an increasing incidence of part-time work, arising from a significant replacement of (mainly male) full-time employment by new part-time employment (shared more or less evenly by gender);
- a declining gender employment gap;
- an increasing share of employment in white collar occupations requiring generally high skill levels (managers, professionals and associate professionals), reflecting both patterns of labour demand skewed towards services and higher skills and the 'natural' upgrading of the workforce as older workers retire and younger cohorts, with higher average qualifications, enter the labour market.

Figure 2: Employment rates of 20–64-year-olds, by Member State, 2008 Q2–2016 Q2



Source: *EU-LFS (Eurostat website)*

However, the starting point for this study is the shifting composition of employment by country within the EU (Figure 2). The crisis and post-crisis periods have been experienced very differently across the labour markets of Member States. In two larger Member States, whose labour market performance has, in living memory, seen each labelled as the 'sick man of Europe', nearly five million net new jobs were created between 2008 Q2 and 2016 Q2. Labour markets in both Germany (+2.9 million) and the UK (+2 million) recovered early from the crisis and account for the lion's share of net new jobs in the EU. Both have met and comfortably surpassed the EU target of a 75% employment rate. They share this achievement with a number of other northern and central European Member States including the Czech Republic, Denmark, Estonia, Lithuania, the Netherlands and Sweden.

Accentuating the geographical shift of employment from south to north is the still largely unrepaired destruction of employment in many southern Member States. Spain has shed more than 2.3 million jobs over the same period, while Greece and Romania have both shed over 900,000 jobs and Portugal over 500,000. In the case of Greece, Portugal and Spain, the severity of the crisis and the consequences of the policies undertaken to confront it explain much of the job attrition. In the case of Romania, the net job loss appears to have as much a demographic as an economic basis. In common with some other eastern European Member States – Bulgaria, Latvia and Lithuania – as well as Portugal, the overall population has declined, and a disproportionate share of that contraction has been among people of working age, indicative of significant net emigration.

While the divergences noted above are stark, and particularly so within the euro zone Member States, the most recent period of employment growth since 2013 has seen some sustained recovery in most of the Member States whose labour markets suffered most during the crisis period. Employment levels have risen faster in Spain in the period 2013 Q2–2016 Q2 (+6.6% increase) compared with the EU as a whole (+3.7%). This has also been the case for Ireland (+7.8%), Greece (+4.7%) and Portugal (+4%) as well as for Estonia and Lithuania, where the crisis began earlier and the recovery is more established. As Figure 2 confirms, employment rates in each of these countries rose substantially from their post-crisis minima. For some countries, notably Greece and Spain, these are just the first steps towards the normalisation of labour markets. Most of the jobs lost in these two countries during 2008–2013 have not been recovered, and unemployment rates remain high (23% and 19% respectively, 2016 Q4).

Jobs-based approach: Methodology

The approach in Part 1 of the report is to focus on:

- how the structure of employment in Europe has changed in recent years (2011 Q2–2016 Q2[3]);
- what implications this has had for aggregate employment quality;
- how the compositional changes already indicated (for example, increasing part-time or a higher share of women in the workforce) have contributed to these changes.

To do this, the 'job' is taken as the unit of analysis. A 'job' is defined here as a given occupation in a given sector – such as a customer service worker in the retail sector or a health professional (doctor) in the health sector. This is an intuitively attractive definition and corresponds to what people would consider when describing their job, or to how an employer advertises a new job opening.

This definition is useful for both theoretical and empirical reasons. The two concepts of occupation and sector correspond to two fundamental dimensions of the division of labour within and across organisations. The sectoral classification designates the horizontal distribution of economic activities within a country across organisations generating different products and services. The occupational classification provides an implicit hierarchy of within-organisation roles – senior managers, line managers, professionals, associate professionals, production staff and so on. Established international classifications, such as ISCO (for occupation) and the Statistical Classification of Economic Activities in the European Community (NACE) (for sector), mean that it is relatively easy to operationalise the jobs-based approach using the standard labour market data sources, such as the EU Labour Force Survey (EU-LFS). This provides a highly detailed disaggregation of the workforce in each country based on commonly applied occupational and sectoral classifications to ensure international comparability.

The jobs-based approach requires not only the definition of a job in an intuitive, conceptually coherent and empirically practical way but also some means of evaluating these jobs in relation to their quality. The job-wage has been the main proxy of job quality in much jobs-based analysis, originating in the work of Nobel Laureate Joseph Stiglitz in the 1990s (CEA, 1996) and subsequently refined by Erik Olin Wright and Rachel

3 In most of the charts of Part 1, 2011 Q2–2016 Q2 is the time frame used. Revision of the ISCO classification in 2010–2011 to ISCO-08 means that figures relating to earlier periods are based on job rankings using the older ISCO-88 classification. Occasionally, shorthand reference in the text is made to 2011–2013 and 2013–2016; unless otherwise noted, figures are based on second-quarter data from the relevant year.

Dwyer (2003) and others. The analysis that follows relies mainly on a wage-based measure to rank jobs, but some overview of recent employment shifts at EU aggregate level is also provided using education- and job-quality-based rankings for comparison (see Annex 3).

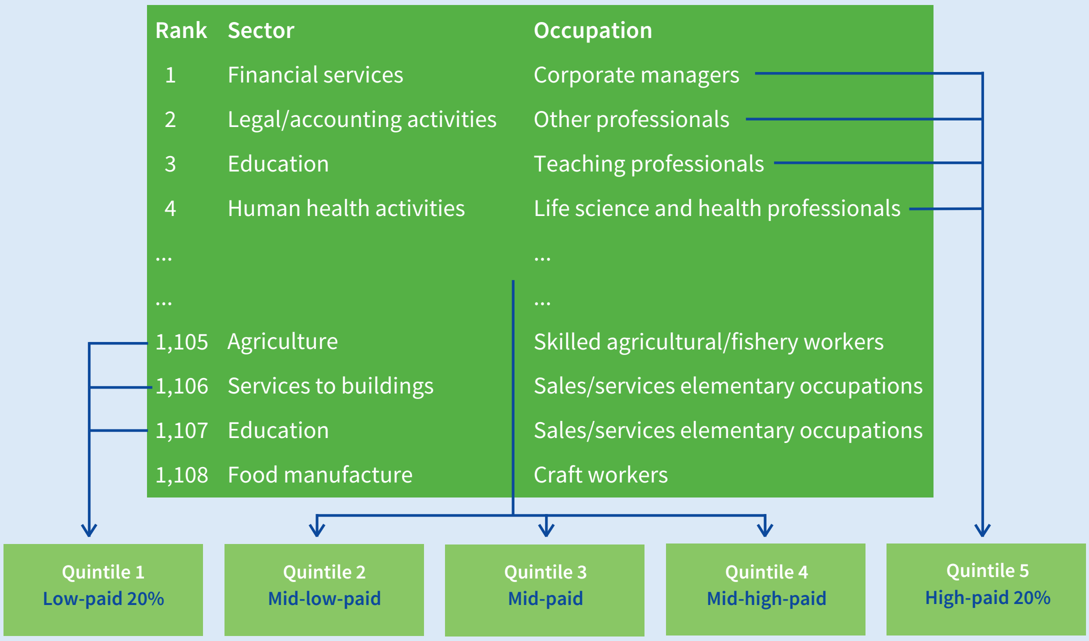
Box 1: Methodological note on the jobs-based approach

The main, simplified steps of the jobs-based approach are as follows:

1. Using the standard international classifications of occupation (ISCO-08) and sector (NACE Rev 2.0) at two-digit level, a matrix of jobs is created in each country. Each job is an occupation in a sector. In total, there are 43 two-digit occupations and 88 two-digit sectors, which generate 3,784 job cells. In practice, many of the theoretical job cells do not contain employment; there are unlikely to be many skilled agricultural workers in financial services, for example. The country total of job cells with employment varies between around 400 and just over 2,000 and is largely determined by country size and labour force survey sample size. The bigger the workforce, the greater the variety of possible job combinations that can be identified using LFS data.
2. The jobs in each country are ranked based on some ranking criterion, mainly the mean hourly wage. The job-wage rankings for each country used in this report are based on combining data from the EU-LFS annual data files for 2011–2014 and aggregated data from the Structure of Earnings Survey (SES) for 2010. These sources allowed the creation of country job-wage rankings for the 28 Member States.
3. Jobs were allocated to quintiles in each country based on the job-wage ranking for that country. The best-paid jobs are assigned to quintile 5, the lowest-paid to quintile 1. Each quintile in each country should represent as close as possible to 20% of employment in the starting period – in other words, jobs are assigned to quintiles based on their employment weights. From this point on, the job-to-quintile assignments remain fixed for each country so that, in all of the charts that follow in Part 1 of this report, a given quintile in a given country (however broken down) always refers to employment data in a specific group of jobs exclusive to that quintile. For presentation purposes, the focus then is shifted to the change in the stock of employment at quintile level during a given period in each country (for example, 2011 Q2–2016 Q2).

Figure 3 illustrates in simplified format the three steps outlined above, using some of the top-paid and lowest-paid jobs that employ large numbers at EU level as examples. (While the jobs are correctly assigned in terms of EU quintile, the individual job-wage ranks, 1–4 and 1,105–1,108, are for illustrative purposes only.)

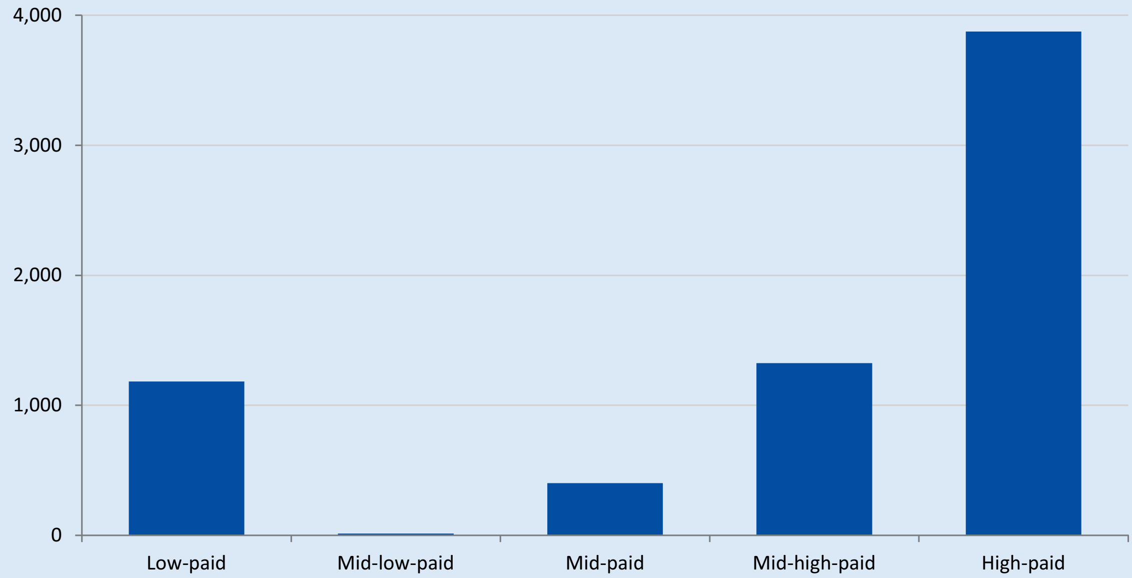
Figure 3: Job rankings and quintile assignments carried out for each country



4. Net employment change between starting and concluding periods (in people employed) for each quintile in each country is summed to establish whether net job growth has been concentrated in the top, middle or bottom of the employment structure. This generates a series of charts similar to Figure 4. Except where otherwise indicated, all charts in the report describe net employment change by quintile for the indicated country or for the EU as a whole. The EU aggregate charts are based on applying a common EU job-wage ranking (based on the weighted average of the standardised national job-wage rankings).

The resulting quintile charts give a simple, graphical representation of the extent of employment change in a given period, as well as an indication of how that change has been distributed across jobs with different pay. (A similar classification of jobs can be carried out using job-holders' skills or a broad-based, multidimensional indicator of job quality as a ranking criterion – see Annex 3.) Figure 4, for example, illustrates employment change for the EU28 during 2011 Q2–2016 Q2 using the job-wage quintiles. The figure should be read from the leftmost bar cluster (quintile 1, representing the lowest-paid jobs) to the rightmost cluster (quintile 5, representing the highest-paid jobs). Net employment change is represented on the vertical axis, generally in thousands but sometimes in annual percentage change. The dominant feature of the chart is the addition of around 3.9 million well-paid (top-quintile) jobs over the period.

Figure 4: Net employment change (in thousands) by job-wage quintile, EU, 2011 Q2–2016 Q2



Note: *EU27 (Luxembourg data omitted); Q2 data in each year.*
Source: *EU-LFS (authors' calculations)*

This method also offers further possibilities of breaking down these net employment changes by such categories as gender, employment or professional status, or working time category (full time or part time), which are used later in Part 1. For a more extensive description of the data processing involved, see Annex 3. Further background documentation includes Eurofound (2008b), as well as extensive material in the annexes of previous European Jobs Monitor (EJM) annual reports – see Eurofound (2008a, 2011, 2013, 2014, 2015b) – where the same jobs-based approach was used.

For the jobs-based approach to characterise employment shifts accurately, an important condition is that the ordinal ranking of a job – whether that ranking is based on hourly wage, educational level of the job-holder or some broader index of job quality – remains stable over the period covered. In practice, there is a high level of correlation of job-based rankings over time – health professionals in the health sector tend to be in the top quintile and cleaners and helpers in the services to buildings sector tend to be in the bottom quintile in most periods – and across countries.

2 Employment shifts in the EU, 2011–2016

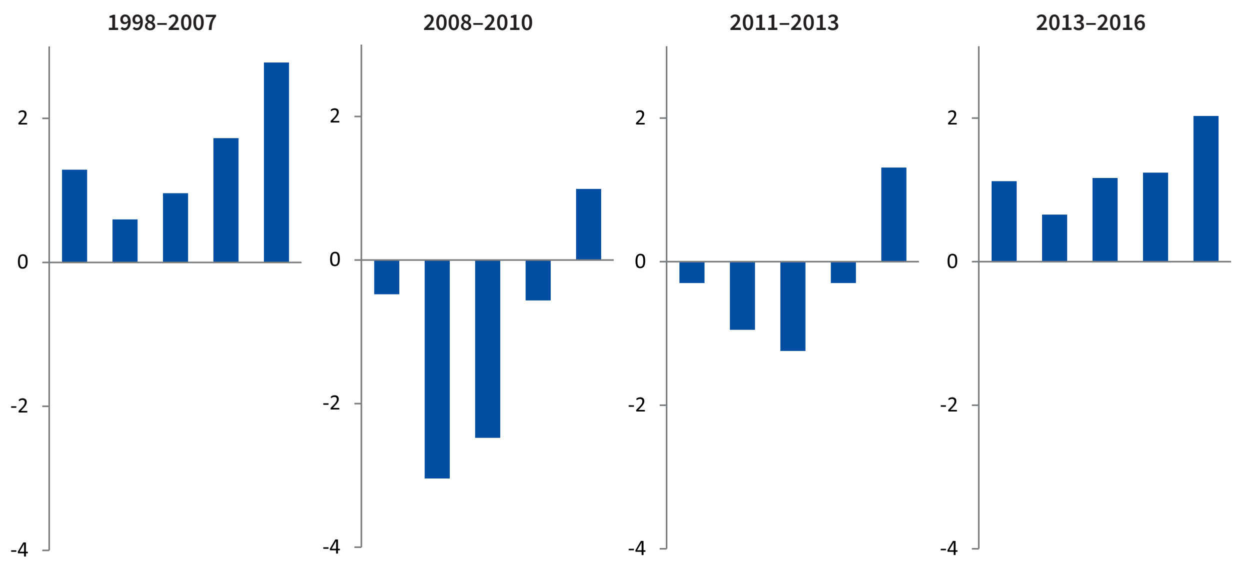
This chapter uses the jobs-based approach to describe employment developments by job-wage quintile primarily during the period from 2011 Q2 to 2016 Q2. Overall trends in the EU are looked at first, with the varying patterns of change in the individual Member States then described. It goes on to examine the individual jobs contributing to the shifting patterns at EU level.

The five-year period between 2011 Q2 and 2016 Q2 divides naturally into two periods. The earlier period of employment decline coincides with the second, so-called 'double-dip', recession following the global financial crisis and covers the period 2011 Q2– 2013 Q2 in this report's analysis. This is broadly also the period of the sovereign debt crisis, tightening budgetary supervision and contracting public budgets. Some 1.2 million job losses were added to the 5 million previously lost during the global financial crisis period (2008–2010). As already noted, 2013 Q2 marks a turning point, and the most recent three-year period has seen some significant employment growth, with approximately eight million net new jobs created in the EU. Figure 5 shows employment shifts by wage quintile for the EU as a whole for 2011–2013 and 2013–2016 as well as for earlier periods based on previous EJM analyses.

As the figure illustrates, new employment since 2013 has been more evenly spread across the wage distribution, with only a mild skew towards the top quintile. Employment grew in each of the job-wage quintiles during 2013–2016. As aggregate economic and labour market performance has begun to normalise (since 2013), the sharpened employment polarisation observed during the period of employment contraction has given way to more balanced growth during 2013–2016. Overall, aggregate growth continues to be modestly upgrading, and the relative performance by quintile remains similar before and after 2013, and indeed going back to the late 1990s – employment growth has been consistently strongest in the top quintile, followed by the lowest and mid-high quintiles and with weakest growth in the middle and mid-low quintiles.

Employment continued to grow in well-paid, high-skilled jobs in the top quintile throughout 2008–2013, although at a more modest pace than in the long period of employment expansion that preceded the 2008 global financial crisis. Bottom-quintile employment also tended to be more resilient than that in the middle quintiles, suffering relatively modest losses.

Figure 5: Employment change (% per annum) by job-wage quintile, EU,* 1998–2016



** Different EU country aggregates and periodisations due to data availability as follows: 1998–2007, EU23 (no data for Cyprus, Malta, Poland or Romania), based on annual EU-LFS data; 2008–2010, EU27 (no data for Croatia); 2011–2016, EU27 (data for Luxembourg omitted).*
Note: *For all periods from 2008, figures are based on Q2 data in each year, extracted from EU-LFS in November 2016, and may differ slightly from previously reported figures due to data revisions.*
Source: *EU-LFS, SES (authors' calculations)*

The consistent feature of employment shifts over all periods is the relative outperformance of the top quintile. Well-paid jobs have added employment even during the peak crisis period (2008–2010) and contribute disproportionately in all periods to overall employment growth. A secondary recurring pattern across the four periods is the relative weakness of employment growth in the mid-low and middle quintiles, though the resulting pattern of employment polarisation was clearest during the recessionary period and has been much attenuated in the most recent period (2013–2016). In summary, while one can certainly make a case that employment polarisation has occurred in each of the four periods covered, the dominant shift has been one of employment upgrading favouring growth in well-paid jobs.

Variety of patterns across Member States

Until recently, the debate about shifts in the employment structure in developed economies was largely focused on two main patterns of change – upgrading and polarisation. Each has its own supporting narrative – 'skill-biased technological change' in the case of upgrading and 'routine-biased technological change' in the case of polarisation.

Upgrading shifts should lead to a linear improvement in employment structure, with the greatest employment growth in high-paid (or high-skilled) jobs and the weakest growth in low-paid (or low-skilled) jobs, with middling growth in the middle. With polarisation, the main difference is that the relative positions of the middle and bottom of the job distribution are swapped: employment growth is weakest in the middle and relatively stronger at both ends of the job-wage distribution, leading to a 'shrinking' or 'hollowed' middle.

In both accounts (skill-biased technological change and routine-biased technological change), the principal driver of employment change is technology, and its principal effect is to increase the demand for skilled labour in developed economies at the expense of less-skilled labour. Higher skills levels endow those who possess these skills with the capacities to utilise and master new technologies. This should enhance their individual productivity. But while technology tends to complement those with higher skills, it is more likely to substitute those with lower skills, whose job tasks are more easily replaceable by machines.

The main explanation of the differences in the two accounts relates to where in the wage distribution – at the bottom or in the middle – those jobs most susceptible to technological displacement lie. Exponents of routine-biased technological change claim that the most vulnerable jobs are routine jobs with a high share of easily codifiable tasks (for example, routine clerical and manufacturing or production jobs). These happen to predominate in the middle of the wage distribution in developed economies (Autor et al, 2006). Less-routine jobs – for instance, personal services at the bottom of the wage distribution, such as hairdressers or restaurant workers, and knowledge-intensive professional services at the top, such as lawyers or medical doctors – are less easy to automate and therefore less vulnerable to replacement.

A sometimes complementary, sometimes distinctive, explanation emphasises the role of international trade and its differential effects on the employment structure. The less-routine jobs indicated above involve services that generally have to be carried out in person or in a particular place. Offshoring them or performing them remotely is often not feasible. They may, additionally, be subject to specific national occupational licensing frameworks, particularly, for example, higher-skilled occupations in the health or professional services sectors. For these reasons, such jobs enjoy some protection from the threats of both technological and trade displacement. More routine administrative, clerical or manufacturing jobs may not benefit to the same extent from these protections and are, as a result, more vulnerable to displacement.

While the academic literature on structural shifts in employment in developed market economies tends to give more weight to technological change as the main determinant of shifts (Goos et al, 2009), there has also been important recent analysis that emphasises the role of import competition from China, for example, in the rapid decline of American manufacturing employment, especially after China's entry into the World Trade Organization in 2001 (Autor et al, 2016). More generally, the decline of developed-world employment in manufacturing sectors clearly arises out of a combination of competition from low-cost economies (trade) and technology, with trade arguably the more important factor in, for example, traditionally labour-intensive sectors relying on basic skills, such as textiles and clothing.

Previous EJM annual reports have drawn attention to other important factors likely to have a bearing on the changing shape of employment in advanced market economies, whose importance is often overlooked. These factors are discussed briefly next.

Role of the state as employer

In terms of direct impact on the employment structure, perhaps the most important policy dimension relates to the state's role as an employer. In most Member States, the state accounts directly or indirectly for between 15% and 35% of employment. In sectors such as health, education and public administration, policy decisions – whether to reduce or expand public expenditure on such services – have a very direct bearing on the shape of overall employment shifts, especially as labour demand in these sectors tends to be biased towards higher skills. In the period of peak austerity (2010–2013), there was a very clear shift in employment growth from public to private services and a notable contraction (of over one million jobs or 6% of employment), in particular, in public administration employment in the EU (Eurofound, 2014).

Labour supply

The orthodox labour economics explanations of changing job structure (skill- or routine-biased technological change, or trade/globalisation) are demand-side explanations indicating why demand for specific types of labour, jobs and tasks in developed economies is being altered by the impacts of new technologies, computerisation or international competition. But, partly in response to these changes, the quality and quantity of labour being supplied to employers is changing rapidly. It is reasonable to expect that the availability of new types of worker affects the job creation decisions of employers. Three particular dimensions of the change in labour supply are especially worth noting: increased female participation in the labour market, educational upgrading, and increasing labour mobility and migration. Why and how are these changes related to changes in the employment structure?

Increased female participation: Women and men tend to work in different types of jobs. For this reason, the majority of men and women work in sectors that are either predominantly male (for example, construction or manufacturing) or predominantly female (for example, personal care or education). The increase in female jobs can be seen particularly in the growth of the 'care economy' (Dwyer, 2013) as many care activities previously provided informally within families have been formalised in paid jobs. These include many of the sectors (such as health and residential care) with the highest employment growth rates in developed economies over the last two generations and where, due to demographic shifts, demand is forecast to continue expanding.

Educational upgrading: Higher-skilled workers can perform a broader variety of tasks and jobs. One of the Europe 2020 strategic objectives is to raise the proportion of 30–34-year-olds with a third-level degree or equivalent qualification to 40% by 2020. In 2015, the share was already 38.7%, up from 23.6% in 2002 (Eurostat, 2016). The availability of a sharply rising share of highly qualified workers responds to employer demands for specific types of labour but also induces fresh demand itself. Oesch (2013) presented data from four European countries showing how the evolution of the employment structure (in terms similar to those used in the EJM – so in terms of the distribution of net new employment across the wage structure) was closely correlated with the evolution of skills supply.

Increasing labour mobility and migration: Migration and cross-border labour mobility generate new forms of labour supply in the destination countries. Intra-EU labour mobility has, for example, increased, and some 12% of the EU labour force were born in a Member State other than the one where they reside and work. The absolute level of intra-EU migrant labour (using those employed workers born in a country other than the reporting country as a proxy) has increased from 5.7 million people in 2008 to 7.3 million in 2016, but this figure is still lower than the number of workers of non-EU origin working in the Member States (13 million).[4] Migrant labour tends, especially initially, to work in lower-paid jobs, regardless of the qualifications of the job-seeker or job-holder. Between 2011 and 2015, non-native employment increased in each of the lower four quintiles in the EU, with the strongest growth in the lowest quintile (Eurofound, 2016a, p. 11), while it decreased in each of the same quintiles for native workers. Similarly, migrant inflows have been the most important component of low-paid employment growth in the UK (1991–2008) and in the USA during the 1990s, contributing to the polarised patterns of employment growth in both countries (Wright and Dwyer, 2003; Oesch, 2015).

Labour market regulation

Employment protection legislation and minimum wage legislation are particularly likely to affect the demand for lower-paid jobs (Fernández-Macías, 2012a; Oesch, 2013). Employment deregulation has been a common policy response to joblessness among the low-skilled following the OECD jobs study recommendations (OECD, 1994), and this may have contributed to boosting employment growth in lower-paid sectors.

Labour taxation

Most labour tax codes are progressive to some extent, with lighter tax burdens on lower-paid workers. This may boost the supply of such workers – and possibly demand for them, to the extent that low income tax is accompanied by reduced levels of employer payroll or social security contributions. Additional tax-based incentives – such as working tax credits – operate in a similar way, implicitly subsidising lower-paid employment.

4 This excludes Germany, where LFS data on the nationality or origin of respondents do not enable differentiation between EU and non-EU migrant workers.

Collective representation

Different modes of collective representation or levels of union coverage may also play a role, particularly in their potential to mitigate the raw impact of market forces on decisions affecting employment. In practice, it has not been easy to demonstrate empirically such effects (Eurofound, 2014). In earlier work, Nellas and Olivieri (2012) developed a model of labour demand responses to technological change where the inclusion of collective bargaining parameters was able to account for the substantial differences in the growth of the employment share of low-paid work between 1988 and 2004 in the USA (where it increased) and European countries (where it was stable). Their conclusion was that higher union coverage impedes the destruction of mid-paid jobs and thereby labour supply to lower-paid jobs. This can result in higher unemployment, as in their model. It could also induce other more positive outcomes, however. A specific counter-example is Sweden, which over many decades has had a consistently upgrading employment structure (Eurofound, 2015a), high employment and low unemployment as well as high levels of collective representation.

Welfare regimes

Unemployment benefit systems indirectly establish reservation wage levels and may thus alter the demand for labour, again primarily for jobs at the bottom of the wage structure. Active labour market policy is also salient as supported employment for job-seekers is more likely to be in lower-paid jobs. More generally, welfare regimes channel the development of particular types of job in different ways, with the state, the market or the family assuming greater importance in, for example, the provision of lower-paid interpersonal services in, respectively, social democratic, liberal or conservative welfare regimes (Esping-Andersen, 1990). This has impacts on the cost and volume of formal paid employment in these (increasingly important) services and thereby on the evolution of employment shares (Oesch, 2015).

Metropolitan concentration

Well-paid jobs are increasingly likely to be found in larger cities. This is reflected in patterns of regional and international mobility in which the overwhelmingly favoured destinations are capital cities or larger metropolitan areas. The two NUTS[5] regions with the greatest inflows of residents who had moved from another country in the preceding year were London (197,000) and Paris (94,000) (Eurostat, 2015). Kaplanis (2007) highlighted that patterns of employment polarisation in the UK were regionally differentiated and much sharper, for example, in London than in the rest of the UK.

Inequality and consumption spillovers

Growing income inequality, related to the disproportionate share of growth accruing to larger metropolitan areas, may also have a role in the changing distribution of employment across occupations, notably via consumption spillover effects. Increasing demand from time-poor, income-rich workers generates fresh employment in low-skilled services (such as in restaurants, households and cleaning or laundry services). Mazzolari and Ragusa (2013) estimated that 'this channel may explain one-third of the growth of [US] employment of non-college workers in low-skill services in the 1990s'.

Stages of economic development

While there are common trends in the employment structure in developed countries (principally occupational upskilling and the service transition), not all countries are at the same stage of development. Processes of catch-up and convergence mean that some countries may experience much swifter bouts of sectoral or occupational transformation than others in a given period. Within the EU, the share of employment in agriculture, for example, declined in 2016 to just over 1% in the UK from 1.6% in 2000, while in Poland over the same period, it declined from 19% to 10%.

Stages of the business cycle

Recessions are generally periods of accelerated job destruction that affect sectoral employment differentially. All of the net employment losses in the EU between 2008 and 2010 were accounted for by just two sectors – manufacturing and construction. Jaimovich and Siu (2012) made a related point when they demonstrated that recent employment polarisation in the USA is largely explained by the concentrated destruction of routine, mid-paying jobs that occurs during recessions. The jobs that disappear do not subsequently reappear during jobless recoveries. They also point out that, in the USA at least, not all of this job destruction was concentrated in manufacturing and construction – which they describe as 'cyclically sensitive goods-producing sectors' – and that it was routine occupations in these and many service sectors that accounted for the recessionary job attrition.

5 Nomenclature of Territorial Units for Statistics – a geographical nomenclature subdividing the territory of the EU into regions.

Levels of economic growth

Employment upgrading is likely to accompany stronger output growth, to the extent that a growing share of more productive workers should lead to greater output (everything else being equal). This theoretical prediction was supported by empirical evidence from an application of the jobs-based approach to recent employment data from the EU and six developed economies (Eurofound, 2015a). Employment shifts were much more likely to be upgrading in countries experiencing periods of higher growth, for example in Australia (2001–2010), China (2005–2010), Russia (2000–2008) and South Korea (2001–2008), while employment polarisation was more characteristic of countries experiencing weaker growth (the EU, the USA and Japan during various recent periods).

Modes of economic development

The varieties of capitalism literature list some of the factors already cited as associated with either side of its core differentiation between liberal market economies (such as the UK and the USA) and coordinated market economies (such as Germany, Japan and Sweden). Each generates distinctive forms of comparative advantage favouring the development of specific sector specialisations – manufacturing in the case of coordinated market economies and services, information technology and new technology in the case of liberal market economies (Hall and Soskice, 2001). The literature on the 'service transition' also assimilates similar distinctions to explain why countries are converging at different speeds on a higher share of service activities in overall employment and output (Wren, 2013).

Some of the above can be considered drivers of change (for example, the role of the state as employer), while many of the others are contextual factors – welfare regimes and rate or stage of economic growth – that influence the contours of employment change, making them, for example, more obviously upgrading or more obviously polarising. Crucially, these drivers and contextual factors vary significantly between countries and across time, even among a subset of relatively homogenous, developed western European EU Member States (Eurofound, 2015a). For these reasons, even if aggregate EU employment displays some consistency in its shifts over time, notably as regards the persistent outperformance of top-quintile jobs in employment growth and relative decline of mid-paid jobs, one would expect much variation between countries. As the next section indicates, this is what is found for the period 2011–2016 and what earlier EJM analysis has documented going back to the mid-1990s.

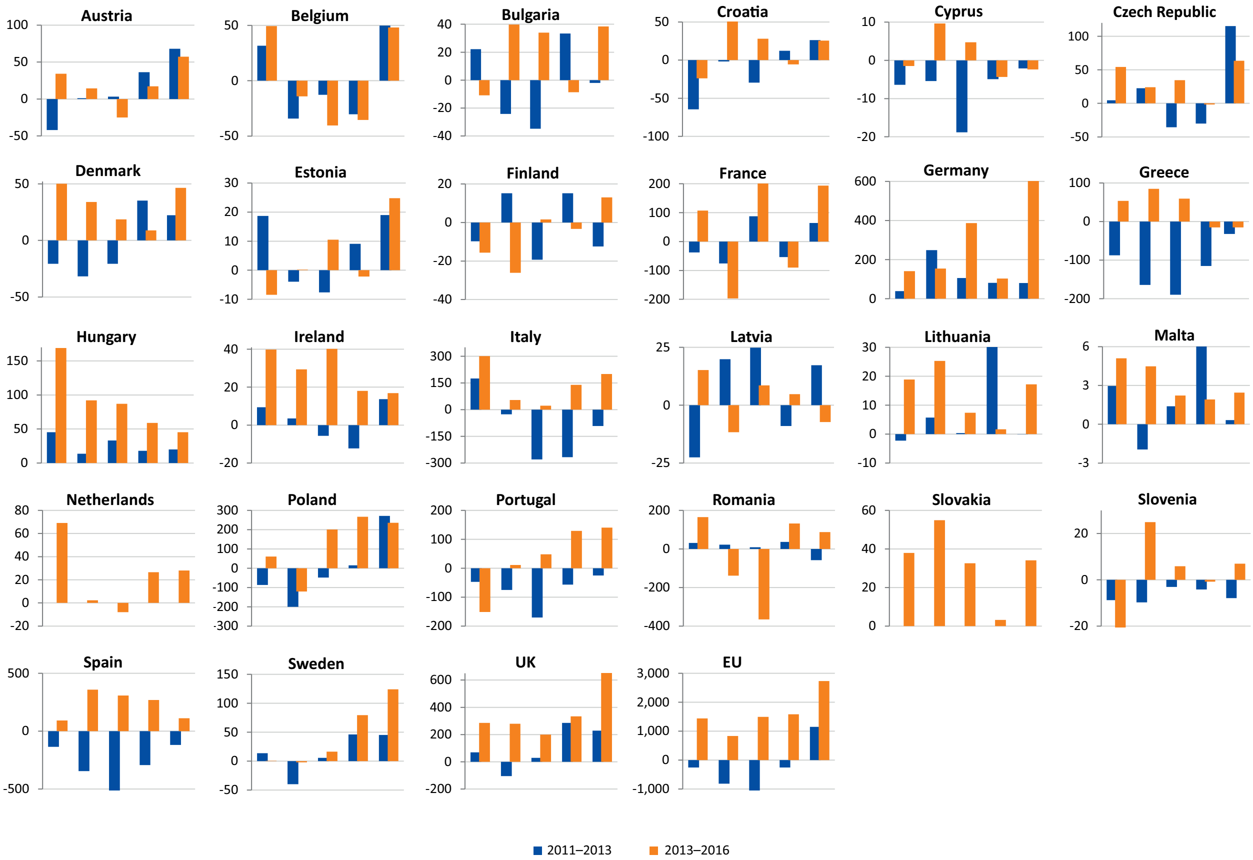
Recovering labour markets

The employment recovery post-2013 is now well established, with eight million net new jobs created across the EU. In Figure 6, this is evident in the predominance of positive employment growth by quintile and country in the 2013–2016 period (orange) compared with the earlier period of 2011–2013 (blue), the period of double-dip recession.

At EU aggregate level, net employment gains after 2013 have been more broadly shared across the quintiles, though with a customary skew to higher-paid jobs. Around 2.7 million of the net job creation since 2013 has been in well-paid, top-quintile jobs, but there have also been gains of between 830,000 and 1.6 million jobs in each of the remaining quintiles. During 2011–2013, employment contracted in all quintiles except the top quintile. Employment growth has, in effect, spread down the wage distribution during the recovery, consistent with a consumption-led recovery raising demand in particular for lower-level, non-tradeable services in most recent years (European Commission, 2016).

This is clearly observed in some Member States – Austria, the Czech Republic, Denmark, Hungary, Lithuania, the Netherlands and the UK. It is also a pattern observed in several of those Member States where the recession hit hardest. For Cyprus, Greece and Spain and, to a lesser extent, Ireland, significant contraction of employment persisted after the peak crisis years (2008–2010) right through until 2013. This job loss tended to have a strong concentration in mid-paying jobs, attributable in substantial part to a continuation of the rapid contraction of manufacturing and construction sector employment that had occurred in 2008–2010. Since 2013, each of these countries has experienced employment growth above the EU average. These gains have tended to occur in the middle quintiles, but with the bulk of the gains occurring somewhat further down the wage distribution. This suggests that while some of the gains may result from rebounds in the strongly recession-affected sectors, much of the net new employment created most recently is in different, lower-paid jobs. This is most clearly the case in Ireland.

Figure 6: Employment change (in thousands) by job-wage quintile, Member States, 2011 Q2–2016 Q2



Notes: *Data for Germany are for 2012 Q2–2016 Q2; data for the Netherlands and Slovakia are not available for 2011 Q2–2013 Q2. See Annex 2 for treatment of data breaks in France, Germany, the Netherlands and Slovakia. Luxembourg is excluded for data reasons.*
Source: *EU-LFS, SES (authors' calculations)*

There is clearly no dominant pattern of employment shift over the two periods covered, as might be inferred also from the divergent labour market performances of Member States over recent years. The aggregate EU pattern is upgrading with some polarisation.

Those more populous Member States with significant positive employment growth in recent years each demonstrate clear upgrading patterns – Germany, Poland and the UK. Around 60% of top-quintile employment growth in the EU since 2013 occurred in these three Member States; they also accounted for around half of total net employment growth. Other unambiguously upgrading countries included Sweden (2011–2016) and Portugal (2013–2016).

In Belgium, employment growth was polarised in both periods (2011–2013 and 2013–2016), occurring only in the top and bottom wage quintiles. In Austria, the Czech Republic, Denmark and Romania, recent (post-2013) growth has been polarised, whereas the most clear examples of employment polarisation in the 2011–2013 period arose in those countries that experienced the sharpest recessions in the wake of the global financial crisis, where the recessionary impacts persisted through to 2012–2013, and where associated employment destruction was concentrated in mid-paying jobs (Greece, Portugal and Spain). As already indicated, the recent rebound of employment in some of these Member States (Greece and Spain) has tended also to occur in mid-paying or mid-low-paying jobs, leading to distinctive 'growth in the middle' employment shifts.

A small number of Member States show downgrading patterns of employment shift since 2013, with greater growth occurring at the bottom of the wage distribution. Hungary, Ireland, Latvia and the Netherlands are the clearest examples of this, while in Italy and Malta, employment growth has been strongest throughout 2011–2016 in the lowest-paying jobs.

Downgrading patterns of employment growth have also been observed in the US labour market recently, with relatively stronger growth in the lower part of the wage distribution in the period 1999–2012, accompanied by relatively stagnant growth in the middle and top of the wage distribution (Autor, 2015, p. 20). More generally, in the longer term, jobs-based patterns of employment change in the USA have tended to shift from unequivocally positive upgrading (in the 1960s) to more polarised patterns each decade until the 1990s (Wright and Dwyer, 2003). This is obviously a development that warrants monitoring, all the more so as none of the more orthodox, demand-based theoretical accounts of how developed economy labour markets are changing offers an explanation for such observed downgrading. It is worth recalling also that earlier diagnoses of employment polarisation related first to the USA (Autor et al, 2003) before emerging in relation to the UK (Goos and Manning, 2007) and other EU Member States (Goos et al, 2009); the USA can be a harbinger of developments in other developed market economies including the EU. Thus far, a similar pattern can be observed only in a small number of Member States and over a shorter 3–5 year time frame. Aggregate employment shifts in the EU continue to be skewed towards top-quintile growth, albeit with a strengthening since 2013 of growth in lower-paid employment.

In many countries, employment shifts do not conform to any obvious pattern, are irregular or are some hybrid of the four patterns already indicated. This is partly due to the short time frame covered. Structural changes generally take longer than three or five years to become apparent. But a second general conclusion based on Figure 6, supported by previous jobs-based analysis carried out over longer time frames (Oesch, 2013; Eurofound, 2015a), is that there has been a variety of different employment shift patterns in different countries.

Growing and declining jobs

The quintile charts compress a lot of data in order to convey graphically the main employment shift patterns. They do not, however, identify the individual jobs (again, as defined in this study's application of the jobs-based approach, occupations in sectors at two-digit level of detail using the ISCO and NACE classifications) that contribute to the overall pattern. Depending on the country, each quintile encompasses between 80 and 300 plus jobs. In practice, a small number of large-employing jobs account for a very large share of employment. It is shifts in the employment headcount in these jobs that contribute most to the observed patterns of change in the quintile charts. Table 2 lists, in sequence, the top 12 jobs in terms of employment in the EU as well as those large-employing jobs (employing more than 600,000 people in the EU28 in 2016, n = 57) with the fastest rates of growth or contraction in 2011–2016. Details are also included of the composition of employment in these jobs by gender, age and share of part-timers.

Table 2: Top 12 jobs by employment (2016 Q2) and top 12 fastest-growing and fastest-declining large-employing jobs (2011 Q2–2016 Q2), EU

Largest-employing jobs		Employment		Employment composition (%)				Job quintile		
Occupation	Sector	2016 (millions)	Average annual % growth	Female	Age 55+ years	Age <30 years	Part time	W	E	JQ
Sales workers	Retail trade	12.2	**0.3**	70	14	29	34	1	2	3
Teaching professionals	Education	9.8	**0.6**	71	21	12	22	5	5	5
Skilled agricultural workers	Crop and animal production, etc.	6.2	**-2.6**	↓ 36	32	13	17	2	1	2
Health professionals	Human health activities	4.9	**2.0**	70	↑ 24	14	22	5	5	4
Personal services workers	Food and beverage service activities	4.4	**2.7**	53	9	41	35	1	2	1
Drivers and mobile plant operators	Land transport and transport via pipelines	4.1	**0.1**	5	↑ 23	10	8	3	2	1
Building and related trades workers	Specialised construction activities	4.0	**-2.2**	2	15	↓ 19	7	2	2	2
Health associate professionals	Human health activities	3.8	**0.5**	82	↑ 16	22	28	4	4	3
Business and administration associate professionals	Public administration and defence	3.1	**-0.2**	60	22	11	16	4	4	5
Building and related trades workers	Construction of buildings	2.3	**-1.3**	1	15	↓ 15	5	3	1	1
Cleaners and helpers	Services to buildings, etc.	2.2	**2.9**	78	↑ 23	12	64	1	1	1
Personal services workers	Other personal service activities	2.1	**2.1**	85	12	↓ 28	32	1	3	3

Fastest-growing large-employing jobs		Employment		Employment composition (%)								Job quintile		
Occupation	Sector	2016 (millions)	Average annual % growth	Female		Age 55+ years		Age <30 years		Part time		W	E	JQ
ICT professionals	Computer programming, consultancy, etc.	1.6	**7.0**	↑	15		8		21		7	5	5	5
Legal, social and cultural associate professionals	Education	1.0	**6.1**	↓	79		16		27		46	3	4	3
Drivers and mobile plant operators	Warehousing and support activities	0.6	**5.8**		4	↑	20	↑	15		5	3	2	1
Business and administration professionals	Activities of head offices; management consultancies	0.7	**4.6**		44	↑	22		13	↓	18	5	5	5
Health associate professionals	Residential care activities	0.6	**4.5**	↓	84	↑	19	↑	23	↓	35	2	4	3
Food preparation assistants	Food and beverage service activities	1.1	**3.8**	↓	59		11		41		53	1	1	1
Legal, social and cultural professionals	Legal and accounting activities	1.1	**3.2**	↑	47	↑	19		11		9	5	5	5
Stationary plant and machine operators	Manufacture of food products	0.8	**3.2**		42	↑	14		22	↓	8	2	1	1
Business and administration professionals	Financial service activities (excluding insurance)	0.7	**3.1**		49		9		19		8	5	5	5
Personal care workers	Residential care activities	2.0	**3.1**		87	↑	20	↓	22	↓	40	2	3	3
Cleaners and helpers	Services to buildings and landscape activities	2.2	**2.9**		78	↑	23		12		64	1	1	1
Personal services workers	Accommodation	0.9	**2.8**	↑	56		15		31		26	2	2	2

Fastest-declining large-employing jobs		Employment		Employment composition (%)								Job quintile		
Occupation	Sector	2016 (millions)	Average annual % growth	Female		Age 55+ years		Age <30 years		Part time		W	E	JQ
Hospitality, retail and other services managers	Food and beverage service activities	0.9	**-2.8**		40		19		15		7	3	3	3
Metal, machinery and related trades workers	Manufacture of fabricated metal products	1.6	**-2.8**		4		18		21		4	3	2	1
Skilled agricultural workers	Crop and animal production, etc.	6.2	**-2.6**	↓	36		32		13		17	2	1	2
Hospitality, retail and other services managers	Retail trade	0.7	**-2.6**	↑	49		16		15		6	4	3	4
Customer services clerks	Financial service activities (excluding insurance)	0.9	**-2.2**		63	↑	16	↓	24	↑	22	4	4	4
Building and related trades workers	Specialised construction activities	4.0	**-2.2**		2		15	↓	19		7	2	2	2
General and keyboard clerks	Public administration and defence	1.3	**-2.2**		74	↑	26		9		19	3	3	4
Cleaners and helpers	Education	0.6	**-1.8**		87	↑	32		4	↓	34	1	1	2
Cleaners and helpers	Activities of households as employers	1.4	**-1.7**		95	↑	26	↓	7		68	1	1	1
Sales workers	Wholesale trade	1.0	**-1.6**		43		15		20		18	3	3	4
Building and related trades workers	Construction of buildings	2.3	**-1.3**		1		15	↓	15		5	3	1	1
Agricultural labourers	Crop and animal production, etc.	1.3	**-1.0**	↓	33	↓	18		23	↓	28	1	1	1

Notes: *EU28, 2016 Q2 data for top 12 jobs by employment; also for employment composition estimates. For individual Member State shares of employment for each of the top 12 jobs, see Annex 5. Figures for average percentage growth per annum are based on the average yearly growth rate for different EU aggregates due to data breaks in certain countries, as follows: 2013–2016, EU26 (no data for France or Luxembourg); 2012–2013, EU24 (no data for France, Luxembourg, Slovakia or the Netherlands); 2011–2012, EU23 (no data for France, Luxembourg, Slovakia, the Netherlands or Germany). Red arrows indicate declining share by at least 2 percentage points; green arrows indicate increasing share by at least 2 percentage points (over period 2013–2016, EU26 (no data for France or Luxembourg)). Job quintiles: W = wage, E = education, JQ = job quality (see Eurofound 2013 annexes for details of construction).*

Source: *EU-LFS, SES (authors' calculations)*

The top 12 jobs account for over a quarter (26%) of all employment in the EU, with the two biggest jobs – retail sector sales workers and education sector teaching professionals – accounting for 1 in 10 jobs. Employment has grown modestly in these two predominantly female jobs, the former in the lowest job-wage quintile and the latter in the highest. Of the other largest-employing jobs, the biggest contractions in headcount were in skilled agricultural workers (-2.6% per annum) as well as two construction sector jobs. However, more jobs were growing than contracting in the top 12 list (8 versus 4), and more of these jobs were growing relatively fast (more than 2% per annum) than declining relatively fast.

The greatest employment growth was recorded in three low-paid jobs: cleaners and helpers in the services to building sector; personal services workers in food and beverages; and personal services workers in other personal services activities. These jobs account for much of the recent bottom-quintile employment growth. They are typical, basic-skilled service jobs, that are hard to automate and where the service is provided directly in person. They are also predominantly female-employing jobs, with a high share of part-timers.

In the two lists of relatively fastest-growing and fastest-contracting large jobs, one can see that the archetypal modern digital economy job – ICT professional in computer programming – is the fastest-growing job (+7% per annum). There are four well-paid, top-wage-quintile jobs in the fastest-growing list but none in the fastest-declining list.

While these top-growing jobs contribute to employment upgrading, they do so only modestly, given their relatively low employment headcount. There are 1.6 million ICT professionals in computer programming and fewer still in the other top-quintile professional job categories with fastest growth. In general, developments in both the fastest-growing and fastest-contracting jobs are likely to contribute more to employment polarisation. Ten of the fastest-growing jobs are in the low-paid, mid-low-paid or top-paid quintiles, while the fastest-contracting jobs are in the middle of the wage distribution.

The fastest-growing jobs are, however, growing faster than the fastest-declining jobs are contracting; the annual growth rate of personal services workers in accommodation (12th in the fastest-growing jobs list) is of the same magnitude (2.8% per annum) as the rate of contraction of the fastest-declining jobs (hospitality managers in food and beverages and trade workers in fabricated metal products production).

In terms of job composition, as already indicated, the main aggregate shifts are the increasing share of employment accounted by female workers, older workers and part-timers. Among the top-growing and top-declining jobs, the most obvious compositional change is the increasing share of older workers, especially in the fastest-growing jobs. This suggests that older workers in these jobs are remaining longer in work and retiring later. Some fast-growing, predominantly female jobs are becoming less female (for example, health associate professionals in residential care), while the very male-dominated job of ICT professionals in computer programming is attracting a growing share of women. Finally, it is interesting to see that in four of the top-growing jobs, the share of part-timers is declining. One manifestation of increased demand may have been the conversion of existing part-time positions to full-time positions as the employment recovery has strengthened. If this is the case, some share of the part-time pool in such jobs may be functioning as a labour reserve.

3 Patterns of employment change by sector, employment status and worker characteristics

In this chapter, employment change is broken down into its components in terms of major sectoral aggregations, employment status and worker characteristics. The objective is to show how the broad outlines of employment change identified in the quintile charts intersect with other dimensions of labour market development, such as the increasing share of services in total employment, the rapid recent growth in part-time work and the increasing share of female employment.

Developments by broad sector: The service transition

Over many generations in developed market economies, employment has tended to decline in primary sectors (agriculture and mining) and secondary sectors (manufacturing), with a corresponding increase in the share in tertiary, service sectors. This has occurred largely as a result of differential rates of productivity growth. The application of successive waves of productivity-enhancing and labour-saving technology in farming and in production has automated many processes and allowed greater output to be generated with fewer and fewer workers. Many service activities are labour intensive and do not have the same potential productivity improvements because they involve tasks that are hard to automate and that continue to require direct human intervention – think, for example, of a haircut, the preparation of a meal or an examination by a doctor. Employment needs in modern economies are therefore increasingly satisfied by a growing service sector. Over 70% of EU employment is now in services, and in the most service-intensive countries such as Luxembourg or in large metropolitan areas such as greater London or the Île-de-France, the figure is between 80% and 90%.

Many of the consequences of 'unbalanced' sectoral growth were first identified in the 1960s (Baumol, 1967; see Nordhaus, 2006 for a more recent assessment). These included decreasing relative costs and employment in technologically progressive sectors such as manufacturing, and increasing relative costs and employment in 'technologically stagnant' service sectors. 'Baumol's cost disease' is probably an important factor in declining rates of output growth and in predictions of 'secular stagnation' in developed market economies. The composition of paid employment has increasingly shifted to sectors and jobs in which it is harder to increase productivity. And even the application of the formidable advances in information technology to services sector work processes has brought about relatively modest improvements in output. As Nobel Laureate economist Robert Solow has observed, 'we see computers everywhere except in the productivity statistics'.

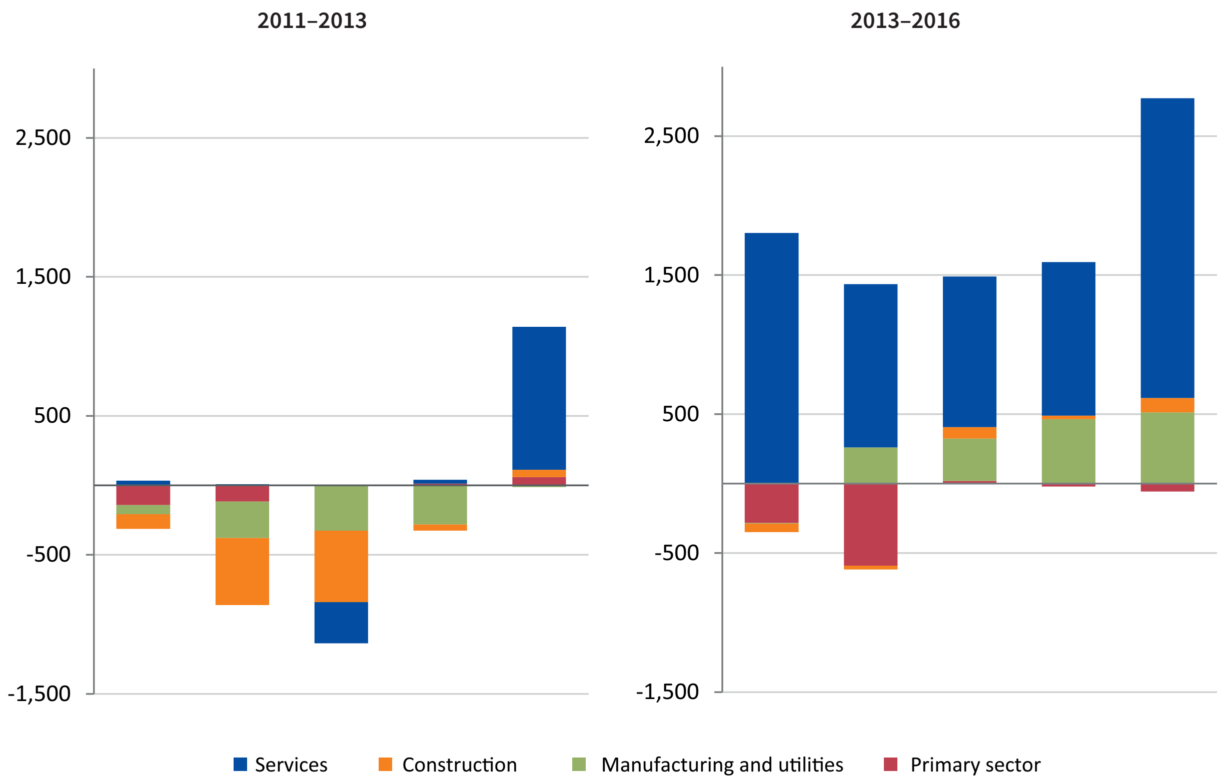
This may, however, be about to change. Recent developments in education (for example, massive open online courses), telemedicine, domestic robots and driverless transport suggest that the application of technology may revolutionise the provision of services that have traditionally been provided personally. This could augur declining labour demand in some high-employing service sectors. But for the moment, this is not occurring in developed-economy labour markets. In structural terms, employment headcount is continuing to grow, especially in services, even as the working age population has begun to contract post-2010.

The long-term secular shift to services employment tended to pick up pace during the post-2008 economic crises as the negative employment impacts of the crises fell disproportionately on non-service sectors. Despite the aggregate net loss of 7.5 million jobs in the EU in the period 2008–2013, the service sector actually grew employment during the period (+0.25% per annum). Manufacturing and construction alone accounted for the net destruction of 8.6 million jobs during 2008–2013. Since the employment recovery in 2013, the average growth rate in services employment has been 1.6%.

Figure 7 highlights again the pivot in terms of employment performance from the earlier post-recession period (2011–2013) and the employment recovery (2013–2016). Only the top quintile grew employment in 2011–2013; there has been growth in all quintiles since 2013, and the bulk of new employment has been in the service sector, which has been – relative to earlier periods – quite evenly distributed across the job-wage distribution.

The same year – 2013 – marks a point of inflection for the other broad sectors presented. Employment losses in the primary sector – agriculture and the mining and extractive industries – have actually increased post-2013 even as the recovery has strengthened. These losses have been in low-paid agricultural jobs almost exclusively and with a strong concentration in a smaller number of Member States that have comparatively

Figure 7: Employment shifts (in thousands) by job-wage quintile and broad sector, EU, 2011 Q2–2016 Q2



Source: *EU-LFS, SES (authors' calculations)*

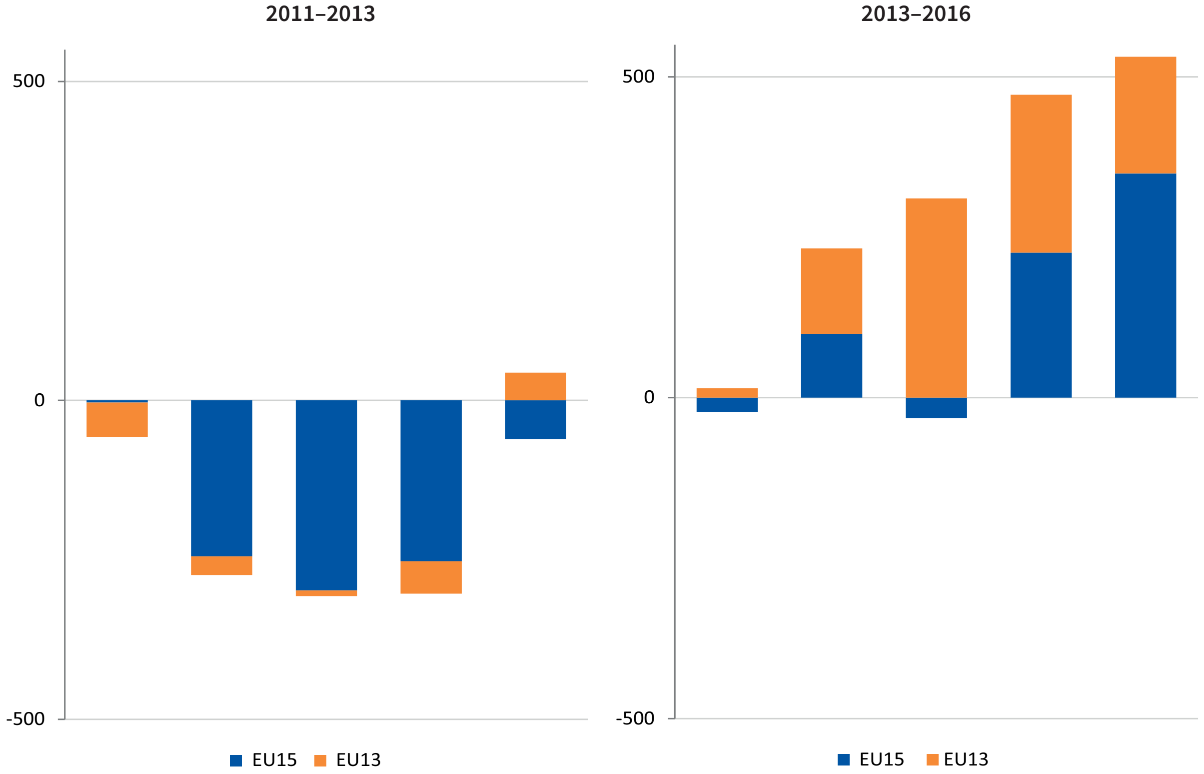
large agricultural workforces, such as Croatia, Greece, Poland, Portugal and Romania.

As regards the construction and manufacturing sectors, even if the majority of post-crisis employment losses occurred during the earlier 'peak crisis' period 2008–2010 (not shown), both sectors continued to shed employment through to 2013. In contrast, there has been positive growth since 2013 in both sectors, very marginally so in construction, but much more robustly in manufacturing, where the annual employment growth rate since 2013 has been only slightly lower than in services (1.4% versus 1.6%). In both sectors, net new employment has been skewed to better-paid jobs.

In manufacturing, this has arisen in part from a recomposition of employment towards higher-skilled professional roles. Manufacturing employment is upgrading: the employment lost mainly in mid-paying jobs up to 2013 is being replaced by higher-skilled and higher-paying employment. Eight of the top 10 fastest-growing manufacturing jobs are in professional, associate professional or managerial grade occupations, with the strongest growth in machinery and equipment production and motor vehicle production. Employment levels of science and engineering professionals in motor vehicle manufacturing (NACE 29), for example, have been rising by 7% per annum since 2013. At the same time, there has also been growth in traditional blue collar production roles such as stationary plant and machinery operators and assemblers, again in the faster-growing machinery and motor vehicle production sectors.

Manufacturing employment in the EU has not only been changing qualitatively but also has been shifting geographically. Figure 8 focuses on manufacturing employment shifts and differentiates between the 'old' EU15 Member States and the primarily eastern European Member States that joined the EU after 2004 (the EU13).

Figure 8: Employment shifts (in thousands) by job-wage quintile in manufacturing, EU15 and EU13, 2011 Q2–2016 Q2



Source: *EU-LFS, SES (authors' calculations)*

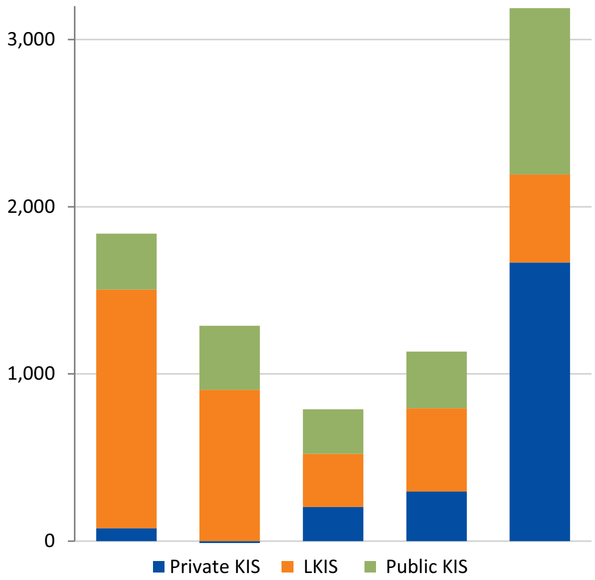
Most employment losses in the earlier 2011–2013 period were recorded in the EU15. During the recovery, around 60% of the net 1.5 million new manufacturing jobs created in the EU have been in the EU13, even though these countries account for just over a quarter of the total EU manufacturing workforce. It is also worth noting that the growth in EU15 manufacturing employment has been mainly in high-paid jobs, while that in the EU13 has been more evenly distributed across the top four quintiles, with a skew towards mid-paid jobs. One likely explanation is that some 'traditional' blue collar, mid-paying manufacturing jobs – of the type that were cut in the older Member States with a higher GDP during the recession – have relocated eastwards following the recovery, as primarily western European companies take advantage of lower labour costs in the eastern European Member States. Such an explanation is consistent with patterns of employment gains and losses arising from restructuring activity captured by the European Restructuring Monitor in recent years (Eurofound, 2017), especially in the two manufacturing subsectors that have contributed most to the recent manufacturing 'renaissance' – the motor vehicle production and machinery and equipment production sectors.

The contribution of manufacturing to overall employment growth pales beside that of the service sectors. These have added over eight million new jobs since 2011, the majority of the job gains occurring after 2013. Consistent with a consumption-led recovery, a large share of this new employment has come in less-knowledge-intensive services[6] – jobs such as personal care workers or service workers in the food and beverages sector. These account for most of the growth

6 This breakdown relies on the Eurostat aggregation of service sectors into knowledge-intensive services (KIS) and less-knowledge-intensive services (LKIS). As there is no specific question in the EU-LFS regarding the public or private status of the respondent's employer, it is not possible to estimate accurately the respective shares of public and private sector services employment. To make the distinction in this report, the KIS category has been further broken down into public and private service components. Public KIS comprises the following NACE sector categories: public administration; social security and defence; education; and human health activities. Private KIS comprises all remaining knowledge-intensive services (see Annex 4 for a full list). It should be noted that, as a significant minority of workers in the health and education sectors are in fact private sector employees, the public KIS category is an imprecise proxy of public sector employment.

in the bottom two quintiles in Figure 9. There has also been a reprise of growth in the predominantly public sector knowledge-intensive service employment, notably in the top quintile, as public spending restrictions were relaxed after 2013. As noted in Table 2, employment growth has been particularly strong in the category of health professionals. Knowledge-intensive services in the private sector – including media, ICT, consulting, legal and accounting services as well as financial services – account for around half of the growth in well-paid, top-quintile jobs but only modestly for growth in the other quintiles. All four of the top-quintile fastest-growing large jobs (see Table 2) fall into this category, including that of ICT professionals in computer programming and consultancy.

Figure 9: Employment shifts (in thousands) by job-wage quintile in services, EU, 2011 Q2–2016 Q2



Note: *KIS = knowledge-intensive services; LKIS = less-knowledge-intensive services.*
Source: *EU-LFS, SES (authors' calculations)*

Atypical employment growing across the wage distribution

One effect of the 2008–2013 crises was to reduce the share of European workers in full-time permanent dependent employment. This traditional status – henceforth referred to as 'core employment' status in this report – described 58.2% of EU workers in 2016 Q2 (compared with 59.5% in 2009). In particular, there was a steady expansion of part-time work even as the numbers of those in full-time work decreased. As the recovery in EU labour markets has broadened since 2013, a (very modestly) growing share of net new employment has been in core employment status. This is consistent with greater confidence among employers as economic conditions and prospects have improved.

Member State labour markets show a great diversity in terms of the shares of core employment and of the distribution of non-core employment between those who are self-employed, on temporary contracts, working part-time or some combination of these categories. For example, just over one in three Dutch workers has core employment status; this country's very particular experiment in flexibilised working time has resulted in there being more part-timers than full-time workers. In recent years, an increasing number of self-employed workers in the Netherlands has added another vector of destandardisation. While most western European EU15 Member States have shares of core employment close to the EU28 average (±5 percentage points), the percentages tend to be much higher in the EU13 countries (70%–85% in most cases),[7] although here, too, they are in decline. The incidence of part-time work in particular tends to be much lower in eastern European Member States.

In summary, the main vector of destandardisation has been the increasing share of part-time employment.[8] At aggregate EU level, shares of temporary work and self-employed are not much changed since 2008.

7 Poland is the exception with its very high share of temporary workers.

8 This analysis relies on the LFS's main variables capturing employment status. These differentiate between full-time and part-time work (ftpt), self-employment and dependent employee status (stapro), and between those dependent employees with a permanent contract and those with a temporary one. However, a weakness can be noted in any analysis of 'atypicality' or employment destandardisation that relies on these distinctions. It is increasingly obvious that some emerging forms of employment relationship (for example, online platform workers, on-call workers or those working zero-hours contracts in the UK) are not directly identifiable using the available LFS variables. Many online platform workers are likely to be part time, but it is only now in some cases that labour law is being called on to arbitrate whether, for example, a taxi driver operating on a particular taxi-service platform is self-employed or an employee of the platform provider. Even where such distinctions may have acquired legal clarity, an additional complication with the LFS data – as with all surveys – is that it is based on individual survey responses, and respondents in similar situations may report differently on their own status.

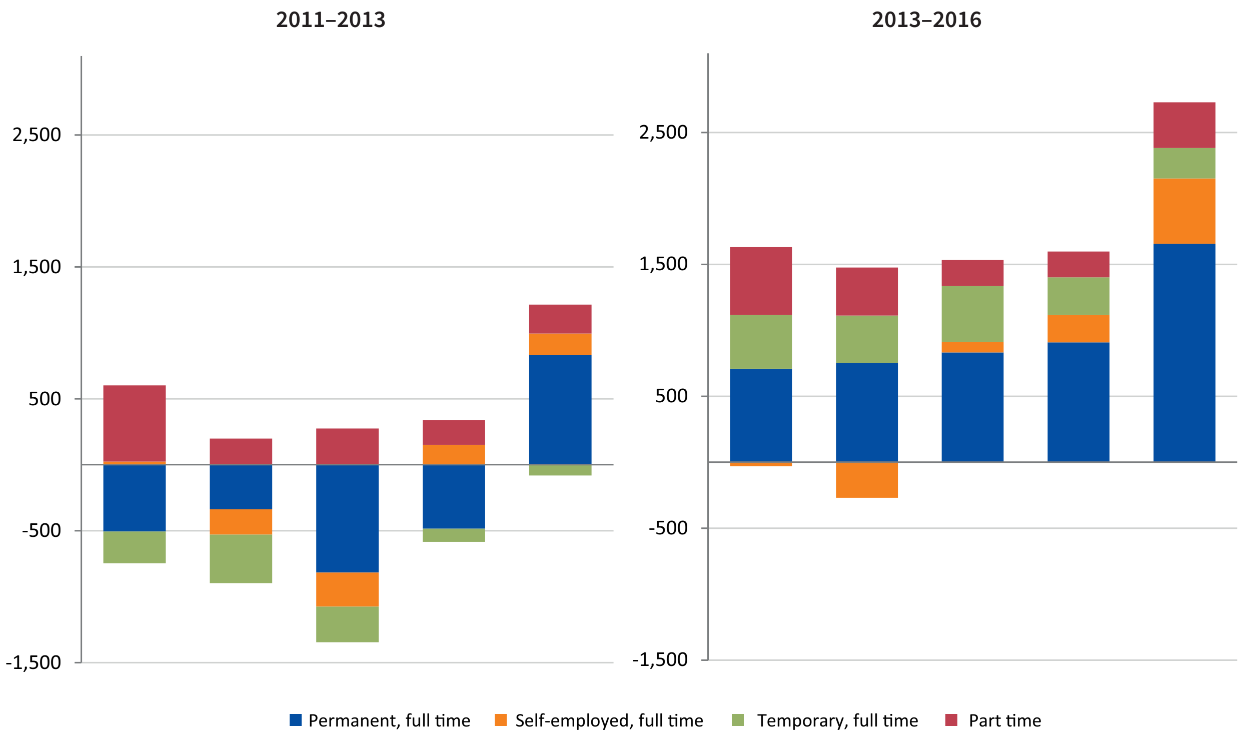
Core employment share stabilising

Figure 10 breaks down recent EU employment growth by job-wage quintile for core workers (those on full-time permanent contracts) and various forms of 'atypical' worker[9] (those who work part time or on full-time temporary contracts or who are full-time self-employed). The analysis compares the period of ongoing job loss (2011–2013) with the recovery period (2013–2016); the reference category is core workers (represented by a dark blue bar in Figure 10). The two periods are quite different, not only in terms of the sign of the employment shifts, but also in the shifts by employment status.

The period 2011–2013 saw a destandardisation of employment. This was a continuation of developments previously observed in 2008–2010 (Eurofound, 2011). The main elements of this were a net decrease of full-time employment in all except the top quintile, partly compensated for by an increase in part-time employment in all quintiles. While core employment accounted for the majority of job losses, there was also a broadly shared decline in temporary employment (usually the most vulnerable category in a downturn) and also of self-employment in mid-paid and mid-low-paid jobs (mainly in agriculture and likely to be structural).

After 2013, as labour market conditions improved, the share of core employment has stabilised. Core employment status has been the category accounting for the biggest share of employment growth in each of the quintiles, though only in well-paid, top-quintile jobs does it account for the majority of net new employment. Part-time employment continues to grow across the wage distribution, and there has been an across-the-board increase in temporary employment – a customary labour market response in conditions of recovery. While self-employment accounts for only a small share of net new employment, it is interesting to see that this is very clearly skewed towards high-paying jobs such as professionals in the health, education, and legal and accounting services as well as in the fast-growing category of ICT professionals.

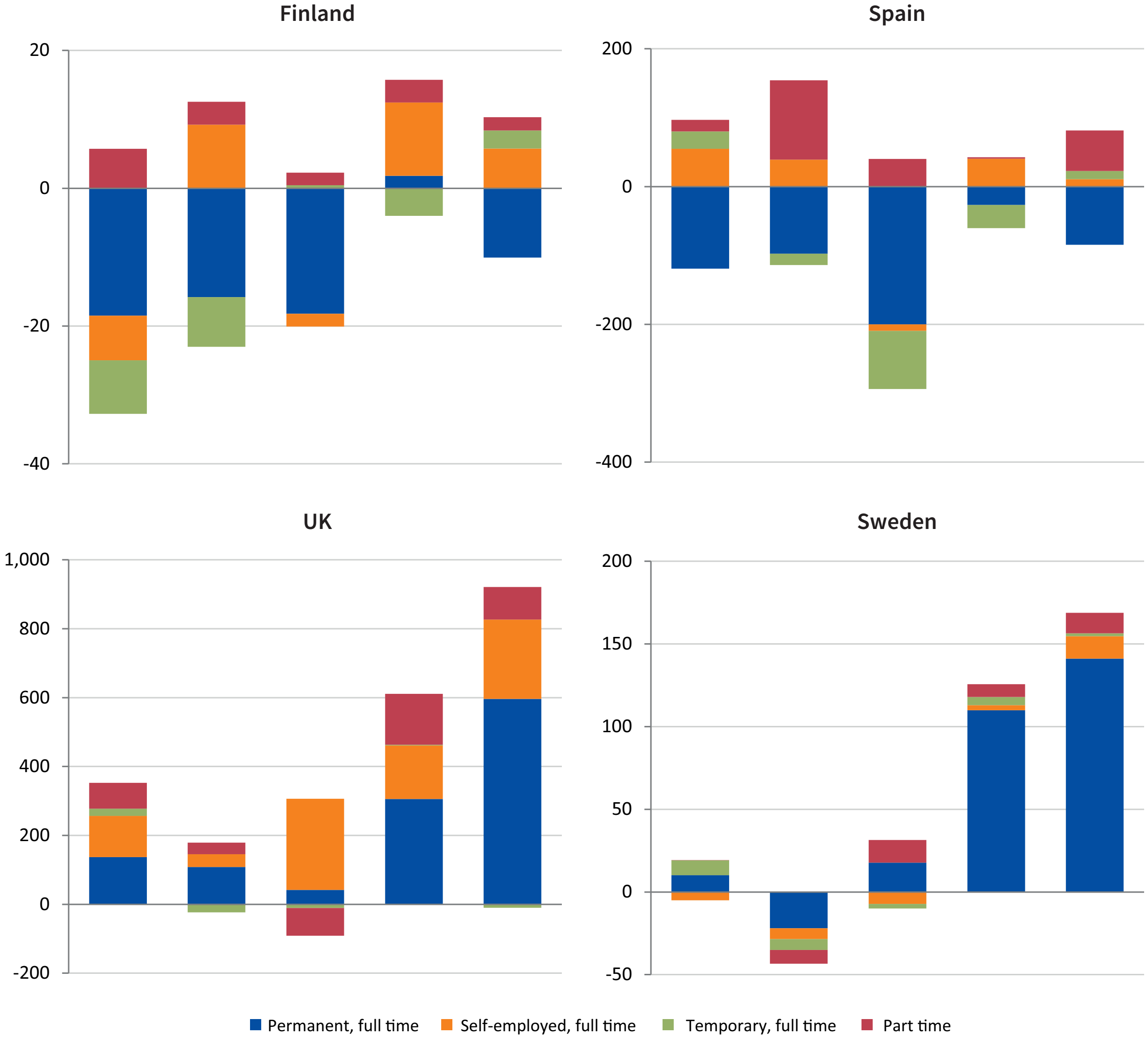
Figure 10: Employment shifts (in thousands) by job-wage quintile and employment status, EU, 2011 Q2–2016 Q2



Source: *EU-LFS, SES (authors' calculations)*

9 Family workers are omitted from the description of employment shifts by core/non-core employment status; these accounted for just over 1% of the total EU workforce (2.46 million people) in 2016 and are in decline.

Figure 11: Employment shifts (in thousands) by job-wage quintile in core and non-standard forms of work, selected Member States, 2011 Q2–2016 Q2



Source: *EU-LFS, SES (authors' calculations)*

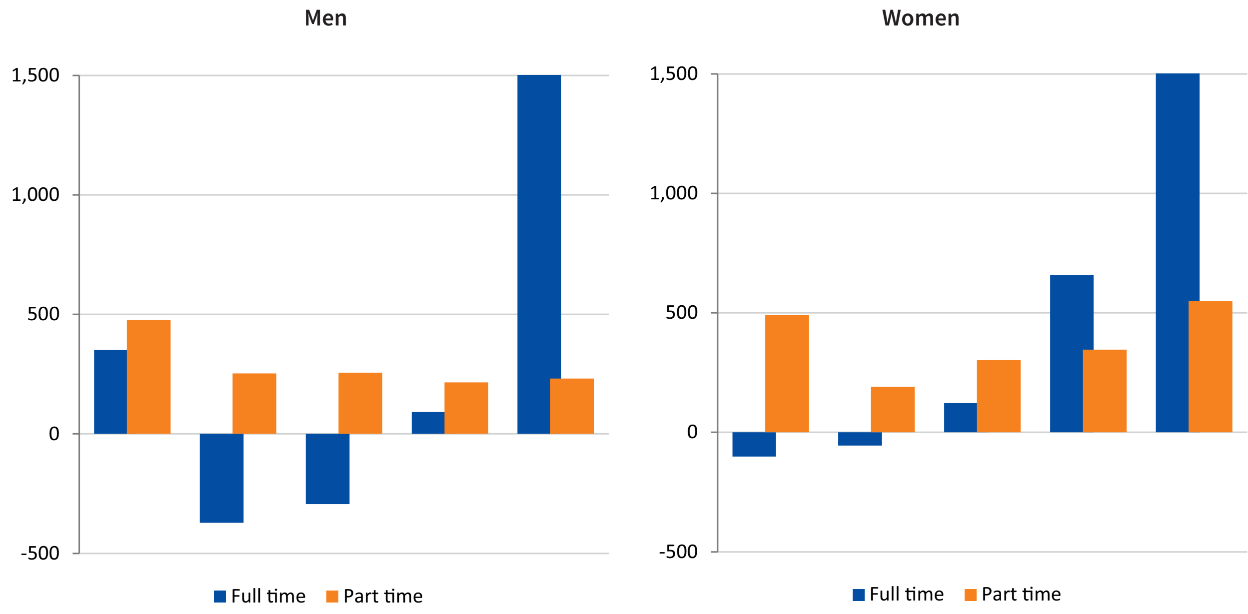
Trends in temporary employment and core employment outside the top quintile have tended to be sensitive to the business cycle. The more obviously structural trends are the growth of part-time employment and core employment in the top quintile; this has been consistent through periods of employment contraction and expansion alike. Similar conclusions can also be drawn based on earlier EJM analyses looking at the pre-crisis period (1998–2007) and the peak crisis period (2008–2010) (Eurofound, 2011, 2013). Part-time employment levels have grown consistently since 2008, even in periods of steep recession, while full-time employment has tended to grow only in periods of relatively higher growth.

Different manifestations of these developments can be seen in Figure 11 in four Member States with quite different recent economic and labour market performance.

In Finland and Spain, where there was a net destruction of employment in 2011–2016, most of the job loss has been in core employment while there have been some countervailing gains in atypical work – predominantly part-time work in Spain and self-employment in Finland. In contrast, where workforces have been growing, these gains have either been primarily in core employment status in higher-paid jobs – as in Sweden – or have been shared between core and atypical employment – as in the UK, where increasing self-employment, in particular, has contributed to growth at the top.[10]

10 Indeed, the rapid rise of self-employment in the UK – from around 4 million workers in 2011 to 4.8 million in 2016 – is the main factor behind the rise of self-employment in the EU overall.

Figure 12: Employment shifts (in thousands) by job-wage quintile and full-time and part-time status, according to gender, EU, 2011 Q2–2016 Q2



Source: *EU-LFS, SES (authors' calculations)*

Last year's EJM analysis concluded that the core employment relationship – with its customary benefits in terms of greater contractual security, career advancement possibilities and full-time earning capacity – was increasingly the privilege of those in well-paid jobs (Eurofound, 2016a). The addition of one year of reasonably vigorous employment growth has largely qualified this conclusion. Core employment has accounted for much of the recent growth across the wage distribution, although still with an upgrading skew towards higher-paid jobs. And atypical employment is tending to grow across the wage distribution and not just in lower-paid jobs, as atypical employment forms such as part-time work and self-employment appear to be 'normalising' even in higher-skilled, higher-paying jobs.

Growing male share of part-time work

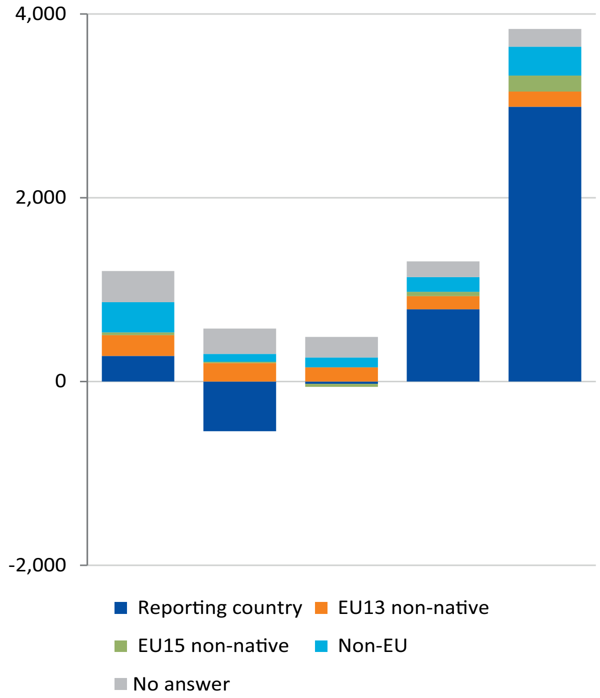
At first glance, it may be surprising that net new part-time employment – in both periods – is so evenly spread across the job-wage quintiles. Part-time work is associated with a wage penalty, and part-time employment is skewed towards the lower quintiles. The main explanatory factor is gender, as Figure 12 illustrates. This covers the whole period from 2011 to 2016 and breaks down employment shifts by gender and full-time versus part-time status. There are increasing numbers of part-time professionals, particularly in the health and education sectors, and, in line with the overall gender share of employment in these sectors, these are primarily female jobs. These have supported the growth in part-time work in the top quintile. Part-time employment has also grown very significantly for men over recent years, but this growth has been strongest in low-paid service jobs, including many jobs which, to date, have been mainly female-employing, such as retail sales assistants and personal services workers in the food and beverages sector.

One potential explanation is that male workers who lost their jobs in the manufacturing and construction sectors during the crises have subsequently taken up generally lower-paying service jobs. While such a hypothesis is not possible to test using cross-sectional data, Salvatori observed in relation to the UK labour market that 'the decline in middling occupations is entirely accounted for by non-graduates, who have both decreased in numbers and seen their employment become more concentrated at the bottom' (2015, p. 12).

Non-natives dominate new employment in lower-paid jobs

Just over 27 million workers in the EU (12% of the total) were born in countries other than the countries in which they work. Since the majority of this subgroup was born in non-EU countries, a minority is mobile EU workers taking advantage of the freedom of movement that EU citizens enjoy to settle and work in other Member States. The mobile/migrant worker population has increased by over three million since 2011 and thus accounts for just less than half of net employment growth over the last five years, although, as the recovery has become more established in 2015–2016, the share of net new employment held by natives has risen sharply.

Figure 13: Employment shifts by job-wage quintile and country of birth, EU, 2011 Q2–2016 Q2

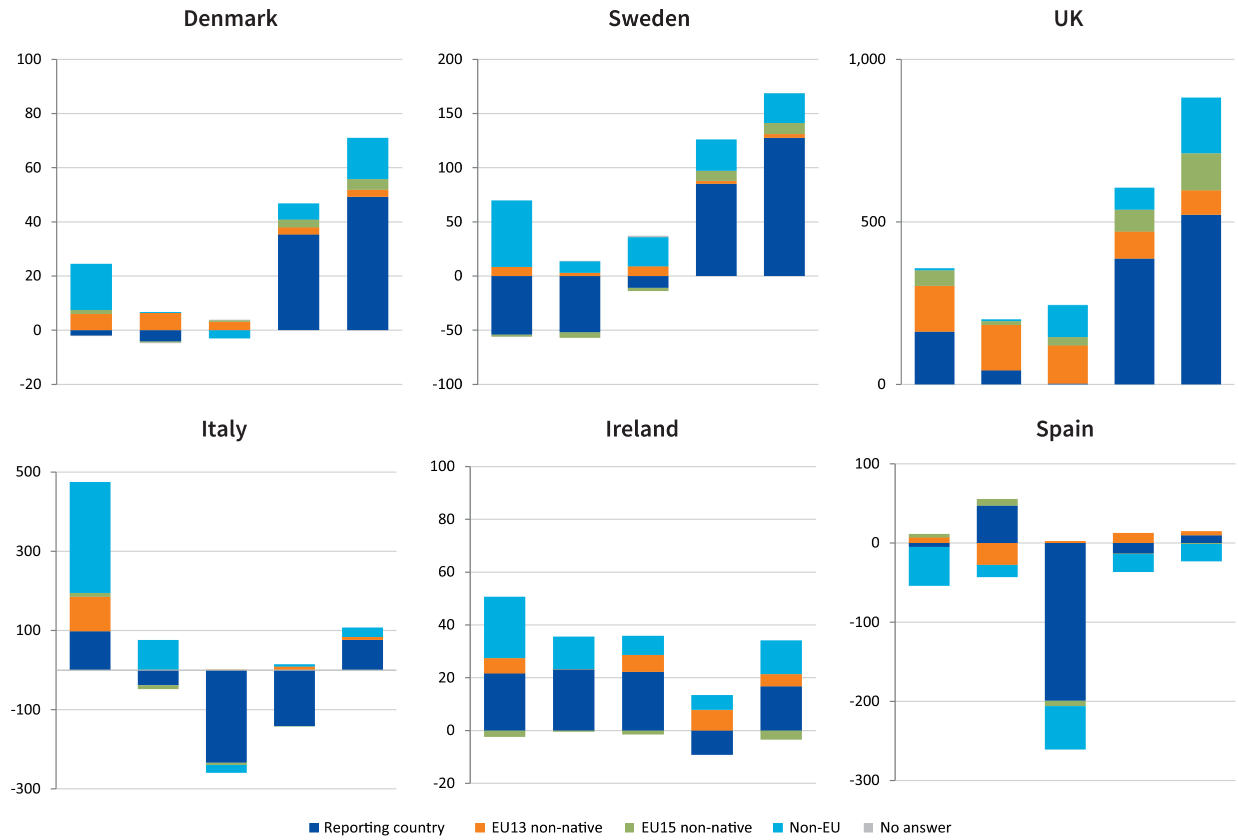


Source: *EU-LFS, SES (authors' calculations)*

As can been seen from Figure 13, most of the net employment growth in the bottom three quintiles in the EU is accounted for by non-natives. In these low-paid and mid-paid jobs, native employment has either increased only marginally (first quintile) or has contracted. Meanwhile, natives have been the main beneficiary of the more resilient employment growth in better-paid jobs and especially in top-quintile jobs. At aggregate EU level, therefore, developments in native employment tend to be more upgrading while those in non-native employment contribute to employment polarisation by bolstering growth at either end of the wage distribution.

Around half of the growth of migrant employment is accounted for by Germany where, for historical reasons, the LFS does not record the different categories of the country of birth variable but instead assigns all respondents not born in Germany to a 'No answer' category. This category has grown by some 1.2 million since 2011 and is likely to comprise a high share of non-EU migrants, given the nature of recent immigrant flows to Germany. The other big increases in non-native employment were for EU13 non-nationals, which now account for the majority of EU mobile workers, and non-EU nationals. Each of these groups grew by around one million workers. The numbers of mobile EU workers

Figure 14: Employment shifts (in thousands) by job-wage quintile and country of birth, selected Member States, 2011 Q2–2016 Q2



Source: *EU-LFS, SES (authors' calculations)*

from EU15 Member States were relatively stable, increasing by around 200,000 over the five-year period. As has been the case for over a decade, intra-EU labour mobility flows have been predominantly east–west, from countries with lower GDP per head to countries with higher GDP per head, but these EU13 mobile workers are more likely to be working in lower-paid jobs compared with their EU15 counterparts.

The non-native working population is highly concentrated in older Member States; it accounts for only a marginal share of employment in eastern European Member States such as Bulgaria, the Czech Republic, Hungary, Romania and Slovakia. But 15% of workers in Austria, Cyprus, Germany, Ireland, Luxembourg, Sweden and the UK are non-natives.

In all large host countries except Spain, there has been an increase in the levels of non-native employment. On the top row of Figure 14, the patterns of native and non-native employment growth in Denmark, Sweden and the UK are similar to those observed in the EU as a whole (Figure 13); non-natives account for most or all of the growth in the lower three wage quintiles but also contribute to growth at the top of the wage distribution, where high demand for certain professional qualifications is met by supply from internationally mobile workers. For example, non-natives accounted for a majority of the employment increase in the fastest-growing, well-paid (top-quintile) job in the UK, that of ICT professionals in computer programming. Native employment shifts in these countries have also been strongly upgrading with nearly all of the net gains concentrated in the top two quintiles.

In Italy, where most employment growth has been in low-paid jobs, it is non-natives that have largely accounted for this growth, and they have also been an important factor in growing low-wage employment in Ireland. The travails of the Spanish labour market have affected both natives and non-natives alike, notably non-EU workers – mainly those from other Spanish-speaking countries that arrived to work in the pre-crisis boom and who subsequently have either become unemployed or left the country. But as employment levels have increased in Spain so too has its non-EU non-native working population – by some 230,000 since 2014.

Summary

- During 2013–2016, employment levels in the EU have exhibited their first sustained increase since the global financial crisis. There were eight million more people at work in 2016 Q2 compared with three years previously, and newer jobs are increasingly likely to be full time rather than part time.
- The resumption of employment growth since 2013 has been manifested in particular in increasing shares of new employment in low-paid and mid-paid jobs.
- Over a longer time frame (going back to the late 1990s), higher-paid jobs have continued to show the fastest employment growth relative to those in the rest of the wage distribution in both recessionary and non-recessionary periods.
- There continues to be a variety of patterns of employment shift across Member States. During 2011 Q2–2016 Q2, some countries exhibited one of the two main patterns of employment shift identified in the literature – upgrading or polarisation; for example, Sweden was clearly upgrading while Belgium was clearly polarising. Other countries, such as Hungary, Ireland and Italy, exhibited downgrading shifts, where relative employment growth was strongest in low-paid jobs. As employment has recovered since 2013 in countries such as Greece and Spain, where it had previously fallen sharply, much of the fresh growth has been in mid-paying jobs – where most jobs were destroyed during the recession.
- More than 7 out of 10 jobs in the EU are now in services (71%); the service sector alone has added over 8 million jobs in the EU since 2011. Recent service sector employment growth has been asymmetrically polarised, with greater gains in the bottom and top quintiles relative to the middle. The predominantly state-funded sectors of education and health have made an increasing contribution to top-quintile employment growth, consistent with less-constrained public finances.
- There has been an increase of manufacturing employment headcount by 1.5 million since 2013. Most of this increase has been in top-quintile engineering, professional and management jobs and not in more traditional, blue collar production roles. EU13 countries have been the main beneficiaries of net new manufacturing employment.
- The large-employing job with the fastest rate of growth (7%) is that of ICT professionals in computer programming, a job occupied by relatively young and high-skilled workers. It is predominantly male but with an increasing female share of employment (15%).

- In the majority of other faster-growing large jobs, the share of older workers has increased significantly (by over two percentage points since 2011), suggesting that extended working lives and later retirement are an important factor in explaining recent employment growth.
- As the recovery has strengthened, the standard or 'core' employment relationship – full-time, dependent employment with a permanent contract – has accounted for much of the recent growth across the wage distribution but with a skew towards well-paid jobs. At the same time, there is some evidence that atypical employment forms such as part-time work and self-employment are becoming more prevalent even in higher-skilled, higher-paying jobs.

Part 2:
Wage inequality from an occupational perspective

4 Background and methodology

It is well established that wage inequalities have been growing in many advanced economies in the past two or three decades, although there are important exceptions and differences in terms of the extent and timing of the change across countries. The clearest and most intense expansion of wage inequalities took place in the USA and the UK in the 1980s (OECD, 2011), extending in a generally more moderate form to many European countries in the 1990s and 2000s (with some noteworthy exceptions such as France).

A separate but related debate has focused on the phenomenon of job polarisation in the same countries over the same period. According to many analysts (Autor et al, 2006; Goos et al, 2009), recent technological change and international trade have biased labour demand against mid-skilled workers, polarising the occupational structures of advanced economies. Others (Oesch and Rodriguez Menes, 2011; Fernández-Macías, 2012a) have argued that job polarisation is not so pervasive across developed economies; nor is it primarily driven by market forces but by changes in labour supply, institutional processes of labour market deregulation and destandardisation of employment contracts. However, both sides would agree that labour demand in recent years has been biased towards particular types of occupations, producing either job polarisation or occupational upgrading.

It seems more than possible that increasing wage inequality and occupational restructuring could be somehow related. In particular, it seems reasonable to think that an upward or polarised bias in labour demand could have contributed to increasing wage inequality (although not necessarily as its main cause). Even if the average wages paid by occupations and the distribution of wages within occupations remained stable, a process of occupational polarisation would increase wage inequality by expanding the proportion of workers with low and high wages relative to those in the middle (in contrast, occupational upgrading would compositionally reduce wage inequality by reducing the relative share of low-paid work). Furthermore, a consistently uneven demand for labour in occupations across different skill levels would tend to affect occupational wages in biased ways. All other things being equal, a polarised labour demand would reduce wage inequality in the bottom half of the distribution (since the wages of those at the very bottom would increase with demand, relative to those in the middle), while increasing it at the top half. Occupational upgrading would lead to a relative increase in the wages of the highest-paid occupations, thus contributing to wage inequality even more directly.

However, whether the two phenomena are related in any significant way is an empirical question, and nothing should be assumed without solid evidence. There could be both job polarisation (or upgrading) and growing wage inequality without any significant link between the two phenomena. That could be the case if the distribution of wages *within* occupations had changed significantly in recent years; those changes could be much more consequential for wage inequality than any change in the occupational structure. In fact, some recent influential studies on inequality trends would point in this direction (Piketty, 2014). In many cases, growing inequality is largely the result of a concentration of earnings at the very top of the wage distribution – the top 1% or even 0.1%. However, it seems unlikely that this development is significantly linked to broad occupational dynamics. Behind this increasing concentration of earnings at the very top of the distribution would be institutional changes such as financial deregulation and destandardisation of employment (Saez, 2015), phenomena that seem more plausibly linked to growing within-occupation (or occupation-independent) inequality than to between-occupation inequality. But again, this is an empirical question that must be discussed with figures, which this report aims to do.

What does the existing literature say about the role played by occupations in explaining growing inequality? There have been significant contributions on this from economics and sociology. In mainstream economics, occupations have traditionally played a secondary role as explanatory factors, with skills differentials being the prime explanation for wage inequality. But recent economic analysis of the labour market effects of computerisation has assigned occupations a much more central role. Since computers have a different effect on the demand for different types of tasks, occupations (understood as bundles of tasks) are a key mediating factor in the effect of recent technological change on labour markets (Autor, 2013). On the other hand, in sociological research, occupations (understood as positions within the division of labour in society) have always been considered one of the main determinants of the distribution of earnings and life chances (Weeden, 2002). There is some controversy as to whether occupations are becoming more or less important as drivers of wage inequality and, more specifically, whether they are behind the recent increases in inequalities previously mentioned. Some scholars argue they are (Mouw and Kalleberg, 2010; Acemoglu and Autor, 2011), while others argue the opposite (Kim and Sakamoto, 2008; Mishel et al, 2013).

The analysis that follows uses EU data on wages and occupational structures to contribute to this debate from a comparative European perspective.

- First, it evaluates to what extent wages are a significant explanatory factor for wage inequalities, using some of the main arguments from the social sciences debate to orient the analysis.
- Second, taking advantage of the fact that this study covers nine European countries with rather different institutional and economic structures, it focuses on differences in the role played by occupations in the distribution of wages across different institutional families.
- Finally, a time dimension is introduced, looking at changes in the importance of occupational wages during the recent recession.

Methodology

To the authors' knowledge, there are no previous studies of the role played by occupations in recent wage inequality trends covering such a wide range and diverse set of countries. The main reason is probably the formidable methodological difficulties involved in such a comparison. To do this kind of analysis, data sources covering many countries and periods are needed, including adequate and comparable measures of the two main variables of interest – occupations and wages. In strict terms, there is no single international dataset that fulfils all these criteria, which means that it is necessary to construct the analysis using different sources and to be flexible in the operationalisation. This section provides some details on the main concepts used for the analysis and their measurement, discussing the limitations of the data sources used and how they have been dealt with.

Occupations: Concept and classifications

Occupations are defined here as 'coherent bundles of tasks that require specific skills, corresponding to different positions within the division of labour in society' (Fernández-Macías, 2012b). The division of labour refers to the breakdown of economic processes into different tasks to be performed by specialised workers (leading to enormous gains in efficiency but also increasing structural complexity), which in contemporary market economies is coordinated by two different mechanisms: markets and hierarchies. Markets coordinate the division of labour between companies (horizontal division of labour), while hierarchies coordinate the division of labour within companies (vertical division of labour). The conventional classifications of sector and occupation correspond to the horizontal and vertical division of labour, respectively. Sectors classify companies and workers operating in different markets, while occupations classify workers according to the position they occupy within the hierarchy and skill structure of their organisations.

The division of labour along the vertical and horizontal dimensions, in practical terms, means that in most cases, the unit of analysis will be a specific occupation within a specific sector (an occupation-by-sector combination: for instance, a secretary within the construction sector). In the first part of this report, this unit of analysis is called a 'job', but in the current part, the term 'occupation' or 'detailed occupation' is used interchangeably with 'job', for the following reasons.

- Empirically, occupations are the main structuring factor for most of the aspects of work and employment that have been investigated over the years (see Eurofound, 2013 and Eurofound, 2016a for analyses of job quality and tasks, respectively).
- Conceptually, occupation as defined above (coherent bundles of tasks that require specific skills and correspond to positions in the division of labour) encompasses both dimensions of the division of labour (conventionally called occupation and sector).

In fact, ISCO incorporates sector distinctions at all levels (for instance, at the one-digit level, there are different groups for agricultural, manufacturing and services workers). Previous EJM work relied on the combined classification of ISCO and NACE because the level of detail of ISCO that was available in EU-level data (two-digit level, corresponding to 23 categories) was not enough for the type of analysis intended. In practice, ISCO at the three-digit level provides a level of granularity that is equivalent to the combination of ISCO and NACE at the two-digit level.

In the current analysis, the level of detail of the occupational classification used will depend on the possibilities afforded by the data at hand, as explained later. For international comparisons, the ideal level of detail of occupations would be ISCO at three digits or ISCO at two digits combined with NACE at two digits. This level of detail should generate a sufficient internal homogeneity within each job and external heterogeneity between them for the purposes of this study, while retaining international comparability (beyond three digits, the comparability of categories in ISCO across countries is problematic; see Elias, 1997). In some cases, however, ISCO will have to be used at the two-digit level only or combined with NACE at the one-digit level (or even ISCO one-digit level by NACE one-digit level). In those cases, some of the heterogeneity between jobs at the detailed level will appear as heterogeneity within jobs at the aggregate level. Since this type of flexibility in the definition of occupation is necessary to carry out the intended analysis, one can only address it by being careful in its interpretation and explicitly discussing this problem whenever necessary.

When using data from the SES, occupations will be defined as the combination of ISCO at two-digit level and NACE at one-digit level, with a further breakdown of some categories (in practice very close to the standard two-digit by two-digit classification of jobs normally used in the EJM). In the case of the European Union Statistics on Income and Living Conditions (EU-SILC), occupations will be defined by combining ISCO at two-digit level and NACE at the one-digit level – thus with a higher level of aggregation than in the standard EJM approach.

Wage: Concept and measurement

The second key variable in this report is the wage, defined as the gross hourly remuneration of the work of employees. In other words, the focus is on the compensation of labour, not the earnings of employees; hourly wages, not monthly or annual labour income. Monthly or annual labour earnings are strongly affected by issues such as working time and employment stability, which are not directly related to occupational differences (even though they may themselves be unevenly distributed by occupations, their effect on wages is of a different nature).

As in the case of occupations, the actual operationalisation of this concept in the analysis will have to be adapted depending on the characteristics of the different sources. The SES uses strictly defined hourly wages for employees, obtained at the establishment level (so the information is provided by managers rather than the workers themselves). In the case of EU-SILC, an approximation to hourly wages is used, obtained by dividing annual labour income in the year before the survey by the number of months worked, taking into account whether the workers were full time or part time and adjusting for people with more than one job (for more details on this measure, see Eurofound, 2015b). So in practice, with EU-SILC, a measure of full-time-equivalent wages is used rather than hourly wages, which should be equivalent even if not identical.

Data sources

The 2010 SES is used to make a static analysis of the role played by occupations in wage inequality in Europe. The SES has been conducted every four years since 2002 and collects harmonised data on wages in enterprises with more than 10 employees in all sectors except agriculture, fishing, public administration, education, health and community, and social services. The inclusion of small enterprises and the above-mentioned sectors is optional for the participating countries, and, in fact, many of them opted for such comprehensive coverage in the last edition of the survey (2010). Although the actual method for collecting the information can differ considerably across countries (between specific surveys and administrative registers), in all cases it is collected at the company level and based on payroll data (rather than on workers' responses). The sample is representative of both enterprises and workers in the sectors covered and in companies of different sizes.

The main advantage of the SES for the purpose of this study is that it is a survey aimed explicitly at measuring wages with a high degree of detail. What this means is that the target variable of wages can be constructed in a relatively direct and precise way. The sample is very big in most countries, which allows for a detailed breakdown of wages by occupations. It also provides reasonably detailed classifications of occupation (ISCO at two-digit level) and sector (NACE at one-digit level with some further breakdown of large categories such as manufacturing, which in practice makes it similar to two-digit level).

Its main disadvantage is the limited and inconsistent coverage of the economy in different countries. Small companies and public sector organisations are covered in only some countries, and, unfortunately, the microdata for public use do not allow the construction of a consistent dataset in terms of coverage across countries, unless all companies with fewer than 50 employees are eliminated from the sample, which is obviously too restrictive. So, in practice, some countries include companies with fewer than 10 employees and some do not. Another problem with the SES is that it cannot be used for analysing the change over time in the effect of occupations on wages, because only three waves are available and the classifications and coverage change in each wave.

EU-SILC is used for the analysis of change in the effect of occupations on wage inequality between 2005 and 2014. EU-SILC is a cross-sectional and longitudinal database on income, poverty, social exclusion and living conditions in the EU, coordinated by Eurostat, with data drawn from different sources at national level. It is representative of all private households and their current members residing in the territory of the countries at the time of data collection. A key advantage of EU-SILC for the purposes of this study is that it provides consistent cross-sectional data on wages and occupations for the period 2005–2014. Furthermore, it provides complete coverage of the economy.

However, EU-SILC provides only an approximate measure of wages (which has to be computed on the basis of annual labour earnings information). Sector is only available at the one-digit level (occupation is available at two digits). The sample size is considerably smaller than that of the SES, which complicates the detailed decomposition of the distribution of wages by occupations.

5 Static analysis of the role of occupations in determining the wage distribution

Initial considerations and theoretical arguments

As mentioned in the previous chapter, occupations have traditionally played a secondary role as explanatory factors in mainstream economics. In economics textbooks, wages primarily reflect productivity differentials between individuals, and occupations are hardly mentioned (Mankiw, 2012, pp. 397–412). But even from a mainstream economics approach, there are reasons to believe that occupations could be associated with wage differentials without playing a direct role in wage determination.

Economic perspective

First, occupations may be associated with compensating wage differentials. As Adam Smith famously argued in *The Wealth of Nations*, if some jobs involve performing very disagreeable or dangerous tasks, they should be more highly compensated, all else being equal (Smith, [1776] 1976, p. 117). Since different occupations obviously involve different levels of hardship and hazard, this factor could create systematic between-job wage differentials. Empirical evidence, however, suggests that this factor plays a very marginal role in explaining overall wage inequality; it seems to be important only in some extreme cases (Muñoz de Bustillo et al, 2011, pp. 42–45).

Second, occupations may be associated with differences in the amount of human capital. Human capital refers to accumulated knowledge and experience that makes individuals more productive and therefore likely to receive higher wages (Becker, 1993). Since different occupations typically require different amounts of human capital, it could be associated with systematic wage differentials. Two observations ought to be made about this argument. First, it implies that occupations do not play a role on their own; they just group workers with a similar stock of human capital. Therefore, if one could control for human capital, wage differentials between occupations should disappear. Second, this theory can provide only a one-dimensional explanation of occupational wage differentials (linked to skill levels), since its focus is on the *amount* and not the *type* of human capital. In other words, wages would vary across occupations depending only on the amount of human capital they require; the fact that different occupations involve performing very different types of tasks and therefore require qualitatively different skills is not part of this argument.

A third and more recent argument assigns occupations a prominent role, associated with differences in the types of tasks they involve. Technological change can have a different effect on different types of task input into the production process, being complementary to some but substitutive to others. Since different occupations involve different types of tasks, this could lead to systematic wage differentials between occupations that cannot be reduced to differences in the stock of human capital. More specifically, arguments from this perspective have posited that recent technological change tends to depress labour demand for occupations that involve higher levels of routine, which tend to be in the middle of the skills continuum (Acemoglu and Autor, 2011). So it is important to note that, despite remaining within mainstream economics, the tasks approach does assign a prominent role to occupations, at least to the extent that the types of tasks carried out are one of the main defining characteristics of occupations (tasks cannot exist on their own, they have to be coherently bundled into actual occupations; see Autor, 2013; Eurofound, 2016a).

Sociological perspective

In contrast, occupations have always played a central explanatory role in the sociological and institutional economics traditions. From these perspectives, occupations are understood as highly differentiated and specialised positions within the complex division of labour in modern societies, associated with different cultures and lifestyles, and differential access to economic resources and life chances. The key mechanism linking occupations and the distribution of wages (and economic inequality in general) is Weber's notion of social closure: 'social groups formed around positions in the technical division of labour create social and legal barriers that restrict access to resources and opportunities to a limited circle of eligibles' (Weeden, 2002, p. 57). Some specific mechanisms and strategies of occupational closure from this perspective include licensing, credentialing,[11] certification, unionisation and representation by associations. These strategies would allow some occupations to generate rents, that is, payments attached to positions independently of the level of effort or productivity of the people occupying those positions (Weeden, 2002, p. 58), leading to the observed occupational wage differentials.

Measuring the effect of these mechanisms of occupational closure would require systematic information on institutional differences that is not available at EU level, so it is beyond the scope of this report (for an example of this approach comparing two specific countries, see Kampelmann and Rycx, 2013 and Bol and Weeden, 2014). However, they provide a plausible explanation for occupational wage differentials that cannot be directly linked to differences in human capital, compensation for working conditions or routine task content.

Other strands of the sociological literature provide important qualifications to the centrality of occupations in the structuring of wage inequalities.

In many sociological traditions, social class rather than occupation is the central structuring factor of economic outcomes. In general terms, social class can be understood as broad groups of socioeconomic stratification, defined by their position in relations of exploitation, authority relations, employment contracts or other factors (Erikson and Goldthorpe, 1992; Wright, 1997; and, for a more recent proposal, see Oesch, 2006). In practical terms, social classes are often constructed by aggregating from occupational classifications, although secondary variables such as authority in production are sometimes also used (Wright, 1997). In other words, social classes can be often understood as aggregated occupations, or occupations as very disaggregated classes: this is an argument made explicit in the neo-Durkheimian approach of David Grusky, who conceptualises occupations as microclasses (Grusky and Galescu, 2005). In order to explain a particular phenomenon such as growing wage inequality, the comparison of developments at the aggregate level of big classes and at the detailed level of microclasses can reveal different dynamics and underlying mechanisms (for an example, see Weeden et al, 2007).

Other theories have argued that occupations play a mediating role for the effect of separate social stratification factors such as gender or race, via the mechanism of occupational segregation (Tomaskovic-Devey, 1993; Grimshaw and Rubery, 1997). Differential (culturally and socially constrained) preferences and labour market discrimination can produce a systematic under- or over-representation of some social groups in specific occupations. This may affect the status and social power associated with the occupations and may end up reinforcing the inequality that initially generated the segregation, further expanding occupational wage differentials. As in the case of human capital, this argument assigns occupations a mediating role in the structuring of wages, and therefore it should (at least partly) disappear if one could eliminate the effect caused by the underlying segregation factors.

Another important qualification is that the role of occupations in structuring economic outcomes depends on other attributes of the socioeconomic system, such as industrial relations or labour regulation. For instance, in some countries unions are craft-based while in others they represent the interests of the working class as a whole; in the latter, occupations may be less important for the distribution of wages than in the former. Some of the mechanisms of occupational closure previously mentioned (apprenticeship systems or occupational licensing) are very different across countries, which can also lead to systematic differences in the effect of occupations on wages. So, even if occupations are expected to play a significant role in structuring wage inequality in most developed economies, the importance of such a role is likely to vary. In the particular case of Europe, this variation can be expected to be associated with the well-known institutional families (welfare regimes, varieties of capitalism). These differences will be explored in some detail in Chapter 6.

Finally, some recent studies on the evolution of inequalities would suggest that the role of occupations in determining wage inequality may be declining. According to the thinking of Atkinson et al (2011), the recent surge in income and wage inequality, particularly in the economies of the USA and the UK, results from the ‘retreat of institutions developed during the New Deal and World War II – such as progressive tax policies, powerful unions, corporate provision of health and retirement benefits, and changing social norms regarding pay inequality’ (Saez, 2015, p. 5). These factors are either unrelated to occupational differences or would tend to undermine some of the institutional mechanisms behind them, and therefore would make between-occupation differentials account for a declining share of overall wage inequality. This argument contrasts particularly with the previously discussed idea of task-biased technological change as a key factor behind growing inequalities. The role of occupations in recent wage inequality trends in Europe will be discussed in detail in Chapter 7.

11 The process of formally accrediting competences in a defined area of practice to confirm that a person is fit to practise in that area.

Occupations and wage inequalities: An initial overview

How much wage inequality is associated with occupational differentials in a European context? In common with many previous studies on this issue (for instance, Acemoglu and Autor, 2011; Mouw and Kalleberg, 2010), one can try answering this question by using a variance decomposition approach. The total variance of wages in a country can be split into two components when the data are grouped by occupations:

- the variance that results from between-group differentials;
- the variance that results from within-group variability.

If the groups (in this case, occupations or jobs) play an important role in structuring inequality, the between-group component will be large. If they are not, most of the variation in wages will take place within the groups, and the within component will dominate.

According to this approach and using data from the 2010 SES, between-job differentials account for around 50% of the total variance in log wages (wages transformed into logarithms) (and consequently, within-job variability would account for the other half), with some differences across countries, from 42% in Germany to 53% in Poland (Table 3, Column 6). This percentage of variance explained refers to the most detailed occupational level, which in the EJM is called a 'job' and corresponds to two-digit occupations combined with two-digit sectors (the number of these jobs also varies across countries, between 450 and 650). The most important component for the distribution of wages in such a definition of jobs is actually *occupation* as measured by ISCO: even with the 36 categories of ISCO at two digits, one can already explain most of the

Table 3: Impact of occupations on wage inequalities: Results of analyses

			ANOVA decompositions – % variance in log wages explained by between-group differentials according to:						
	1. No.of observations	2. No. of jobs	3. ISCO only (36 categories)	4. NACE only (19 categories)	5. ISCO + NACE, no interaction	6. Jobs (ISCO x NACE)	7. Jobs, excl. small companies	8. Jobs, wages not logged	8b. Jobs, wages < top 1%
France	187,177	444	40.96	7.94	43.21	**45.32**	43.69	18.11	44.77
Germany	1,745,189	652	34.84	9.03	38.01	**41.67**	44.32	38.88	47.13
Italy	264,506	514	41.34	13.84	42.91	**47.39**	50.59	41.46	47.39
Netherlands	158,004	493	37.46	15.12	40.1	**42.54**	42.93	29.13	42.19
Poland	629,176	590	46.98	15.77	50.2	**52.93**	54.11	36.34	49.44
Romania	233,877	574	39.52	10.81	45.48	**48.91**	53.14	35.15	42.81
Spain	205,132	484	37.42	11.61	40.29	**43.48**	48.98	31.55	42.58
Sweden	270,491	473	41.62	7.85	43.97	**47.24**	48.18	32.48	43.47
UK	167,467	470	45.99	12.07	48.72	**51.12**	54.6	12.04	41.7

	9. Variance explained by a model with sociodemographic variables	Inequality indices (wages not logged)				Human capital approach, log wages	
		10. Gini	11. Theil	12. Theil between jobs	13. Between jobs/total Theil	14. Variance explained by a model with education and tenure	15. Wages net from education and tenure, variance explained by jobs
France	42.25	27.28	16.25	6.93	42.68	25.38	29.43
Germany	56.25	32.68	19.00	9.16	48.19	41.03	25.33
Italy	43.02	28.66	15.16	7.58	50.01	33.67	20.65
Netherlands	53.47	29.40	16.19	6.52	40.28	42.9	14.8
Poland	45.57	35.27	23.01	12.07	52.46	35.25	25.35
Romania	40.98	39.02	29.74	15.14	50.92	28.49	28.44
Spain	47.99	29.58	16.07	6.98	43.41	36.4	19.68
Sweden	31.79	18.91	7.98	3.68	46.13	11.56	41.97
UK	35.5	36.83	30.85	12.69	41.11	16.39	37.75

Notes: *The model in Column 9 includes the variables gender, age, education, tenure, part-time, temporary contract (except Sweden), company size, company ownership, collective bargaining (except Sweden) and region. ANOVA = analysis of variance. Small companies (Column 7) are those with fewer than 50 employees.*
Source: *SES 2010 (authors' analysis)*

variance shown by the full range of 450+ jobs (see Column 3). However, NACE and the combination of NACE and ISCO also add significantly to the explanatory power of this model (they add another 20% of variance explained, see Table 3, Columns 4 and 5), so the detailed definition of occupations, or jobs, can be kept.[12]

In other words, occupations play a significant role in the structuring of wage inequality in Europe. In order to evaluate the significance of this result, it is useful to compare it with a different variance decomposition model, in this case using 10 key socioeconomic variables as predictors (including gender, age, education, tenure, company ownership and others, with no interactions). As Column 9 of Table 3 shows, the variance explained by such a model is comparable to the variance explained by the 'jobs' classification – again, with some differences across countries.

Wages are known to have a log-normal distribution: strongly asymmetric and skewed to the right because of a high concentration of values below the mean, which is usually inflated by some very large values. Transforming them to logarithms generally makes the distribution more normal (more symmetrical, less skewed by very high values) and therefore more tractable to econometric modelling, which is why it is routinely performed in economics. This approach is followed in most of this analysis, as shown in Table 3. However, it is important to note that transforming wages into logarithms has a very significant effect on the distribution of wages, making it 'less unequal', for obvious reasons: the logarithmic transformation compresses the distribution, with an increasing effect on very large values. To evaluate the effect of such transformation, a variance decomposition of wages by jobs where wages have not been logged has also been included (see Column 8). It can immediately be seen that the variance explained by between-job differentials is significantly reduced in most cases. This means that there are some very large values of wages whose occurrence cannot be linked to occupational differences.

This is not a technical point, but a very significant result for the purposes of this analysis, particularly so for cross-country comparisons. As is well-known, the existence of some very high values is a key attribute of the distribution of wages (and income) in advanced economies; according to recent research, it is one of the drivers behind increasing inequalities (a point discussed later). What the comparison between Columns 8 and 6 shows is that, while occupations play a significant role in the distribution of the majority of wages, they play a marginal role in the distribution of a minority of very large wages. That is why not logging wages mostly adds to within-job inequality (if all the super-high wages were concentrated in a few occupations, not logging wages could even make between-occupation differentials more important). This can be confirmed by yet another approach (shown in Column 8b), in which wages are not logged but the top 1% of the distribution is excluded: the variance explained by occupations in this 'truncated' wage distribution is similar to the variance explained when wages are transformed to logarithms. Hence, occupations play a very significant role in structuring the majority of wages, but they cannot explain the distribution of some very large values. This on its own suggests that occupational differences may not be driving the recent surge in inequality in some advanced economies, at least to the extent that such a surge is associated with developments at the very top of the wage distribution.

However, there are very important differences across European countries in this respect. In France and the UK, the variance explained by occupation drops more precipitously when wages are not logged (they fall to 18% and 12%, respectively, from around 50%), whereas in Germany and Italy the decrease is quite small (just 3%–6%, to around 40%). These differences can result from two factors:

- the importance of those very high wages in the overall distribution of wages (which would be highest in France and the UK);
- the extent to which those very high wages are linked to occupational differences (for instance, there are also outliers in Germany and Italy, but they seem to be better predicted by occupations).

Table 3 also includes an alternative approach to evaluate the impact of occupations on the distribution of wages, in this case using the Theil index instead of a decomposition of variance. The Theil index can also be broken down into a between-group and a within-group component, but has the advantage of additionally providing an overall assessment of the level of inequality in a distribution. The Gini index is also included for this purpose since it is the most well-known measure (Table 3, Column 10). In this case, wages are not logged.

12 Table 3 (Column 7) also includes the results for a sample in which small companies have been eliminated from all countries. This makes the results more comparable across countries by removing the previously mentioned problem of the SES having inconsistent samples for small companies in different countries. The results are very similar, generally increasing the share of variance explained by jobs (which ranges from 43% to nearly 55%) and slightly reducing the cross-country variation.

The highest levels of wage inequality are observed in Poland, Romania and the UK and the lowest in Sweden. The overall level of wage inequality does not seem to be related to the importance of occupations/jobs in explaining it: for instance, the amount of wage inequality explained by between-job differentials is similar in countries with high and low overall levels of inequality. This point is discussed later in connection with country patterns. For now, it is important to note that the Theil and the variance decomposition approach provide a very similar overall assessment of the role of occupations/jobs in the distribution of wages (they would account for 40%–50%), although the specific position of individual countries varies slightly in both approaches.

Analysing the economic arguments

The oldest economic argument to explain occupational wages is probably the theory of compensating differentials, advanced by Adam Smith more than 200 years ago. As mentioned above, empirical evidence is not very supportive of this theory, at least in terms of the overall distribution of income (though it may work in some particular cases). However, one can try to evaluate it empirically from an occupational perspective: are between-job wage differentials related to differences in the conditions of work? More specifically: do higher occupational wages compensate for bad conditions?

Figure 15 shows the relationship between the conditions of work in different occupations and their average wage for the nine European countries studied. The vertical axis represents the average log wage. The horizontal axis represents the average value on a 0–1 normalised scale for a composite index of job quality (based on the proposal by Muñoz de Bustillo et al, 2011; see also Eurofound, 2013) and its four higher-level dimensions: intrinsic quality of work, quality of employment conditions, health and safety conditions and work–life balance. Each job (occupation–sector combination) is represented as a dot in the charts (the size of the dot being proportional to the employment share of the job). A lowess (locally weighted scatterplot smoothing) regression line to represent the shape of the association is superimposed, and the Pearson correlation coefficient is shown.

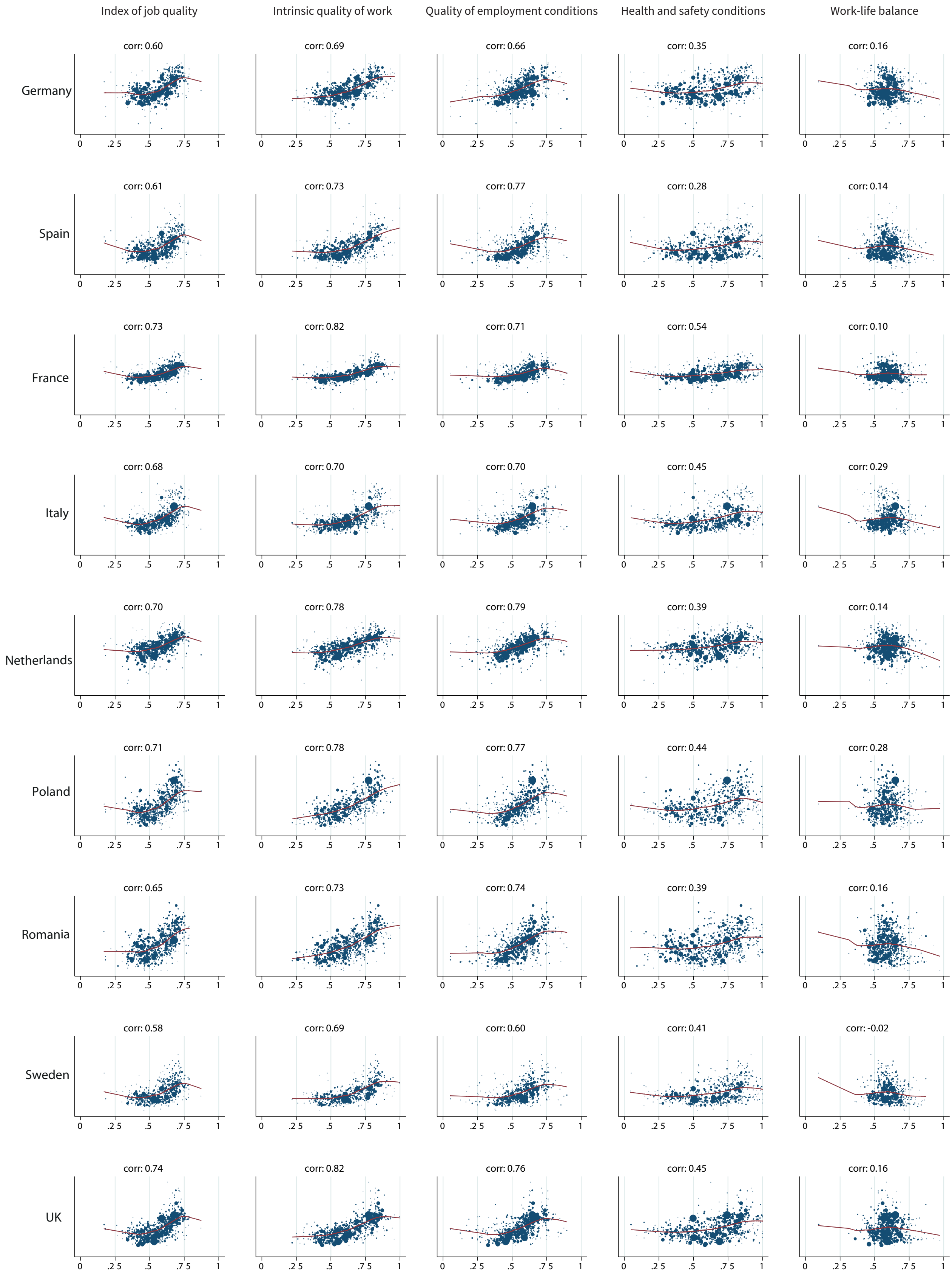
The results clearly show that compensation for bad working conditions is not a significant factor shaping between-job wage differentials. In fact, between-job wage differentials tend to be positively correlated with job quality: jobs with bad working conditions tend to also have lower wages and vice versa. This can be seen in the overall job quality index (with correlations above 0.6 in all the countries covered) and in the dimensions of intrinsic quality of work and employment quality. The correlation with health and safety is also positive, but less strong. And in the case of work–life balance, there is essentially no correlation, positive or negative, reflected in the lowess regression line, suggesting a mild negative association in some countries. The aspect of work–life balance, therefore, is the only one where there could be a very weak case for compensating differentials in some occupations, but even in that case, the fact that there is no significant association does suggest that compensation plays no significant role whatsoever.

So working conditions and wages tend to correlate rather than compensate for each other, which may suggest that both depend on some third variable. Perhaps that variable is human capital and the associated productivity differentials, as suggested by another economic hypothesis reviewed earlier. Can that hypothesis be also tested with these data? Human capital cannot be directly observed or measured, but it is frequently proxied by education and work experience (Mincer, 1974). Following such an approach, Column 14 of Table 3 shows the variance of log wages that can be explained by a model with education and tenure as predictors.[13] Despite its simplicity, this model accounts for a significant amount of the total variance of wages (again, there are differences across countries, but in most countries, it is above 30%), although it is well below the results for occupations or jobs.

However, the most important result is shown in Column 15 of Table 3, where log wages are expressed net of the effect of education and tenure (in technical terms, using the residual from the predicted values of the model shown in Column 14), and the variance decomposition is repeated by job using this new variable. A wage net of differences in the stock of human capital is just the observed wage of a person minus the average wage for all workers with the same level of human capital (the same education and years of tenure). If detailed occupations or jobs were predictors of wage inequality only because they are associated with different stocks of human capital, they would not be able to explain any of the differences observed in wages when expressed net of human capital differences. Column 15 of Table 3

13 In the SES, the only education variable that can be used for international comparisons is one based on educational attainment, with three categories (low, medium and high), which were included as dummies in the model. Work experience was included as years of tenure, a continuous variable (a quadratic term was also included to allow for non-linearity).

Figure 15: Relationship between working conditions in different occupations and their average wage, nine Member States



Source: *European Working Conditions Survey for working conditions and SES 2010 for wages (authors' analysis)* shows that is not the case; although the share of variance explained decreases in all countries, between-job differentials still account for a significant share of the inequality between wages net of differences in human capital (from 42% in Sweden to 15% in the Netherlands). Therefore, although human capital differences explain part of the role played by occupations in the distribution of wages, they are only part of the story. In terms of their effect on the distribution of wages, occupations are not just groups of workers with similar levels of human capital. Occupational wage differentials cannot be reduced to differences in education and tenure.

A related argument suggests that the *type*, rather than the level, of human capital required to perform the different jobs may be a key determinant of between-occupation wage inequalities. The routine-biased technological change hypothesis argues that technological change depresses demand for occupations that require a high level of routine task content, and one should therefore expect those occupations to have lower wages than the rest. Expressed in more general terms, wage levels could be negatively associated with the degree of routine involved in each occupation.[14] Figure 16 shows the correlation between an index of routine tasks at work calculated at the job level (the one presented in the EJM 2016 annual report; see Eurofound, 2016a for more details) and the average wage of each job, with jobs shown as dots proportional to employment in size, a lowess regression line and Pearson's correlation coefficient (the same representation used earlier in Figure 15).

According to these results, there is no clear correlation between the overall level of routine of jobs and their wage levels, and certainly not a negative association. If the index of routine tasks is broken down into its two subcomponents, repetitiveness and standardisation (Eurofound, 2016b), it can be seen that this lack of correlation conceals two opposite associations for the lower-level indicators. The degree of repetitiveness in the job is negatively associated with wages, whereas the degree of standardisation is positively associated, though to a much lower extent. This suggests that the extent (and type) of routine task content of the different occupations may be also part of the story, although not a very significant one. It should also be noted that routine task content, particularly in its repetitiveness dimension (the one most plausibly linked to occupational wage differentials, according to Figure 16), is strongly correlated with the skills required by the different jobs (see Fernández-Macías and Hurley, 2016 for a detailed discussion). In other words, the routine-biased technological change argument would not add much to the earlier more robust finding about the role played by differences in the stock of human capital. If one controls for the average educational level of jobs, the role played by routine or repetitiveness becomes much less important.

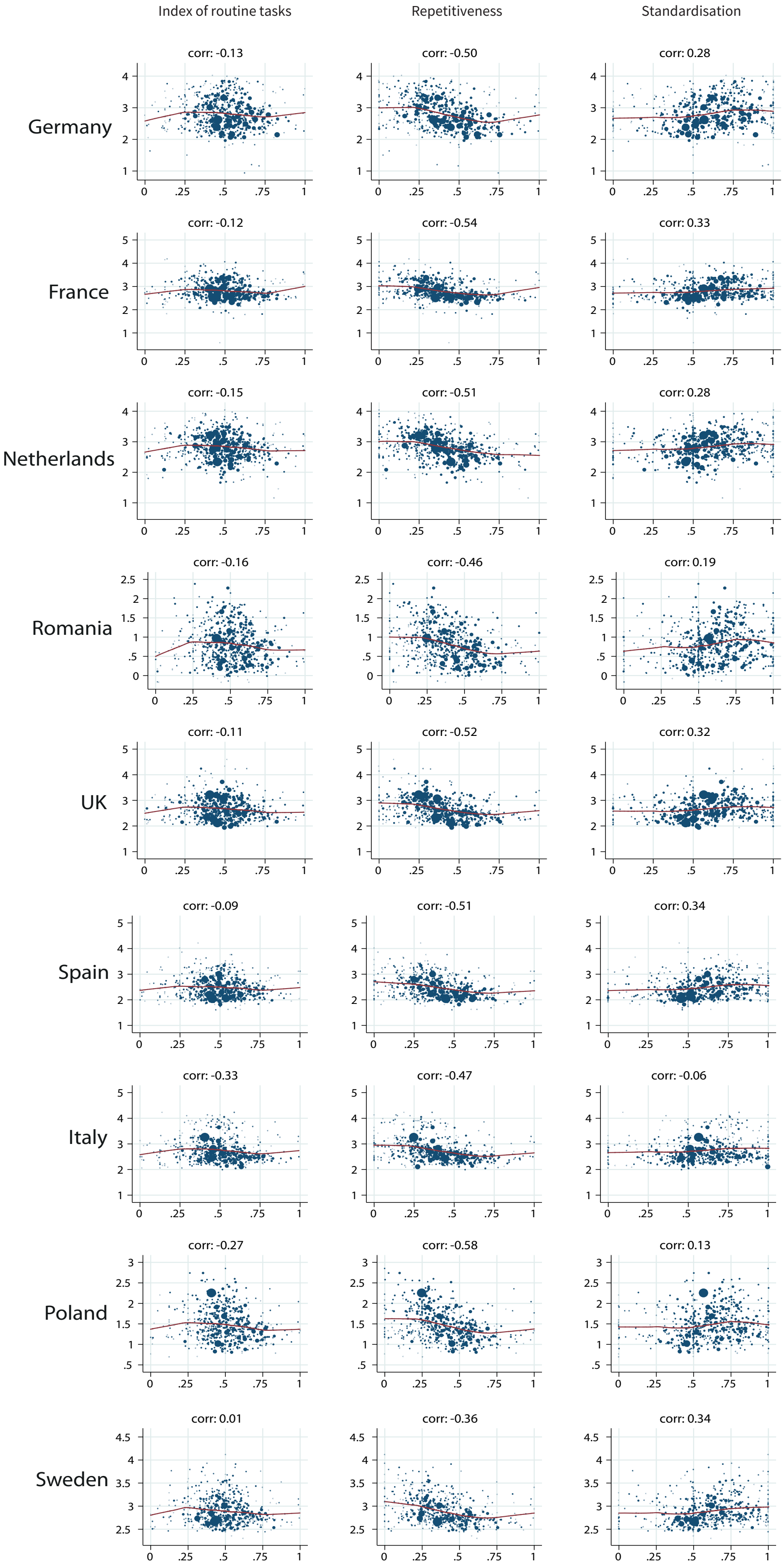
Analysing the sociological arguments

The evidence presented so far seems, in principle, more in line with the sociological than the economic tradition. Occupations play a significant role in shaping wage inequality and not just by grouping workers with similar levels of human capital. The fact that occupations still account for a significant part of the variance of wages net of human capital suggests that occupation-specific mechanisms (such as occupational closure) may be at play.

In fact, one could even reinterpret the previously discussed evidence on the role of human capital (in particular, education) in a different way. The observed association between levels of education and occupational wage differentials may be the result of credentialism and occupational closure, rather than productivity differentials. Some occupational groups may try to artificially inflate educational requirements as a way to restrict new entrants and increase their bargaining power, a process which could also generate the observed association between education and occupational wage differentials. The data used for this study does not allow this to be clarified, but an ambiguity in the interpretation of the results on the role of human capital differences must at least be acknowledged in explaining occupational wage differentials.

14 This is a very simplified version of the argument of routine-biased technological change, for two reasons. First, the argument refers to change in wage levels rather than the wage differentials observed at any point in time. Second, it does not replace but complements the human capital argument: the level of routine would constitute a secondary axis of wage inequality, additional to the traditional axis of skills (thus, highly routine occupations would tend to be in the middle of the wage distribution, rather than the bottom). A detailed discussion of this argument is beyond the scope of this report (see Acemoglu and Autor, 2011 and Mishel et al, 2013), but the simple analysis presented in this report is still useful because, after decades of computerisation, the predicted decline in wages of routine occupations should already be reflected in actually lower wages. In addition, recent empirical evidence suggests that routine tasks and skill level are very strongly correlated, forming a common axis in terms of occupational differences rather than two different ones (see Fernández-Macías and Hurley, 2016).

Figure 16: Relationship between level of routine in jobs and their average wages, nine Member States



Source: *European Working Conditions Survey for level of routine and SES 2010 for wages (authors' analysis)*

However, one can try to test some of the sociological arguments discussed earlier, in particular whether the observed occupational differentials are less important than broader class distinctions. Occupations have always played a very important role in **class theory**: they are the backbone of the two most influential contemporary class schemes (those of E. O. Wright and J. Goldthorpe), although both also rely on other variables (employment status, managerial and supervisory roles). But the full list of occupations or jobs would be, from this perspective, unnecessarily detailed for the analysis of most social phenomena (such as the wage distribution), as well as lacking in some important dimensions of social power within productive organisations (such as capital ownership or supervisory position). In empirical terms, this argument would imply that a much smaller set of categories (classes) would be able to account for most of the observed inequality in wages.

Unfortunately, the SES data used here do not include the self-employed nor any information on the managerial or supervisory roles of employees (beyond what is implicit in ISCO); this means a full test of this hypothesis cannot be tested with the data. However, a crude approximation to the Goldthorpe scheme can be constructed (which is in practice quite close, though not identical, to a reaggregation of occupations into one-digit ISCO codes), assigning two-digit ISCO codes to each of five categories:

- higher service class (professionals, administrators, managers and high-grade technicians);
- lower service class (technicians and lower-grade professionals);
- routine non-manual workers (routine administration, commerce and other service workers);
- skilled manual workers;
- semi-skilled and unskilled manual workers.

The Goldthorpe proposal differentiates social classes according to two principles: first, the ownership of the means of production; and second, the nature of the employment relationship (Erikson and Goldthorpe, 1992). The first principle is almost entirely missing in this crude five-class classification, but the second (mainly aimed at distinguishing those employees with a labour contract from employees with service relationships, as well as differentiating skill levels) is reasonably well covered.

Figure 17 shows a visual decomposition of the total variance of log wages in each country into three components:

- the variance resulting from between-class differentials (‘explained between classes’, shown in blue);
- the variance resulting from between-job differentials within each of the five classes (‘explained between jobs within classes’, in orange);
- the residual inequality that exists within jobs, also distributed across the five classes (‘not explained, by classes’, in green).

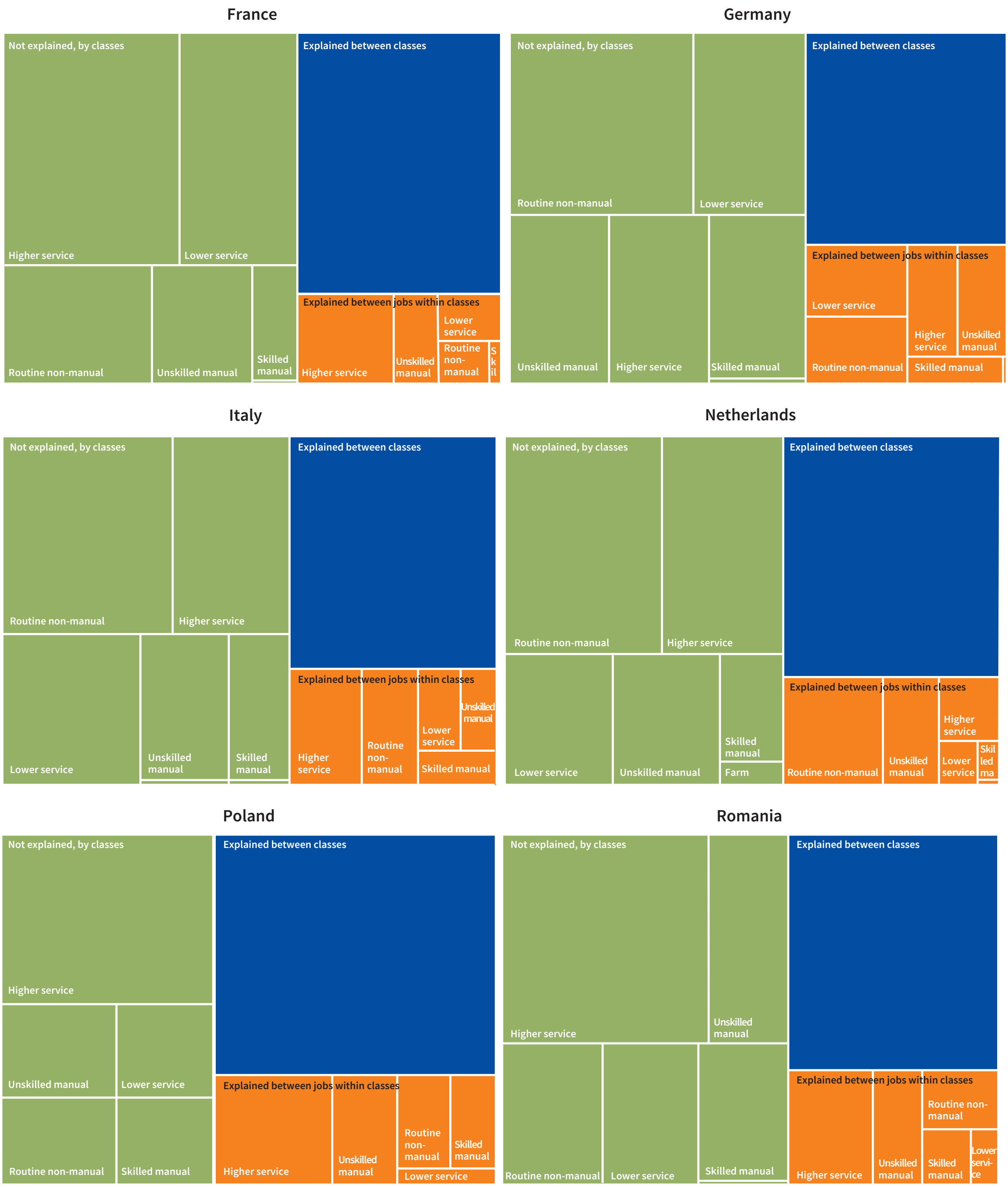
It is striking that the five very simple and crude pseudo-classes account in all countries for a significant amount of the variance explained by jobs. As usual, there is cross-country variation, but in all countries the differences between the five classes account for more than half of the variance explained by jobs, and in most countries for more than two-thirds. But the five simple classes also provide a very interesting additional piece of information: the extent of wage inequality within each one of them also differs quite significantly, both between and within jobs. In most countries, the most unequal class is the higher service one (the exceptions being Germany and the Netherlands), whereas the classes more internally homogeneous in terms of wages are skilled and unskilled manual workers everywhere.

So even with this very crude approach, the social class argument seems quite compelling. Five very broad classes defined by the type of employment relationship and skill level can already account for a significant proportion of the variance explained by a very detailed list of jobs (between 450 and 650). At least for some purposes, one could argue on the basis of parsimony that the simple class scheme should be used rather than the long list of occupations. Furthermore (although this is only speculation) it seems likely that, if the classes could have been built properly, the results would have been even more significant.

However, as in the case of the human capital argument, the full list of occupations/jobs still adds a significant amount of explanatory power to this analysis, so it is empirically justified to keep using them. Because of the limitations of the data (the impossibility of building proper classes), it cannot confidently be said that a detailed occupational approach is superior to a simpler class scheme to explain the observed wage inequalities. But it can be said that the full classification of occupations works better with the data and tools available: as was argued earlier in the case of human capital, classes are (a significant) part of the story but not all of it.

The final argument to be evaluated refers to **occupational segregation** as an explanation for occupational wage differentials. As with human capital, in this argument occupations are not the source of the differentials but a mediating factor for an external mechanism, in this case discrimination linked to sociodemographic characteristics (though other mechanisms such as culturally or socially mediated self-selection may be at play too). The most important occupational segregation factors mentioned in the literature are gender, ethnicity or migrant origin, and, to a lesser extent, age. Unfortunately, the SES does not provide information on the ethnicity or migrant origin of respondents, so that important factor cannot be covered. However, data on gender and age are available, so this argument can at least partially be evaluated.

Figure 17: Class versus job decomposition of wage inequality, nine Member States

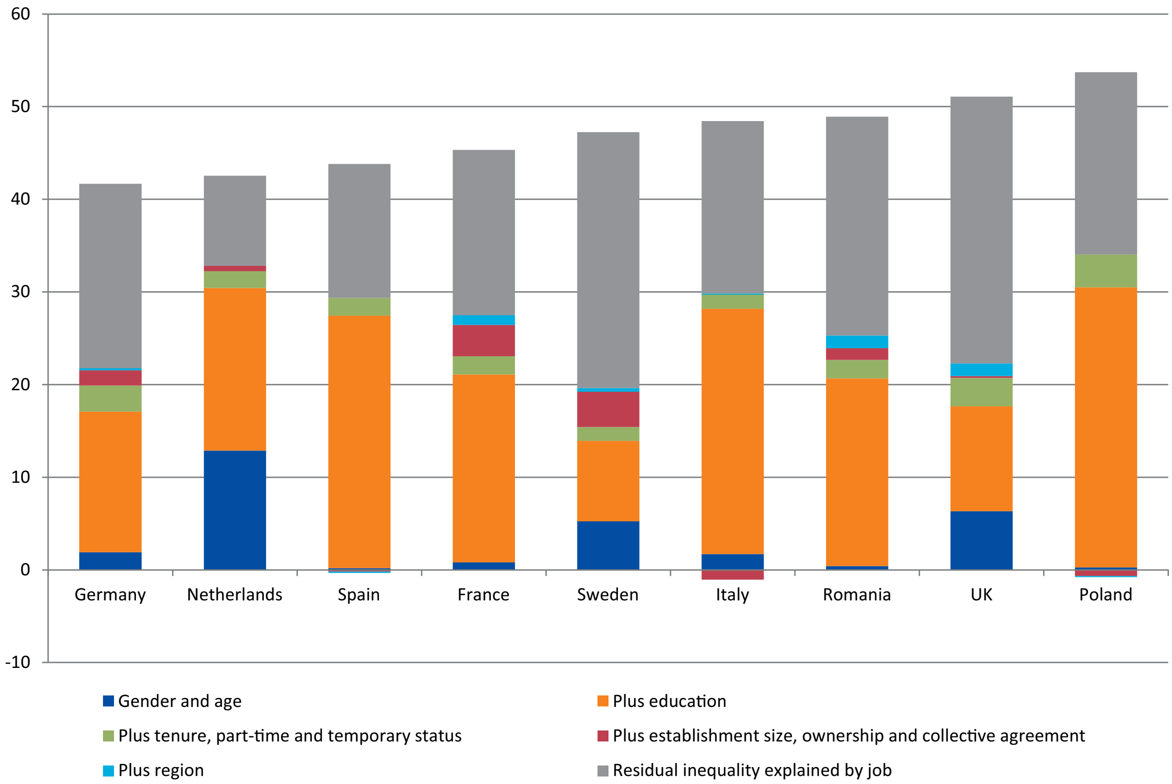


Source: *SES 2010 (authors' analysis)*

Figure 18 shows a decomposition of the total log wage variance explained by jobs (the same previously shown in Column 6 of Table 3) for different sets of explanatory variables. The approach is similar to the one used earlier for evaluating the human capital argument: fit a multivariate regression equation using different explanatory variables, and then see whether the variance of the residual is linked to occupations/jobs. In this case, the approach is generalised by adding more and more variables to the model, starting with gender and age, then adding education, then employment attributes (tenure, part-time and temporary status), then company-level variables (establishment size, ownership and collective agreement) and finally region. By comparing (subtracting) the variance explained by jobs for wages computed net of the factors of each of those successive models to the variance explained for the original wage variable, the role they play (if any) can be evaluated in the observed between-job wage differentials.

The first variables modelled are gender and age, and their impact on between-job wage differentials can be interpreted as evidence of (gender and age) segregation. If most of the differences in wages between occupations are the result of differences in pay by gender and age (and differences in the gender and age composition of jobs, that is, segregation), eliminating them from the picture (expressing wages net of their compositional effect) would leave very small residual between-job differentials. As Figure 18 shows, according to this approach, gender and age segregation only account for a significant share of occupational wage differentials in the Netherlands (more than one-quarter) and to a lesser extent in Sweden and the UK. It is important to note that this does not mean that there is no occupational segregation or indeed wage discrimination in the other countries; what it means is that gender and age do not play such a significant role in occupational wage differentials. It is very unfortunate that information on ethnicity or migrant origin is unavailable (which would probably explain some of the occupational wage differentials in some countries), but it seems unlikely that adding it would change the overall picture very significantly. So, again, segregation is part of the story, although in this case a smaller part and not even in all countries. The structuring role that occupations play in wage inequalities is not mainly the result of segregation mechanisms.

Figure 18: Decomposition of the total log wage variance explained by jobs for different sets of explanatory variables, nine Member States



Source: *SES 2010 (authors' analysis)*

The addition of education and other factors in Figure 18 allows a rough estimate to be made of the 'pure' explanatory power of occupation/job with respect to wage inequality (the segment labelled 'residual inequality explained by job'). It is significant in all countries, but there are very wide differences, from just under 25% in the Netherlands to nearly 60% in Sweden and the UK. It is tempting to interpret this residual as an indication of the effect of the main factor that could not be empirically tested with the data, that of occupational closure (and mechanisms such as occupational licensing, credentialing, certification, unionisation and representation by associations). However, the authors would caution against such interpretation. Firstly, the measurement level of the key variables included in Figure 18 is often crude and, in some cases, even inconsistent across countries in the SES (for instance, establishment variables and regions are not strictly comparable). These inconsistencies may partly explain some of the observed differences in Figure 18, but it is impossible to know to what extent. Secondly, understanding education as a variable exogenous to occupation in this context is problematic because it is explicitly used as a criterion to differentiate occupational levels. This makes it logically impossible to disentangle the effect of occupation on the distribution of wages from the effect of education, at least in the simple way shown in Figure 18. Educational differences (or more precisely, differences in educational requirements) are a crucial aspect of the occupational classification itself.

Summary

This first empirical section can be summarised with the following points.

- Detailed occupations or jobs account for a significant part of wage inequality in Europe: between 40% and 50% in the countries studied here.
- Human capital differences are part of the reason why occupations account for such a significant amount of wage inequality, but not all. Occupations matter for wage inequality even if human capital differences are controlled for.
- Broad occupational classes defined by the nature of their employment contract and skill level can account for a significant part of the explanatory power of occupations on wage inequality, though not all of it.
- Occupational segregation by gender and age is also part of the reason why occupations structure a significant amount of wage inequality, but only in some European countries.

Overall, occupations seem to play an important role on their own that cannot be (entirely) reduced to other factors such as human capital, classes or segregation. Although the data used did not enable the direct evaluation of the role of occupational closure mechanisms, they remain a plausible explanation for some of the observed variance in wages that is linked to occupations but cannot be explained away by other factors.

6 Occupational wage differentials across European institutional models

Varieties of capitalism and occupational wage structures

The main empirical observation made in Chapter 5 was that occupations are an important structuring factor of wage inequalities in all the European countries studied. However, there were differences between countries in some important details with respect to how occupations structured wage inequalities. For instance, in some countries, there were big outliers in the distribution of wages that seemed unrelated to the occupational structure. The extent to which occupational wage differentials could be explained by the composition of jobs by gender, age or education varied significantly across countries, as did the significance of broadly defined social classes in the structuring of occupational wage inequalities.

Is it possible to make sense of those country differences? Can the countries be somehow grouped in different categories or models with respect to how occupations structure wage inequality? And perhaps most importantly, can those patterns and country groupings be related to different socioeconomic models, as identified by the recent political economy literature on varieties of European capitalism?

Literature on the varieties of capitalism distinguishes two distinct types of advanced capitalist economies, liberal market economies (LME) and coordinated market economies (CME), according to the predominant ways in which companies coordinate with each other and other actors in five different spheres – industrial relations, vocational training and education, corporate governance, inter-company relations, and relations with employees (Hall and Soskice, 2001, p. 8). In LMEs, the main forms of coordination are competitive markets and hierarchies, while in CMEs, companies rely more on non-market forms of coordination. These different forms of coordination produce different outcomes in terms of wage distribution (Rueda and Pontusson, 2000). Wage-bargaining structures and skills systems are key mechanisms in this respect. Whereas in CMEs union density tends to be high and wage bargaining relatively centralised and coordinated at the industry or national level, in LMEs the social partners are less organised, and bargaining takes place primarily at company level. In CMEs, workers tend to have specific skills tied to the company or industry where they work, while in LMEs, they tend to have more general skills that can be moved across companies and industries. As a result, the distribution of wages in LMEs tends to be more unequal and less structured by industries or sectors than in CMEs.

It seems plausible that the distinction between LMEs and CMEs would also have implications for the role of occupations in structuring wage inequality. Although overall wage inequality is lower in CMEs, the higher level of coordination in wage bargaining, generally at industry level, could be expected to make within-occupation (or industry) wages more homogeneous and between-occupation (or industry) wages more heterogeneous, thus making occupational differentials more important for the distribution of wages. Furthermore, the higher specificity of skills in CMEs could reinforce occupational boundaries. As a result, one could expect lower wage inequality in CMEs but a more important structuring role for occupations, whereas LMEs would produce higher levels of inequality in overall terms, but primarily within rather than across occupational boundaries (making occupations less relevant for wage inequality).

However, the relevance of this approach for the purposes of the current analysis is limited by its generality. In this study's small sample of nine European countries, there is only one clear case of an LME (the UK), with all the others being variations of the CME model. And there are reasons to believe that the variations within the CME model are indeed substantial and likely to produce very different results in terms of the structuring role of occupations in the distribution of wages. The degree of centralisation and coverage of collective bargaining in CMEs varies considerably across Europe (European Commission, 2009), as well as union strategies and even ideological orientation; for instance, in Sweden, unions have traditionally pursued a national strategy of wage compression, explicitly aimed at reducing the gaps between high-paid and low-paid occupations and sectors, whereas in other countries, wage bargaining is considerably less coordinated across industries and less explicitly egalitarian. The role of unions and collective bargaining in wage determination is also changing in different ways and at different rates across CMEs; in Germany, for instance, collective bargaining coverage has declined significantly since the 1990s, which has contributed quite clearly to growing wage inequality and to a widening gap between unionised and non-unionised industries and occupations (Dustmann et al, 2009). The systems of vocational training and education also vary quite significantly between different CMEs; whereas in Germany, apprenticeship systems are highly developed (with the significant participation of unions and occupational associations) and likely to reinforce the role of occupations in structuring wage inequality (Bol and Weeden, 2014; see also Kampelmann and Rycx, 2013), in other CMEs, apprenticeship systems hardly exist.

Furthermore, the occupational closure approach emphasises the importance of specific institutional settings such as occupational licensing or credentialing that are difficult to associate clearly with the very broad distinction of LME versus CME. For instance, occupational licensing plays a very important role in the LMEs of the UK and the USA, but also in CMEs such as Denmark, Italy and Spain (Kleiner, 2015).

In short, it is difficult to make specific hypotheses about how occupational wage differentials should vary across European institutional families. At most, countries that are institutionally similar can be expected to be also similar in this respect, and distinct from the rest. Perhaps one could even advance the hypothesis that Sweden and the UK (as perhaps the most distinct cases of the CME and LME models, respectively) should produce the most clearly different results, with the other countries and models somewhere between. In the following pages, the role of occupations in structuring wage inequality is analysed systematically in the sample of nine European countries, looking for patterns and similarities, and trying to link them to the patterns of overall inequality and to broad institutional differences.

To do this, this study first re-evaluates some of the main findings discussed in Chapter 5, in particular:

- the levels of overall wage inequality;
- the variance of wages that can be explained by occupational differentials;
- the link between occupational differentials and human capital, age, gender and social classes.

Secondly, some extra analysis focuses specifically on country differences. The similarity of occupational structures is evaluated across Europe, constructing with a principal components analysis a hypothetical EU-level occupational wage distribution (the one that is most correlated with all national wage structures simultaneously) and then comparing it with each individual occupational wage distribution.

Finally, a detailed analysis of the relative distance between the average wages of a set of specific occupations in each country is added, as well as between occupational quintiles.

A discussion of country differences

All the results are summarised in Table 4. The nine countries analysed here (representing different European institutional families) have been more or less sorted in the table by their overall level of wage inequality, shown in the first row of results using the Gini index. The most unequal wage distribution is that of Romania, closely followed by the UK and Poland, then southern Europe (Italy and Spain), continental Europe (France, Germany and the Netherlands), and finally the lowest level of wage inequality by far of Sweden. Germany is something of an outlier, since its level of wage inequality puts it closer to the UK or eastern Europe than to the continental countries.[15] However, it is left in that position to facilitate the comparison with countries that are institutionally similar.

UK

In the UK, the second most unequal country in Table 4, occupational differences account for more than half of all the inequality in log wages (see Row 2a). This would contradict some of the arguments stated earlier, although there is an important qualification: as discussed in Chapter 5, in the UK, occupations matter for wage inequality only if wages are logged. If raw wages are used as the dependent variable, the share of variance explained by detailed occupations (all the combinations of occupation and sector at the two-digit level) is remarkably low, at 12.1% (Table 4, Row 2b). The importance of some very large wages, and their apparent independence from the occupational structure, is something peculiar to the UK – only in France can a similar phenomenon be observed, but to a lesser extent.

Rows 6a and 6b of Table 4 show another peculiar aspect of the UK occupational wage structure. A principal components analysis of occupational wages was performed for the nine European countries shown in the

15 Recent literature argues that the German model has taken a dualisation path in recent years, which has led to a significant expansion of labour market inequalities (Thelen, 2012). But dualisation involves an increasing divide between the conditions of work and employment of insiders and outsiders, not a generalised flexibilisation of the labour market. Therefore, the German model remains different from the liberal regime of the UK. Dualisation can be seen as an inegalitarian version of the CME model. The effect of dualisation on the structuring role of occupations in wage inequality will depend on whether the boundaries between insiders and outsiders cut across occupations or are associated with different occupational categories.

Table 4: Summary of country differences

	Sweden	France	Germany	Netherlands	Italy	Spain	Poland	Romania	UK
1. Overall wage inequality (Gini)	18.91	27.28	32.68	29.40	28.66	29.58	35.27	39.02	36.83
2a. Variance of log wages explained by job	47.24	45.32	41.67	42.54	47.39	43.48	52.93	48.91	51.12
2b. Variance of wages (not logged) explained by job	32.48	18.11	38.88	29.13	41.46	31.55	36.34	35.15	12.07
2c. Difference 2a - 2b	14.76	27.21	2.79	13.41	5.93	11.93	16.59	13.76	39.05
3a. Variance of log wages explained by education + tenure	11.56	25.38	41.03	42.90	33.67	36.40	35.25	28.49	16.39
3b. Variance of log wages net of human capital explained by job	41.97	29.43	25.33	14.80	20.65	19.68	25.35	28.44	37.75
4a. Variance of log wages explained by five broad classes	25.56	33.77	24.41	29.27	34.47	30.73	36.24	26.95	39.68
4b. Variance within jobs in upper service class versus empirical share	1.53	1.40	1.03	1.00	1.64	1.46	1.35	1.61	1.59
4c. Same, for skilled and unskilled working class	0.50	0.78	0.89	0.92	0.67	0.71	0.72	0.68	0.58
5. Effect of control by gender and age in variance explained by job	5.23	0.80	1.90	12.87	1.70	0.18	0.25	0.41	6.34
6a. Uniqueness in occupational wages logged (PCF)	0.18	0.11	0.13	0.16	0.17	0.11	0.18	0.14	0.08
6b. Uniqueness in occupational wages not logged (PCF)	0.14	0.12	0.12	0.13	0.22	0.12	0.20	0.18	0.20
7a. Relative differences between job-wage quintiles: quintile 3/quintile 1	1.22	1.34	1.54	1.64	1.40	1.33	1.59	1.81	1.70
7b. Relative differences between job-wage quintiles: quintile 5/quintile 3	1.60	1.94	2.04	1.69	1.93	1.92	2.30	2.25	2.16
8. Differences between quintiles within inequality	Low	Mid	Low	Low	Mid	Mid	Mid	High	High
9. Percentage difference between wage of cleaners in business services and wage of:									
9a. Sales workers in retail	23%	21%	31%	0%	33%	2%	29%	35%	8%
9b. Building and related trades workers in construction	41%	23%	47%	62%	45%	19%	47%	57%	109%
9c. Metal and machine trades workers in metal manufacturing	30%	36%	72%	42%	43%	47%	76%	94%	73%
9d. Business administration associated professionals in private business services	90%	94%	230%	102%	181%	107%	166%	204%	216%
9e. Health professionals in health and social services	74%	160%	253%	153%	362%	185%	159%	203%	215%

Notes: *Shading from light to dark highlights low to high values per row. PCF = principal component factor.*
Source: *SES 2010 (authors' analysis)*

table. This statistical procedure generates a new variable (factor) that is a linear combination of the occupational wages of all nine countries and can therefore be understood as a kind of latent pan-European wage structure, since it assigns to each 'job' a value that is closest to the observed values of wages of all countries simultaneously. In other words, this factor is a newly constructed variable that summarises most efficiently the distribution of occupational wages in all countries. The factor accounts for 84% and 86% of the observed variability in occupational wages and log wages, respectively. This, on its own, means that there is a remarkable consistency in occupational wages across European countries: when a particular job is very well-paid in one country, it tends to be very well-paid in other countries too. But by looking at the correlation (or lack of it) between the occupational wages of each country and the generated factor, one can also get an idea of how peculiar each wage structure is: this is the coefficient of 'uniqueness' reported in Rows 6a and 6b for wages and log wages. Looking at the results for the UK, it can be seen that it goes from being one of the most 'unique' countries in terms of its occupational (raw) wages to being one of the least 'unique' when the wages are logged. If one disregards (or rescales) the values of some large outliers, the UK wage distribution is very similar to that of any European country; if one does not, the UK becomes very idiosyncratic.

Rows 7, 8 and 9 in Table 4 provide a further glimpse into the peculiarities of occupational wages in the UK. The relative distance between occupational wages in the UK is very large, as could be expected considering the very high levels of general inequality. For instance, the occupations/jobs in the middle quintile are 1.7 times higher, on average, than those in the first quintile (Row 7a); and those in the top quintile are 2.16 times larger than in the middle quintile (Row 7b): only in eastern Europe are those differentials slightly bigger. Looking at specific jobs (Rows 9a–9e), one can see that the between-job differentials in the UK are, on average, larger (even if there may be specific cases of jobs with much larger differentials in particular countries, such as health professionals in Italy). A final interesting peculiarity of the UK is that the five broadly defined social classes constructed in Chapter 5 account for the largest proportion of overall wage variance in any country (four-fifths of the total variance explained by detailed jobs can be explained by just five broadly defined social classes).

So the UK comes out as a very unequal labour market with large occupational wage differentials, strongly related to broad occupational classes, and an occupational wage hierarchy similar to that of the rest of Europe except for the (very important) existence of a small minority of very large wages seemingly unrelated to occupations.

Sweden

At the other extreme of the table is Sweden, which is in many aspects the polar opposite of the UK. In Sweden, overall wage inequality is very low, as are occupational differentials. The wages of the middle quintile in Sweden are only 1.2 times those of the bottom quintile, and the wages of the top quintile only 1.6 times those of the middle. On average, business administration associate professionals earn only 90% more than cleaners in business services, and health professionals only 74% more. The five broad social classes account for a smaller share of overall wage inequality than in any other country except Germany, and the degree of residual within-job inequality is similarly low in all five quintiles.

But even though wage inequality is generally smaller, the role played by occupations in structuring it is actually high, almost as high as in the UK (occupational wages account for 47% of the variance of log wages and 32% if wages are not logged). It is important to note that this does not mean that wage differentials between occupations are as high in Sweden as in the UK: as can be seen by comparing the values in Rows 7a–7b and 9a–9e of Table 4, they are much smaller in Sweden. But wage inequality being generally smaller, it is similarly structured by occupations in both countries (again, with the important qualification of the distorting incidence of very large wages in the UK, a phenomenon that is not observed in Sweden).

Another surprising similarity between Sweden and the UK is that human capital differences seem less important in both countries for explaining occupational wage differentials than in other countries. Row 3a of Table 4 shows the variance explained by a model with education and tenure (a simple Mincer equation), which is lowest in these two countries as well. The result for Sweden is consistent with previous estimates such as those of Badescu et al (2011), while the result for the UK seems a bit low though not implausible. But the important thing is that in these two countries, occupation accounts for a large share of the variation of wages net of human capital differences (the residual of the Mincer equation's fitted values), suggesting that occupational wage differentials are less explained by broad human capital differences than in other countries. So contrary to expectations, and despite their big differences in terms of wage inequality and actual occupational wage differentials (big in the UK, small in Sweden), the role played by occupations in structuring wage inequality seems equally important in both countries.

Poland and Romania

Besides the UK, Poland and Romania have high levels of wage inequality. As shown by Rows 7a–7b and 9a–9e of Table 4, occupational wage differentials are as large or even larger than in the UK. And, as shown by Rows 2a–2c, occupations account for a very significant share of overall wage inequality, irrespective of whether wages are logged or not (which means that big outliers are not so important in these wage distributions and that their occurrence is better predicted by occupation). One can also see that the Polish occupational wage structure is one of the most peculiar in Europe (Rows 7a–7b).

Italy and Spain

Italy and Spain have middling levels of wage inequality and mid-low levels of occupational wage differentials (see Rows 7a–7b and 9a–9e in Table 4). However, even though Italian occupational wages are not very unequal, there are some very large outliers such as health professionals (who earn almost four times as much as cleaners in business services). The Italian occupational structure is, in fact, the most peculiar of all of Europe, with some jobs occupying very different positions in the wage structure than in other European countries (as shown by the uniqueness statistic of factor analysis in Rows 7a–7b). As for the role played by occupations in the wage distribution, the ANOVA results of Rows 2a–2c show moderate values for Spain and high values for Italy, irrespective of whether wages are logged or not.

France, Germany and the Netherlands

The group of three continental European countries is the most diverse. Germany has relatively high levels of wage inequality and France relatively low, with the Netherlands somewhere in the middle. The wage differentials between occupations are quite high in Germany, among the highest in the sample of nine countries (Rows 7a–7b and 9a–9e in Table 4), whereas in the Netherlands occupational wage inequality is high only in the lowest half of the distribution (as shown in Row 7a). An interesting peculiarity of the Netherlands is that it shows the clearest evidence of segregation by gender and age as a driver of occupational wage differentials (controlling for gender and age reduced the variance explained by occupation by nearly one-third; see Row 5 in Table 4), probably linked to the very high incidence of part-time employment.

The role played by occupations in wage inequality is also quite diverse in the group of continental European countries. It is relatively high in France and relatively low in Germany and the Netherlands. Not logging wages changes the picture quite significantly in France (because of the incidence of wage outliers and their strong contribution to within-occupation inequality), but very little in Germany. In Germany and the Netherlands, the five big occupational classes account for a small proportion of overall inequality, and wage inequality within working class occupations is particularly high. In Germany and the Netherlands also, human capital differences account for a very significant part of occupational wage inequalities, more than in any other country.

Conclusion

This chapter has tried to identify systematic differences between European countries in the way occupations structure wage inequality and to link those differences with European institutional variations.

Perhaps the most significant result is the high level of similarity across all countries, rather than the differences. In the nine European countries analysed in the previous pages, occupations account for a similar level of overall wage inequality, between 40% and 50%. It is useful to contrast this with the variation in the level of wage inequality itself: as measured by the Gini index, the most unequal country (Romania) has more than double the value of the least unequal (Sweden). What this means is that, independently of how unequal the distribution of wages is in each country, the proportion of such inequality that occurs within occupations is roughly the same everywhere (between 50% and 60%), as well as the proportion of inequality that results from occupational wage differentials (the remaining 40%–50%). It is also surprising that the big differences in wage-setting mechanisms and institutions (coordinated by markets or collective agreements, with different levels of centralisation and coverage, or with different systems of occupational licensing, credentialing and apprenticeship) do not produce significant differences in the extent to which occupations shape the different wage distributions. Again, these differences produce clearly different outcomes in terms of inequality levels, according to this analysis, but the same results shows no significant differences in the role played by occupations in structuring wage inequality.

A second striking finding concerns the similarity of occupational hierarchies in Europe despite the large differences in the actual wages associated with the same occupations in different countries. A principal components analysis enables the construction of a hypothetical or latent EU-level occupational wage hierarchy (a linear combination of all occupational wage hierarchies, constructed according to their observed correlations) that could, on its own, account for nearly 90% of all the information contained in all the country-level observed occupational wages. In other words, if occupation A is better paid than occupation B in one European country, it is very likely to be also better paid in all the other countries. This does not mean that the relative (or absolute) difference between the average wages of those two occupations is also the same across countries: the actual wage differentials will vary considerably, as overall wage inequality itself.

What these findings suggest is that behind all European wage distributions, there is a very similar underlying occupational backbone. Different institutional frameworks may produce different levels of wage inequality overall, but they do not alter the backbone itself. They may stretch it or compress it (thus increasing or decreasing overall wage inequality), but the sorting of different occupations in a hierarchy will remain essentially untouched, as well as the distribution of the additional inequality between and within those occupations. The striking similarity of this occupational backbone across different European countries and institutional families suggests that it is the result of more fundamental features of economic systems, which are shared by all similarly developed economies. In the authors' view, what this backbone may reflect is the underlying similarity in the technical division of labour and level of technological development of European economies. Even if different European countries have different economic structures, institutional frameworks and cultural values, their underlying economic processes and organisations share some key features to the extent that they are similarly developed and organised in a technical sense. Among those similar features are the division of labour and the broad range of technologies available for economic processes; these shared features would produce the underlying backbone to European occupational wages.

But although the underlying similarities in occupational wages are striking and suggestive, they are not perfect. There are also some significant differences across countries, especially in some of the details and associated factors. Can they be linked to varieties of European capitalism?

Occupational wage differentials (the relative differences between the average wages associated with different occupations) as such do vary across countries as much as wage inequality itself and can be easily linked to European institutional families. The differences between highest- and lowest-paid occupations are largest in the UK and eastern Europe, smallest in Sweden, and with different gradations across continental and southern European countries. But this is hardly a new or exciting finding since occupational wage differentials just reproduce the European distribution of wage inequality. The fact that occupations explain a similar level of wage inequality in all countries, and that wage hierarchies are very similar, implies that the variation in occupational wage differentials will be almost identical to the variation in wage inequality itself.

Some of the differences in the association between occupational wage differentials and other variables are more interesting, although not always easy to explain or link to institutional frameworks. The link between human capital and occupational wage differentials is smaller in the two polar extremes of European wage inequality and the most different ‘varieties of European capitalism’: Sweden and the UK. Conversely, the strongest association between occupational wages and human capital as measured by education and experience is observed in continental and southern Europe. Despite their differences in other respects, Sweden and the UK do share a similar orientation in their educational systems towards general rather than specific skills development, in contrast with continental and southern European systems, where credentialing, apprenticeship, vocational training and other features of the educational system tend to produce more specific skills in workers. These differences may explain some of the observed differences in the link between occupational wages and human capital in the different countries.

Another interesting finding is the wide differences in the share of occupational wages that can be explained by differences between five broadly defined social classes. In Italy, Poland and the UK, this value is remarkably high (close to 40%), suggesting that, to a large extent, the structuring role of occupations in wages reflects broader processes of social stratification rather than occupation-specific processes of wage differentiation. In other words, broadly defined occupational classes (and their associated mechanisms of differentiation) are considerably more important in those countries than other European countries. In Germany and Sweden, in contrast, these broadly defined classes are considerably less important factors of wage structuration.

Overall, the attempt to identify groups of European countries where occupations structure wage inequalities in similar ways, and to link them to institutional variations in economic coordination, has been unsuccessful. Clear groups of countries could not be found, nor could a clear link between the effect of occupations on the distribution of wages and the broad institutional frameworks. However, the reasons for this failure are themselves interesting findings that suggest further possibilities for research. First, very significant differences could not be found because there seems to be a similar underlying structure of occupational wages across Europe in terms of the distribution of inequality between and within occupations, and in terms of the implicit hierarchy of average occupational wages. Second, the differences found seemed related to aspects of their institutional framework that are specifically linked to occupations and do not necessarily vary according to broadly defined variations or institutional families (such as the orientation of educational and vocational training systems or the relevance of broadly defined social classes).

7 Occupations and the evolution of wage inequality in Europe

Introduction

Occupations clearly play an important role in structuring wage inequality. But did they also play an important role in the recent evolution of wage inequality levels? As previously mentioned, in many countries (though not all and to different extents) wage inequality has increased in recent decades. Was this development driven by widening occupational wage differentials, or did these remain broadly stable? Or did they actually become less important in recent years, as a result of a widening of wage inequality within rather than between occupations?

There are some recent studies relevant to this matter, mostly for the USA and the UK to the authors' knowledge, coming from both sociology and economics. But the results are often contradictory in their findings, despite analysing similar periods and even using the same data. Some conclude that widening occupational wage differentials and the changing occupational composition of employment (job polarisation) account to a significant extent for the growing inequality in wages in the USA and the UK in the 1980s and 1990s. For instance, Weeden et al (2007) found that most of the growth of wage inequality in the USA between 1973 and 2005 took place between rather than within occupations. In fact, according to these sociologists, most of this expansion took place between broadly defined occupational classes rather than at the level of detailed occupations. Mouw and Kalleberg (2010) found that between-occupation changes explained two-thirds of the increase in wage inequality in the USA between 1992 and 2008, although they cautioned that at least 23% of this change could be due to a change in occupational codes over that period. The same authors found, however, that between 1983 and 1992, most of the increase in wage inequalities took place within rather than between occupations. The economists Acemoglu and Autor (2011) used a variance decomposition approach to argue that broadly defined occupations (10 categories) became significantly more important as explanatory factors for wage inequality between 1979 and 2009, compared with other factors such as education. For the UK, Williams (2013) reported similar findings, with occupations accounting for an increasing share of the variance in wages between 1975 and 2008; again, most of this increase being related to broadly defined occupational groups or classes.

But in both sociology and economics, other studies contest these findings and claim that most of the expansion of inequalities took place within rather than between occupations. For instance, the sociologists Kim and Sakamoto (2008) studied the period between 1983 and 2002 in the USA, finding no evidence of an increasing role for occupations in wage inequality. The economists Mishel et al (2013), in an explicit rebuttal of the findings of Acemoglu and Autor (using the same data but with a different operationalisation), found only evidence of an increasing role of occupations in explaining US wage inequality between 1979 and 1994, with a significant decline afterwards.

Despite using similar approaches and the same data sources, the contrast between the findings of these different studies is striking. Even within the group of studies defending an increasing role for occupations, there are important contradictions. For instance, Mouw and Kalleberg (2010) found a decreasing role of occupations in wage inequality for the period 1983–1992, in contrast to Weeden et al (2007) and Acemoglu and Autor (2011). Why are the results of different studies so inconsistent, and which should be believed?

These inconsistencies are probably the result of the methodological challenges of assessing the role of occupations in wage inequality over long periods of time. Occupational classifications are updated every few years (in the USA, they were introduced in 1977, changed in the late 1990s and changed again in 2010), and the comparability of results before and after those changes is highly problematic. The updating of occupational codes is necessary because technical change and the unfolding of the division of labour renders them obsolete. But then to the extent that it is better adapted to the new realities of work, an updated classification should produce more internally consistent occupations and therefore should increase the share of variance in wages explained. Even if it may be possible to estimate this reclassification effect in the short run (for instance, Mouw and Kalleberg, 2010 attribute almost one-third of the increase in wage variance explained by occupations in the USA in the 1990s to this effect), the comparability of occupational codes in the long run remains problematic and the results very sensitive to small methodological decisions on how occupations are treated for long-term analysis.

A more general methodological problem is the increasing importance of very large outliers in the distribution of wages. A recent and very influential strand of the literature on income and earnings distribution has argued that the recent increase in inequality is mostly the result of a massive expansion of labour income for those at the very top of the distribution (the top 1% or top 0.1%; see Piketty, 2014, especially Chapter 9; also OECD, 2011). This development, according to the same literature, is very poorly captured in standard government surveys on income and wages such as the US Current Population Survey (Atkinson et al, 2011), as a result of under-reporting, sparse data, non-contact or refusals by top earners (to uncover these trends in top labour earnings, these studies used administrative registers and tax return data instead). Since most of the studies on occupational wages use surveys, they may miss a significant part of the growth in wage inequality. This problem may be compounded by the common practice of using log wages rather than monetary wages as the variable whose variance is to be explained. As seen earlier in the case of the UK, logging wages can increase dramatically the share of variance explained by occupations if there are very large outliers, but it makes the interpretation problematic if large outliers are a feature and not a bug of the distribution. Among the previously mentioned studies, the one that finds less evidence of a growing role for between-occupation differentials (Kim and Sakamoto, 2008) uses dollar wages rather than log wages as the dependent variable.

Of course, some of these methodological problems will affect this study, too, but they will be addressed as explicitly as possible; in the case of changing classifications, by trying to explicitly discuss the potential effect of breaks and, in the case of big outliers, looking at wages both logged and in euros for comparison. The problem of missing the top wage earners is a more intractable one, because the authors do not know of any administrative data source that includes reliable information on occupation.

Before embarking on a data analysis, it is important to clarify the ways in which occupations could affect the evolution of wage inequality. The first and most obvious effect would be via occupational wage differentials: if the differences between the average wages of occupations become larger over time, they would drive up overall wage inequality even if within each occupation the distribution of wages would remain stable. Second, occupations could also affect wage inequality *compositionally*; even if average wages *across* occupations and wage inequality *within* occupations remain stable, wage inequality could increase if employment expanded in high-paid and low-paid occupations relative to the middle. That is how the well-known phenomenon of job polarisation could have led to an expansion of wage inequalities. Finally, overall inequality could also expand if employment in the most internally unequal occupations grew faster than in the most internally homogeneous. For instance, deindustrialisation can produce that effect because the distribution of wages in services tends to be more unequal than in manufacturing.

Analysis of the role of occupations in the recent evolution of wage inequality

Before starting the analysis with EU-SILC data, it is necessary to briefly mention some limitations of this data source, which are mostly related to the data used and the period covered. First, EU-SILC aims to measure income rather than wages, providing only an approximate measure of the latter that must be constructed under weighty assumptions and can conceal some of the real variation of wages while introducing some variation unrelated to wages. Second, the sample size is relatively small (a few thousand cases), which is particularly problematic when the goal is to evaluate how the variance is distributed between and across a very large number of groups (detailed occupations or jobs). Third, although occupation is measured at the two-digit level, sector is only measured at the one-digit level (even slightly more aggregated, in fact), which may not yield a sufficient level of granularity to the approach taken here. Finally, the period 2005–2014 is too short for making an evaluation of the long-term contribution of occupational trends on wage inequality, with any analysis likely to be biased by cyclical developments.

How have those limitations been dealt with? With respect to the measure of wages and the sample, the results of EU-SILC are compared with those obtained earlier with the SES (see previous chapters), which is a much better survey for the purposes of this analysis (it has a very large sample and a good measure of wages) despite being available in practice for just one year. With respect to the classification variables, previous chapters have already shown that occupation at the two-digit level already captures most of the variation of the more detailed occupation-by-sector combination. But since this study is mostly interested in evaluating trends rather than making a precise assessment of the importance of occupations at any point in time, this should not be a big problem. And finally, even if only a short period of time can be looked at, it is a period of particularly intense occupational change in terms of employment, which should allow a broad evaluation of whether this change has affected inequality. This short-term analysis is complemented, however, with some exploratory medium-term results using the Luxembourg Income Study (see Annex 6). In Annex 7, a similar analysis is presented using a national-level dataset with a much larger sample, the Spanish Continuous Sample of Working Life. The results are very consistent with the ones presented here using EU-SILC.

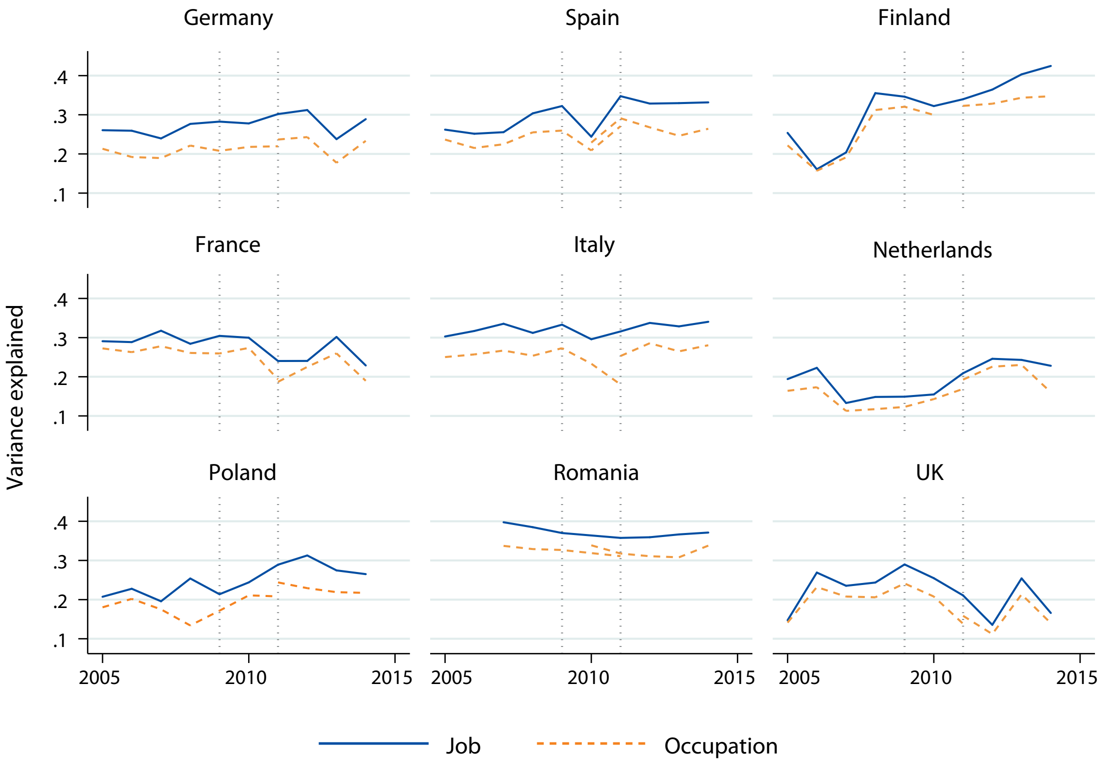
ANOVA test

The analysis begins with a breakdown of the variance approach, which in Chapter 5 established that detailed occupations account for between 40% and 50% of the total variance in wages. Now the same approach can be used to evaluate whether the structuring role played by occupations in the distribution of wages has changed in recent years. This is shown in Figures 19 and 20, for raw and logged wages, respectively, for nine European countries between 2005 and 2014.[16] It is important to compare the values produced by EU-SILC with the values provided previously using the SES, which is a more adequate source. As could be expected because of the limitations previously discussed, the values are generally around 10 percentage points lower with EU-SILC than with SES, but otherwise the picture painted by both sources seems reasonably consistent. And again, the main objective of this chapter is to evaluate the trend rather than to establish the importance of occupations in structuring wage inequality.

Figures 19 and 20 paint a quite diverse and somewhat volatile picture of the recent change in the role played by occupations in structuring European wage inequality.[17] However, it seems a picture of either stability or growth, with only one clear case of a decline in the share of wage variance explained by occupations (France). There are three countries where the variance accounted for by occupations clearly and significantly increased over the period: Finland, Poland and Spain. In Germany and Italy, the trend also suggests an increase, but much slighter (and potentially reversible). In the Netherlands and the UK, the figures show a lot of volatility, which in the case of the Netherlands may be linked to the business cycle but in the UK just looks very inconsistent (especially when wages are not logged). Romania shows a more stable pattern, perhaps also with some cyclicality since it first consistently declines and then marginally increases. Finally, as already mentioned, France is the only case of a more or less clear decline (though again with some volatility).

So bearing in mind all the limitations previously stated, the data suggest a stable or slightly increasing role of occupational wage differentials in structuring wage inequality in Europe during the past decade. This

Figure 19: Share of variance explained by job and occupation, wages not logged

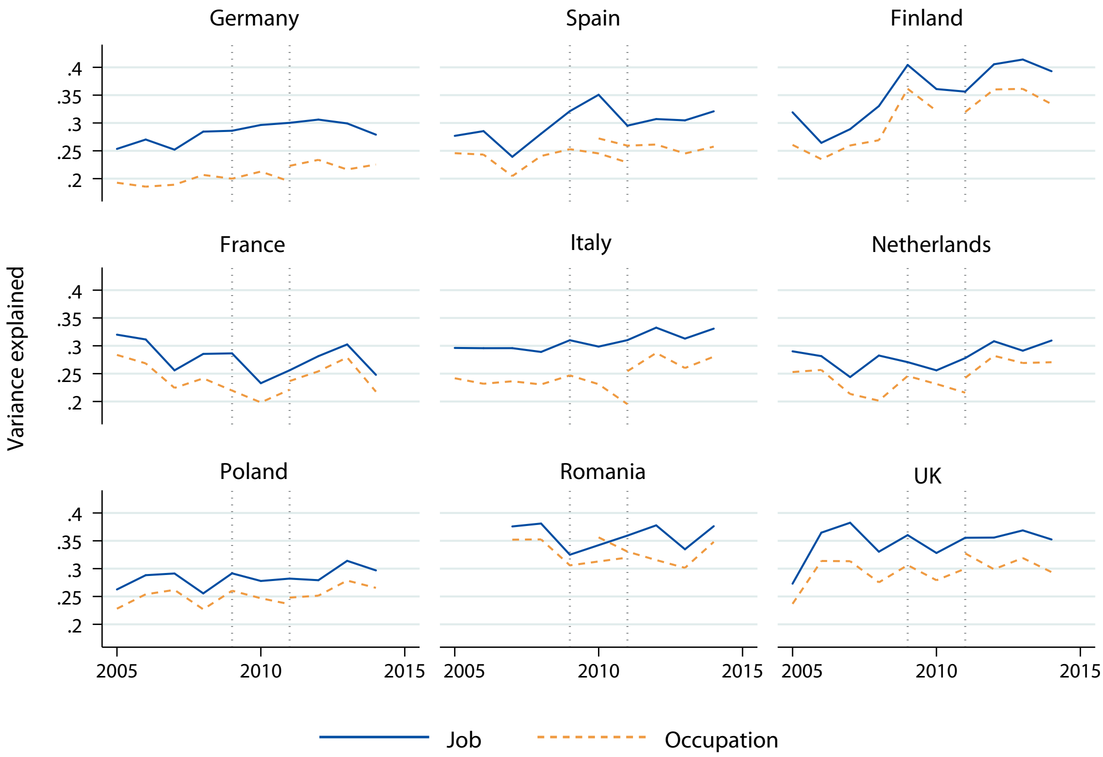


Note: *Breaks in the classifications are indicated by the two vertical dotted lines: the first refers to the change in sector (NACE) and the second to the change in occupation (ISCO).*
Source: *EU-SILC (authors' analysis)*

16 The countries shown are the same as those analysed in Chapter 5 using SES data, except that Finland has replaced Sweden. The reason is that the Swedish results using EU-SILC seem problematic for occupations, with a much lower share of variance explained for no obvious reason. Since SES data are much more adequate for the purposes of this study, it was decided to replace Sweden in this chapter with Finland as another representative of the northern European social democratic economies.

17 The breaks in the NACE and ISCO classifications in Figures 19 and 20 are in some cases associated with discontinuities in the trend that should therefore be ignored in the analysis. The clearest case is Spain, with big jumps around the classification breaks.

Figure 20: Share of variance explained by job and occupation, wages logged



Note: *Breaks in the classifications are indicated by the two vertical dotted lines: the first refers to the change in sector (NACE) and the second to the change in occupation (ISCO).*
Source: *EU-SILC (authors' analysis)*

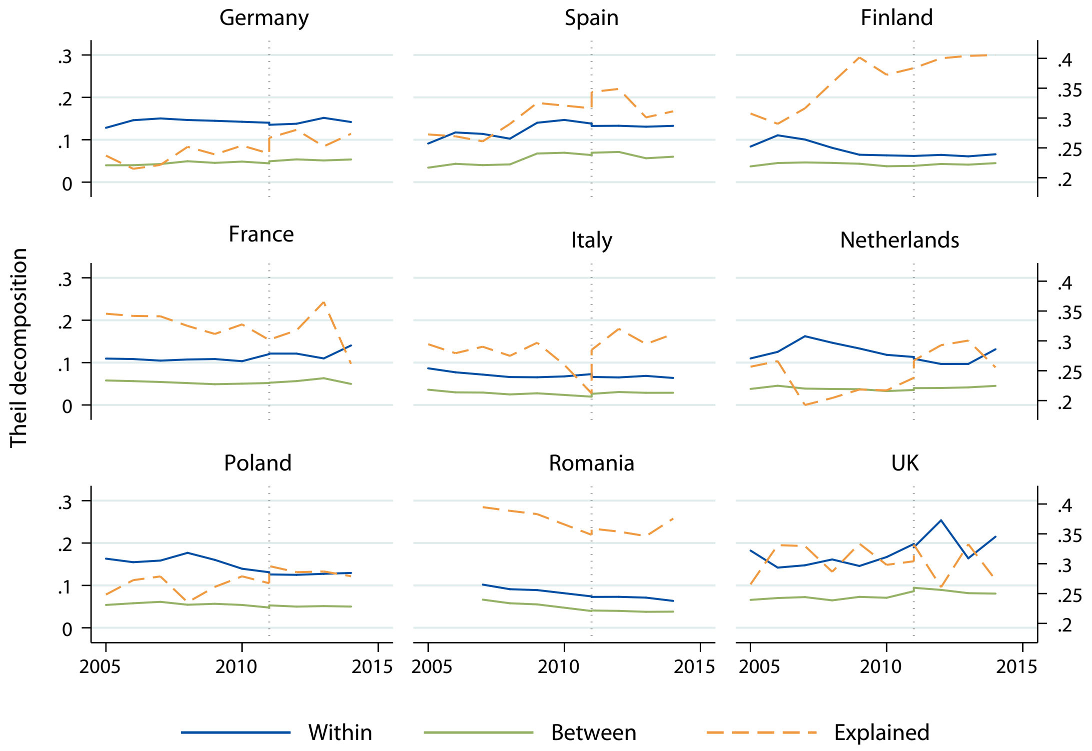
impression is reinforced if one focuses on the period after the onset of the crisis (around 2008), when in some cases there is a change in the trend.

Theil index test

That does not necessarily mean that occupations have been driving wage inequality developments in recent years. A Theil index decomposition can help to clarify this, a tool that was also used for the static analysis in Chapter 5. The Theil index itself is a measure of the degree of inequality in a distribution, which can be directly compared across countries and over time. It can be broken down by any grouping variable such as job/occupation, into a within component (an aggregation of the level of wage inequality that exists within occupations) and a between component (the extent of wage inequality that results from differences between the average wages of different occupations). Figure 21 shows the yearly evolution of the within and between components of Theil (added, they would reflect the overall level of inequality in the country, which is not directly shown in the figure but can be inferred), plus the share that the between component represents over the total Theil (the 'explained' indicator, which has a similar interpretation to the variance explained by occupations and which can be used to evaluate the role they play in structuring wage inequality).

The explained indicator shown in Figure 21 (the dashed line) paints a very similar picture to the ANOVA previously discussed. But the evolution of inequality between and within occupations can now be looked at as well, and it suggests a rather different interpretation. It is the within component that drives change in the overall level of inequality in most cases, even when the share of inequality that is directly linked to occupational differentials tends to grow. The reason is, simply, that the between component tends to be very stable; and when it changes, it tends to move in parallel with the evolution of the within component.

Figure 21: Theil decomposition of wage inequality by detailed occupations (jobs)



Notes: *The vertical dotted line indicates a break in the occupational classification. The 'Explained' indicator is plotted on the right-hand axis.*
Source: *EU-SILC (authors' analysis)*

In Finland and Poland, where the increase in the role played by occupations in the ANOVA was clearer (a result confirmed with the Theil approach), it is a significant decline in the within component of wage inequality that makes the explanatory power of occupations grow (a denominator effect). So, paradoxically, occupations become more important not because occupational wage differentials grow, but because they remain relatively stable in the face of a generalised decline of wage inequality (which takes place mostly within occupations).

The picture is similar in Germany and Italy, although with much more stability in both the between and within components. In Romania, both the between and within components clearly declined over the period, with only a marginal increase in the importance of the former in the very last year. And, in France, the only case where the variance explained by occupations consistently declined, the within component actually increased over the period while the between component remained stable or slightly declined. The apparently cyclical development in the Netherlands is again driven by within-occupation changes, as is the volatility of the UK (with between-occupation shifts being more stable). Even in Spain, where the between component seemed to increase more clearly (particularly between 2008 and 2009), it runs in parallel with the evolution of within-occupation inequality, and therefore cannot be said to drive the overall evolution.

In order to conclude that occupational dynamics are driving wage inequality trends, one should see the between component changing more significantly than the within component; however, the exact opposite is found. A possible objection to this argument is that the within component may be just more sensitive to measurement errors and random noise, while the between component (which derives from a comparison of occupation averages) could just be more stable. Perhaps a long-term analysis would reveal the changes in the within component to be insignificant, whereas steady developments in the between component would become more significant over time. Without looking at long-term data, it is difficult to discuss such an objection. In some countries, it seems plausible that the within development just reflects cyclical developments or even pure statistical noise (this seems a plausible case in the UK). But just by looking at the results, the objection does not seem to apply to other countries, where trends seem similarly consistent in the between and within components of Theil, and the overall trend is more clear. This objection would also imply that the short-term evolution of wage inequality picked up in Figure 21 would itself be too volatile or cyclical, even though it is reasonably consistent with other recent studies.

A dynamic decomposition of Theil's L index

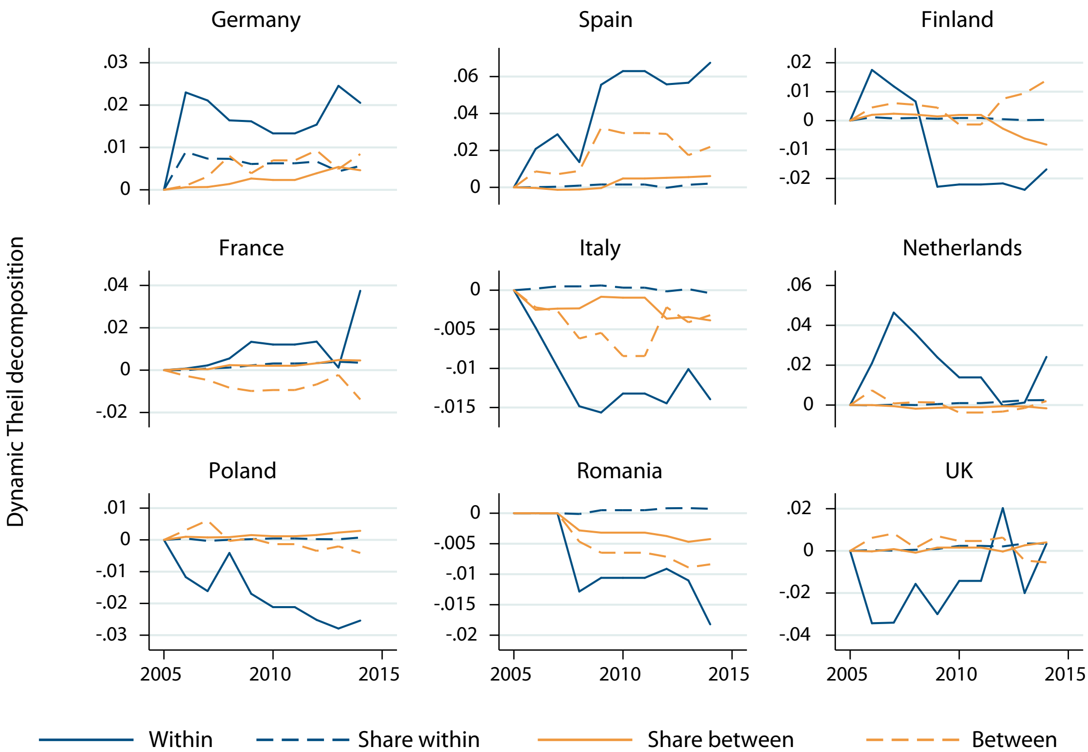
For a final test of whether occupations are driving wage inequality trends in Europe, another decomposable inequality index of the Theil (or Generalised Entropy) family is used: the Mean Log Deviation or Theil's L index. The advantage of this alternative index is that its evolution (change in L) by subgroups can be easily broken down into the following components:

- change in L resulting from changes in within subgroup inequalities (*a*);
- change in L resulting from changes in the subgroup population shares – this can be further differentiated in effect of subgroup population share shifts through the within L component (*b*) and the effect of subgroup population share shifts through the between L component (*c*);
- change in L resulting from changes in the subgroup means (*d*).

The four components add to overall change in L: $\Delta L = a + b + c + d$ (Mookherjee and Shorrocks, 1982). The benefits of this approach are that the effect of the different components is quantified (rather than inferred from the observation of trends), and it allows the impact of compositional change to be evaluated explicitly (again, this effect was only implicit in the previous analysis). The compositional change is particularly important for the purposes of this analysis, because it is how the widely discussed patterns of job polarisation and upgrading could contribute to inequality trends.

The results of this dynamic breakdown are displayed in Figure 22. They show that, at least for the short period and the nine countries studied here, it is changes in wage inequality *within* jobs/occupations that drive overall inequality, not changes in occupational wage differentials (component *d*) or in occupational employment shares (components *b* and *c*). The particularly small contribution of occupational shares to the overall developments of wage inequality should be noted. This is important because it suggests that the widely discussed phenomena of job polarisation and upgrading (or any other compositional change) had at most a very marginal contribution to wage inequality developments in the countries and period covered. It is wage inequality within occupations that changed most (increasing or decreasing, cyclically or consistently) over the period, with a smaller but, in some countries, significant role of occupational wage differentials (such as Romania or Spain and perhaps Finland), but hardly any role whatsoever for the effect of changing occupational shares.

Figure 22: Dynamic Theil breakdown of wage (not logged) inequality, contribution of occupational differentials and shares



Source: *EU-SILC (authors' analysis)*

Conclusion

All the analysis in this report suffers from significant constraints related to the limitations of the data available for EU-level comparative analysis on the distribution of wages by occupations. Those constraints were particularly restrictive in this final section, and they limit considerably the scope of the conclusions that can be extracted. What can be said is that, for the period and countries studied, occupational dynamics have played only a marginal role in the development of wage inequality; within-occupation changes were a much more important driver of the observed trends in wage inequality between 2005 and 2014. This does not mean that occupations became a less important structuring factor for the wage distribution in the countries analysed; in most cases, their structuring role remained stable, even increasing in some cases as a result of a decline in within-occupation wage inequality.

Although the short period covered obviously limits the scope of these observations, they can still make a relevant contribution to the debate, for two reasons. First, because the previously mentioned problems in the comparability of occupational classifications in the long run may suggest looking at short-term periods instead. It is important to emphasise that the time comparability problem is not only about the occupational reclassifications themselves, but also about the reason reclassifications are needed every few years: the changing nature of work is continuously eroding the fit between the occupational codes and the jobs that actually exist, introducing an element of variation in wages and other attributes of jobs that is unrelated to occupational dynamics in strict terms. Second, as mentioned earlier, the period studied is short but particularly eventful. As discussed in previous EJM reports (see, in particular, Eurofound, 2013; and for a similar argument for the USA, see Jaimovich and Siu, 2012), the intensity of structural change in European labour markets in the aftermath of the Great Recession was striking. Not only the intensity of structural change but also its nature (a generalisation of a negative job polarisation pattern, with intense destruction of mid-paid jobs in many countries) should make the effect of occupational dynamics on wage inequality particularly strong in this period. And yet no significant impact was found. This would suggest that changes in occupational structures (phenomena such as job polarisation or upgrading) are unlikely to have significant implications on their own for the evolution of wage inequality. Changes in occupational wages, on the other hand, did play a small but significant role, which perhaps in longer periods can become more important for inequality trends. Unfortunately, studying these longer-term trends from a comparative European perspective is currently hampered by the lack of suitable data.

8 Conclusions

Understanding the link between occupations and wage inequality is necessary for understanding how the division of labour and technological change affect the life chances of workers and provide an underlying structure for the distribution of economic resources in society. In a context of increasing earnings inequality and accelerating technological change, this seems particularly important. And yet existing research on this issue is limited, sometimes contradictory and lacking an international perspective.

Part 2 of this report tries to contribute to a better understanding of the role that occupations play in the structuring of wage inequality from a European comparative perspective, studying recent data for nine European countries. Although this exercise has been constrained by methodological problems imposed by the lack of suitable data, it produced some interesting results, whose significance is amplified by the wider scope of the analysis compared with previous studies. Those results can be synthesised in three main conclusions.

First, occupations play an important role in the structuring of wage inequality in all the European countries studied, an importance that can be quantified as 40%–50% of the total variance in wages being directly the result of occupational differences. These differences are themselves partly explained by systematic differences in the stock of human capital of workers in the different occupations, but only partly. Although, at present, it is impossible to test it directly with EU-level data, an even more significant part of occupational wage differentials seems to be associated with occupation-specific mechanisms of wage differentiation, such as occupational closure. On the other hand and particularly in some countries, such as the UK, occupational wage differentials seem to be strongly structured by broader mechanisms of social class differentiation, not limited to human capital either but to other factors such as the nature of employment relations or power in labour markets. In some countries (such as the Netherlands), occupational wage differentials are also linked to mechanisms of occupational segregation by gender, age or other sociodemographic factors.

Second, the role played by occupations in the structuring of wage inequality has some strikingly consistent attributes in all European countries, irrespective of the overall levels of inequality or institutional frameworks. It seems that the occupational structure provides a unifying backbone to European wage distributions, with occupational wages accounting for a very similar share of overall wage inequality in all countries and occupational hierarchies being very similar despite wide differences in wage inequality levels. The backbone is the same, but it is more or less stretched in the different countries according to the overall level of wage inequality, itself associated with institutional differences in bargaining and educational systems, among other factors. Some further significant differences were found in other aspects of the occupational wage distribution, such as the distorting role played by very large outliers in the UK distribution and the aggregation of occupational wage differentials in bigger occupational classes (much smaller in Germany and Sweden than in the UK, for instance).

Finally, despite the important role played by occupations in structuring wage inequality and the significant changes in the occupational structure that took place in Europe in the aftermath of the Great Recession, occupational dynamics did not drive developments in wage inequality in the last decade in the nine European countries studied. Most of the changes in wage inequality between 2005 and 2014 were the result of changes in the distribution of wages within occupations, with changes between occupations playing a much less important role and changes in the occupational structure (job polarisation) playing a very marginal one. Although the period studied is short, it was particularly intense in terms of occupational restructuring, so it seems unlikely that compositional changes such as job polarisation or upgrading could be a significant driver of wage inequality in the long term.

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Annexes

Annex 1: Shifts in employment composition

Table A1: Indicators of shifting composition of employment, 2008–2016

Indicator	Employment	Employment rate (20–64-year-olds)		Gender employment gap		Part-time workers		Older workers (55 years and older)		High-skilled white collar workers	
Country	Change 2008–2016	2016	Change 2008–2016	2016	Change 2008–2016	2016	Change 2008–2016	2016	Change 2008–2016	2016	Change 2011–2016
	%	%	%	%	%	%	%	%	%	%	%
Austria	5.1	74.9	0.6	6.1	-2.8	28.8	5.1	14.6	4.0	40.7	3.2
Belgium	3.2	67.3	-0.5	8.3	-2.5	25.1	2.5	15.3	5.1	44.8	1.3
Bulgaria	-10.0	68.0	-2.5	6.0	-0.4	2.3	-0.1	19.8	4.6	31.8	1.2
Croatia	-8.8	62.1	-3.2	7.4	-4.9	7.0	-1.1	16.1	2.2	35.5	5.7
Cyprus	-3.5	69.8	-7.3	3.3	-7.5	14.1	6.3	15.9	0.6	35.0	1.5
Czech Republic	2.5	76.5	4.0	11.9	-2.2	6.7	1.8	17.9	2.6	37.6	0.8
Denmark	-0.2	77.7	-2.2	5.5	-1.2	28.4	4.0	20.1	3.5	45.0	1.8
Estonia	0.3	77.7	0.6	1.0	-1.4	11.0	4.5	23.0	4.9	46.0	3.0
Finland	-3.8	73.9	-2.7	4.0	-0.3	16.1	3.2	21.0	3.0	45.3	2.5
France	0.4	70.2	-0.5	3.5	-2.1	18.9	1.9	16.6	5.0	45.5	1.5
Germany	7.5	78.5	4.8	6.5	-2.8	28.1	1.9	22.1	6.8	44.4	1.5
Greece	-20.2	56.6	-10.1	15.7	-5.1	9.8	4.3	14.8	1.1	30.2	0.7
Hungary	13.0	71.4	10.0	8.6	-0.6	5.3	0.7	16.4	5.3	34.2	-1.5
Ireland	-6.2	70.0	-2.9	8.3	-4.3	22.9	4.4	17.6	4.4	40.6	0.8
Italy	-1.4	62.1	-1.2	16.2	-3.5	18.7	4.0	19.3	6.9	35.9	0.5
Latvia	-16.3	73.5	-2.9	-1.9	-2.7	8.7	2.1	21.7	3.5	39.6	0.8
Lithuania	-4.5	75.4	3.0	-2.4	-4.4	8.5	2.0	21.7	6.8	42.2	-0.4
Luxembourg	24.3	70.4	0.9	10.5	-3.8	19.5	3.1	10.5	1.0	57.4	2.2
Malta	21.2	69.5	10.0	22.4	-9.6	15.0	3.5	15.0	3.9	40.2	1.6
Netherlands	-2.0	77.0	-1.9	7.6	-1.6	50.6	3.4	19.0	4.8	46.8	0.2
Poland	3.1	69.1	4.4	9.9	-0.5	6.9	-1.4	16.7	6.1	37.6	3.7
Portugal	-10.6	70.5	-3.0	2.7	-3.6	11.9	-0.4	20.5	1.6	35.7	6.4
Romania	-10.2	66.6	1.3	13.8	3.7	8.8	-1.3	17.2	0.9	22.8	0.6
Slovenia	-7.1	70.6	-2.3	7.3	-1.7	9.8	0.8	13.7	2.9	42.1	-1.3
Slovakia	3.6	69.9	1.6	11.0	-0.9	6.1	3.8	15.2	5.4	31.2	-0.2
Spain	-11.4	63.7	-5.5	9.0	-6.8	15.3	3.5	16.0	4.4	33.2	1.1
Sweden	6.7	81.5	0.7	4.2	-1.2	25.8	-1.2	21.1	0.2	51.7	5.5
UK	6.9	77.6	2.2	6.6	-1.1	26.8	1.6	19.0	2.3	48.8	2.0
EU	0.3	71.1	0.6	8.1	-2.5	20.5	2.3	18.6	4.6	41.0	1.8

Note: *High-skilled white collar workers are those in ISCO main groups 1–3 (managers, professionals and associate professionals). Values are colour coded by column; highest values are green, middle values are yellow and lowest values are red.*
Source: *EU-LFS (authors' calculations)*

Annex 2: Handling of data breaks

Table A2 describes how major classification breaks were handled in the analysis.

Country	Nature of break	Year and quarter	Impact	Solution
France	ISCO occupational classification break	2013 Q1	Some reassignment of employment across ISCO categories – mainly obvious at two-digit level.	Aggregate ISCO two-digit to one-digit for ISCO two-digit categories 10–54 for all quarters covered.
Germany	ISCO occupational classification break	2012 Q1	Significant reassignment of employment across ISCO categories, at one- and two-digit levels of detail.	Use 2012 Q2 to 2016 Q2 data for all German charts, omitting the first year.
Netherlands and Slovakia	ISCO occupational classification break	2013 Q1	Some reassignment of employment across ISCO categories – mainly obvious at two-digit level.	Use 2013 Q2 to 2016 Q2 data for all Dutch and Slovakian charts, omitting the first two years.

Eurostat identified breaks for other Member States in different quarters for the core variables (ISCO and NACE) as well as for employment estimates. However, adjustments were made only in the above cases as they involved obviously artificial and large shifts in employment share by occupation. Luxembourg was dropped in the analysis due to very significant variation in employment share estimates from year to year, so all EU aggregates are for the EU27 rather than the EU28.

For the EU27 aggregate figures for 2011 Q2, the missing data for Germany, the Netherlands and Slovakia are accounted for by backcasting from 2012 Q2 in the case of Germany and 2013 Q2 in the case of the Netherlands and Slovakia to 2011 Q2 using the aggregate employment shift observed, thus preserving the structure of employment observed in 2012 in Germany and 2013 in the Netherlands and Slovakia. The assumption, therefore, is that the composition of employment by jobs did not change in Germany in 2011–2012 or in the Netherlands and Slovakia in 2011–2013; only the levels of employment changed. For the EU27 aggregates in the breakdown charts (for example, gender, full-time or part-time), the missing data for Germany, the Netherlands and Slovakia are generated using a similar backcasting, but also taking into account observed changes in employment for the categories of the breakdown variable(s).

Annex 3: Comparing employment shifts using different job quality measures

Most of the analysis in this and previous EJM annual reports has concentrated on the job-wage as the primary ranking criterion. Wages are clearly an important dimension of quality of work and have the additional advantages of being reasonably well measured and highly correlated with other relevant dimensions of job quality. The use of mean or median job (or occupation) wage as the basic ranking criterion has also been the common approach of much of the employment polarisation literature (see Goos and Manning, 2007).

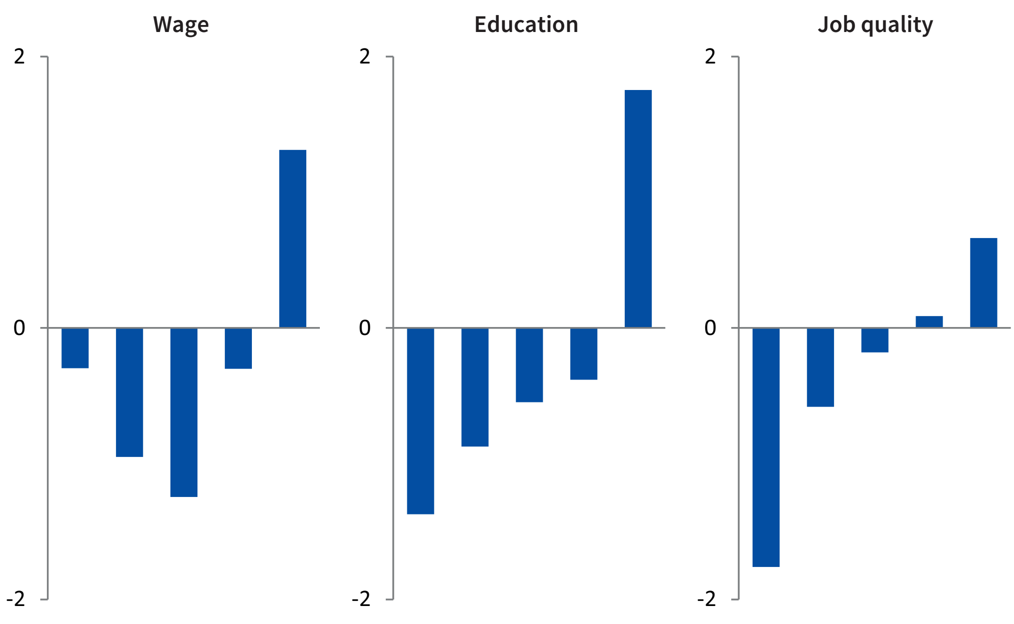
But there are other proxies of job quality and Figures A1 and A2 make use of two different measures to rank 'jobs' (as always using the jobs-based method, these are defined as specific occupations in specific sectors that are then assigned to five quintiles of employment). The first is the average educational level of the job-holder in a job. The second is based on dimensions of job quality more broadly considered – including contractual stability, work autonomy, working time flexibility, development opportunities and risk exposure – and relies on answers to 38 questions in Eurofound's fifth EWCS. This is called a 'non-pecuniary job quality' ranking as it deliberately omits wage income data in order to avoid overlapping with the existing, principal job-wage ranking. Data are shown for two periods: Figure A1 for the late crisis period of contracting employment (2011 Q2 to 2013 Q2) and Figure A2 for the recovery (2013 Q2 to 2016 Q2).

During 2011–2013, as Figure A1 highlights, the job-wage ranking tended to generate more polarised patterns of employment change (greater relative growth at the edges, less in the middle) than the other two ranking criteria. Net employment destruction was concentrated in mid-paid and mid-low-paid jobs. Employment shifts in terms of the education and job quality rankings were, however, clearly upgrading with greatest net employment destruction progressively from the bottom quintile upwards.

At the same time, there are some obvious points of similarity between the three charts reflecting the high correlation (r > 0.7) between the different measures of job quality used to rank jobs. The top quintile is growing fastest regardless of the ranking criterion, and employment growth is relatively weaker in the lower quintiles.

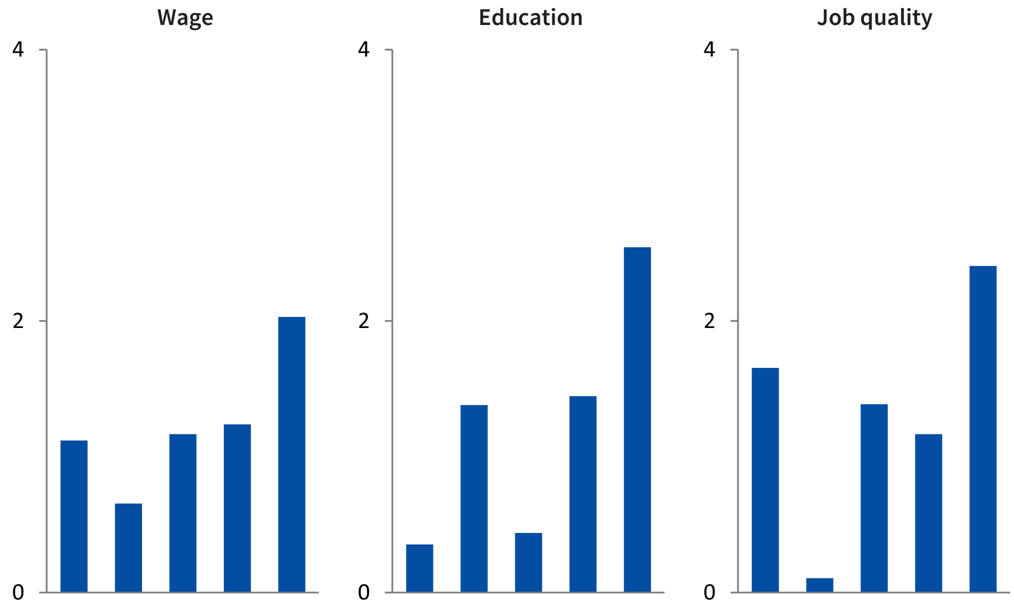
The reason for the (modest) differences between the three measures is that a substantial proportion of jobs in the middle of the wage distribution have a relative wage premium (a higher relative position in terms of wages than education or non-pecuniary job quality attributes), and these jobs were responsible for a large share of overall job destruction during and after the global financial crisis. Two illustrative examples can be seen in the list of large-employing jobs with the fastest rates of employment decline (see Table 2). The first is that of building and related trades workers in the construction of buildings sector, which is in the third

Figure A1: Employment change (% per annum), by wage, education and job quality quintile, EU,* 2011 Q2–2013 Q2



** EU27 (excluding Luxembourg)*
Notes: *Q2 data in each year. Data adjusted for breaks in France, Germany, the Netherlands and Slovakia as indicated in Annex 2. Due to data limitations, job quality rankings could be generated only for jobs accounting for around 90% of EU employment.*
Source: *EU-LFS, SES, fifth EWCS (authors' calculations)*

Figure A2: Employment change (% per annum), by wage, education and job quality quintile, EU,* 2013 Q2–2016 Q2



** EU27 (excluding Luxembourg)*
Notes: *Q2 data in each year. Data adjusted for breaks in France, Germany, the Netherlands and Slovakia as indicated in Annex 2. Due to data limitations, job quality rankings could be generated only for jobs accounting for around 90% of EU employment.*
Source: *EU-LFS, SES, fifth EWCS (authors' calculations)*

quintile as measured by wages but in the bottom quintile as measured by educational attainment or broader job quality. The second is that of metal and machinery trade workers in the manufacture of fabricated metal products, which is in the third, middle wage quintile but in the second education quintile and in the bottom quintile as measured by broader job quality. It was precisely such, primarily male, jobs in the construction and manufacturing sectors that accounted for most of the net job destruction in 2011–2013 (and, previously, from the onset of the crisis in 2008).

The above suggests that the different characterisations of employment shift, based on the three proxies of job quality, arise in large part for sector-specific and business cycle reasons over quite a short time period (2008–2013). However, similar findings have also been identified in developed economies over longer time frames. Based on a jobs-based analysis of the pre-crisis period (1990–2008) in five European countries, Oesch (2013) noted that 'the employment drop in the lower-middle and middle quintiles concerns comparatively well-paid working-class jobs'. In similar fashion, the jobs that were disproportionately affected by employment loss during and after the crisis were male, blue collar, primarily mid-paying jobs that do not require high levels of formal education.

During the recovery period (2013–2016), each quintile has recorded employment growth according to all three of the rankings (Figure A2). As previously, the greatest growth occurred in the top quintile in each (between 2% and 2.5% per year). What has changed is that employment growth has been much more broadly spread across the distribution for each measure, and this has tended to mute some of the patterns previously observed. What were clearly polarising shifts by job-wage ranking are only very mildly polarised after 2013. The pattern has been one of upgrading in terms of job-education ranking, but again less sharply than before and with relatively fast growth in jobs in the second quintile. Finally, in terms of broader job quality, the pattern observed post-2013 is quite distinctive from that of the earlier period, with strong employment growth in the bottom quintile – the reverse of what had occurred previously.

In part, there has been some employment rebound in the types of jobs that contracted during the extended crisis period, for example the largely male jobs of drivers and mobile plant operators in warehousing were among the fastest-growing jobs (see Table 2). More generally, these types of jobs have not continued to incur the declines that took place during the crisis. In addition, many of the fastest-growing large-employing jobs have been in lower-level services. Jobs such as cleaners and helpers in services to buildings, and personal services workers and food preparation assistants in food and beverages have contributed much to employment growth during the recovery, but are ranked in the bottom quintile by most of the ranking measures.

Nonetheless, the one persistent and probably structural trend has been for 'good' jobs to grow faster than poorer-quality jobs – regardless of the measure used to assess the quality of the jobs.

Annex 4: Categorisation of the service sector

Table A3: Knowledge-based services aggregation: Breakdown by NACE Rev. 2 two-digit sector code

Private knowledge-intensive services	50 to 51 Water transport, Air transport
	58 Publishing activities
	59 to 63 Motion picture, video and television programme production, sound recording and music publishing activities, Programming and broadcasting activities, Telecommunications, Computer programming, consultancy and related activities, Information service activities
	64 to 66 Financial and insurance activities (section K)
	69 to 71 Legal and accounting activities, Activities of head offices; management consultancy activities, Architectural and engineering activities; technical testing and analysis
	72 Scientific research and development
	73 to 74 Advertising and market research, Other professional, scientific and technical activities
	75 Veterinary activities
	78 Employment activities
	80 Security and investigation activities
	90 to 93 Arts, entertainment and recreation (section R)
Public knowledge-intensive services	84 Public administration and defence, compulsory social security (section O)
	85 Education (section P)
	86 to 88 Human health and social work activities (section Q)
Less-knowledge-intensive services	45 to 47 Wholesale and retail trade; repair of motor vehicles and motorcycles (section G)
	49 Land transport and transport via pipelines
	52 Warehousing and support activities for transportation
	53 Postal and courier activities
	55 to 56 Accommodation and food service activities (Section I)
	68 Real estate activities
	77 Rental and leasing activities
	79 Travel agency, tour operator reservation service and related activities
	81 Services to buildings and landscape activities
	82 Office administrative, office support and other business support activities
	95 Repair of computers and personal and household goods
	94 Activities of membership organisations
	96 Other personal service activities
	97 to 99 Activities of households as employers of domestic personnel; Undifferentiated goods and services-producing activities of private households for own use (section T), Activities of extraterritorial organisations and bodies (section U)

Source: *Eurostat; Eurostat indicators on high-tech industry and knowledge-intensive services, available at http://ec.europa.eu/eurostat/cache/metadata/Annexes/htec_esms_an3.pdf*

Annex 5: Member State shares of employment in top 12 jobs

Table A4: Top 12 employing jobs at EU level by % of employment, 2016 Q2

Occupation	Sector	EU	AT	BE	BG	CY	CZ	DE	DK	EE	ES	FI	FR	EL	HR	HU
Sales workers	Retail trade	**5.4**	5.6	4.3	8.7	7.4	5.3	4.8	5.8	4.5	7.3	4.8	4.0	9.7	6.5	5.7
Teaching professionals	Education	**4.4**	4.5	5.6	3.7	6.1	4.2	3.2	5.4	4.9	5.2	4.3	4.3	6.7	5.1	4.3
Agricultural workers	Crop and animal production, etc.	**2.8**	3.8	0.5	3.5	1.9	0.8	0.7	1.3	1.0	1.6	2.7	2.3	11.2	4.9	2.2
Health professionals	Human health activities	**2.2**	1.3	3.4	2.2	2.5	2.1	2.0	3.3	1.4	2.8	1.3	1.8	2.3	1.4	0.7
Personal service workers	Food and beverage services	**2.0**	2.3	1.4	2.9	2.8	1.9	1.3	1.6	1.2	5.1	1.5	1.3	5.2	3.6	2.0
Drivers/mobile plant operators	Land transport etc	**1.8**	1.3	1.6	3.3	1.2	2.5	0.7	1.5	3.1	2.3	2.6	2.0	2.0	1.8	2.4
Building workers	Specialised construction	**1.8**	2.3	2.3	0.6	1.5	2.7	1.8	2.3	1.1	1.5	1.5	2.2	1.6	1.4	1.6
Health associate professionals	Human health activities	**1.7**	2.5	1.3	0.2	0.2	1.2	3.6	0.6	1.5	0.6	3.5	2.1	1.4	2.5	1.8
Business and administration associate professionals	Public administration	**1.4**	1.3	1.3	1.0	1.1	1.6	2.8	0.9	1.1	0.7	0.8	1.3	0.6	1.1	1.9
Building workers	Construction of buildings	**1.0**	0.7	1.0	2.0	1.8	0.8	0.5	0.2	2.7	1.2	1.8	0.2	0.8	1.1	1.3
Cleaners and helpers	Services to buildings	**1.0**	0.9	1.7	0.2	1.0	0.4	1.1	0.9	0.4	2.0	1.2	0.9	0.5	0.6	0.4
Personal service workers	Other personal service activities	**0.9**	1.2	0.9	0.7	1.9	0.9	0.9	0.4	0.8	1.2	0.7	0.8	0.8	1.3	1.1
Total share of employment in top 12 employing jobs		**26.4**	27.7	25.2	29.2	29.5	24.5	23.2	24.2	23.8	31.7	26.7	23.1	42.8	31.3	25.5

Occupation	Sector	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	UK
Sales workers	Retail trade	5.6	6.2	5.6	1.7	5.7	6.8	4.8	7.0	5.5	6.0	3.8	5.7	6.2	4.6
Teaching professionals	Education	4.4	5.0	5.4	6.1	5.0	4.9	4.1	4.5	4.9	3.1	6.6	6.2	4.1	4.5
Agricultural workers	Crop and animal production, etc.	4.3	2.0	4.9	0.6	2.2	0.8	1.2	8.5	1.8	19.2	0.9	2.9	0.6	0.4
Health professionals	Human health activities	3.3	1.3	2.8	2.2	1.2	2.2	2.4	2.4	2.3	1.6	3.4	2.1	0.8	3.3
Personal service workers	Food and beverage services	1.7	3.0	1.1	1.7	1.6	1.5	1.8	0.9	2.1	1.6	1.0	2.4	2.2	1.2
Drivers/mobile plant operators	Land transport etc	2.1	1.6	2.9	1.4	3.2	0.9	1.3	3.0	1.6	3.2	2.1	1.8	3.0	1.6
Building workers	Specialised construction	1.9	2.1	1.2	1.3	0.4	1.6	1.2	2.0	0.9	0.7	1.8	1.5	2.0	1.8
Health associate professionals	Human health activities	0.5	2.3	0.6	0.7	0.7	1.1	1.5	0.5	0.5	1.0	0.6	1.6	2.2	0.6
Business and administration associate professionals	Public administration	1.5	0.5	1.0	2.5	1.5	1.2	1.0	1.6	1.0	0.5	1.2	0.7	1.6	1.1
Building workers	Construction of buildings	0.8	1.4	1.9	0.8	2.5	1.1	0.8	1.5	2.0	3.3	1.0	0.3	1.8	0.9
Cleaners and helpers	Services to buildings	0.9	1.4	0.8	1.1	0.2	0.8	0.9	0.6	0.6	0.3	0.8	0.7	0.2	0.9
Personal service workers	Other personal service activities	1.3	1.2	0.9	0.9	1.2	1.0	0.9	0.7	1.2	0.6	0.5	0.7	0.7	0.9
Total share of employment in top 12 employing jobs		28.2	27.8	29.1	20.9	25.3	23.7	21.7	33.1	24.5	41.0	23.7	26.7	25.3	21.8

Annex 6: Occupations and the evolution of wage inequality over three decades

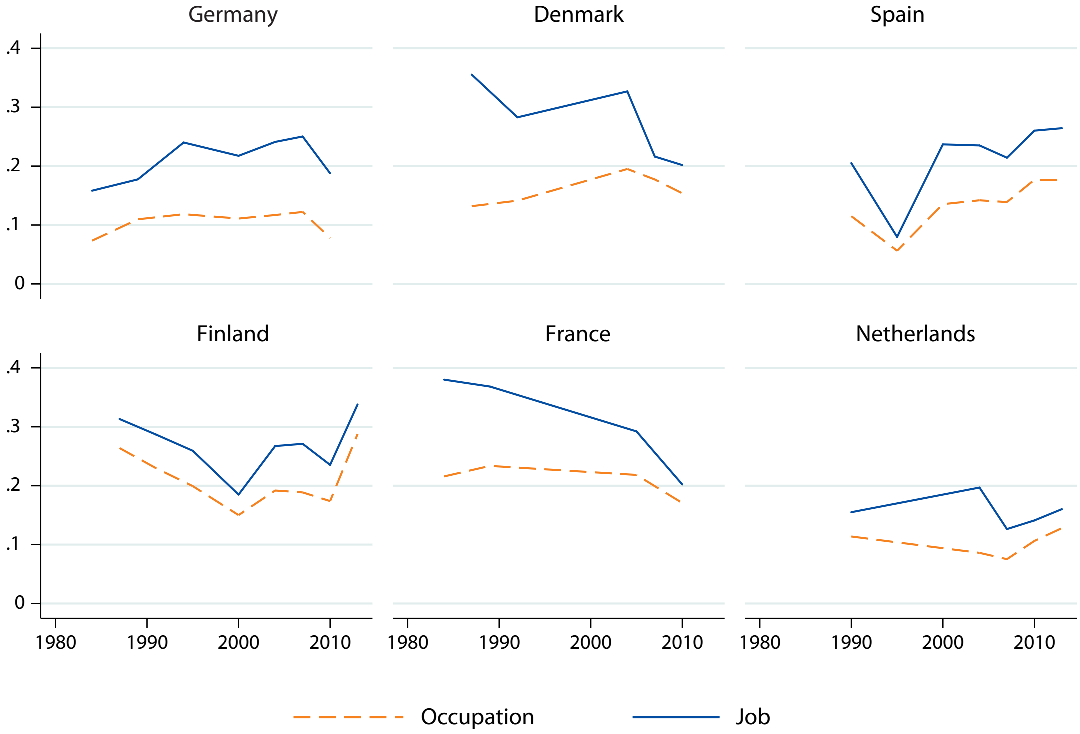
This annex includes a tentative analysis of changes in wage inequality across occupations and countries over the last three decades using the Luxembourg Income Study (LIS) database.[18] This database is the largest available database of harmonised income microdata collected by multiple countries over a period of decades. It provides household and person-level data on market and government income, demography, employment and expenditures from countries in Europe, North America, Latin America, Africa, Asia and Australia since 1965. Although the measures of wages and occupation in the LIS are problematic for the purposes of this analysis, even more so than EU-SILC, they can be used for an approximation of longer-term trends using the same methods presented in Part 2.[19] The variance decomposition approach previously used for the EU-SILC and SES datasets is reproduced here to evaluate whether the structuring role played by occupations in the distribution of wages changed in six European countries across the last two or three decades, according to the LIS database. The results are shown in Figures A3 and A4 for raw and logged wages for Denmark, Finland, France, Germany, the Netherlands and Spain from 1984 to 2013. As might be expected because of the higher level of aggregation of the occupation and sector variables used (one-digit level), the share of wage variance explained by occupations and sectors is around 10% lower in the LIS than in EU-SILC for the common period of analysis (2005–2013), between 30%–40% of the total.

The patterns for the last decade according to LIS are reasonably consistent with those previously discussed using EU-SILC. Both datasets show an increasing role of occupational wage differentials in structuring wage inequality in Finland, Germany (only when wages are logged) and Spain in the most recent period and a decline in the share of wage variance explained by occupations in Denmark and France. In the Netherlands, the trends seem to be inconsistent, with a high degree of volatility. But the most interesting aspect of Figures A3 and A4 is that they also show the previous trends. The increase in the role played by occupations in structuring wage inequality observed in Germany and Spain seems to extend to previous decades, too; the same happens with France in the opposite direction, with a clear long-term decrease. The only case in which the long-term trend seems at odds with the most recent period is Finland, where the long-term trend is one of decline, contrasting with the most recent period. The results for Denmark and the Netherlands seem problematic, for different reasons. In the case of the Netherlands, the high volatility suggests data problems, making it impossible to identify any clear trend. In the case of Denmark, there is surprising inconsistency between the lines for occupation only and the lines for the combination of occupation and sector (Job). Whereas occupation only accounts for a growing share of wage inequality over the period, the combination of occupation and sector shows a clear decline over time. This, which happens only in Denmark, implies that the effect of sector on wage inequality shrank very significantly over the period. Although it is theoretically possible, this effect seems implausibly large and may reflect problems in the classification of sector.

18 Further information about the LIS database is available at http://www.lisdatacenter.org/

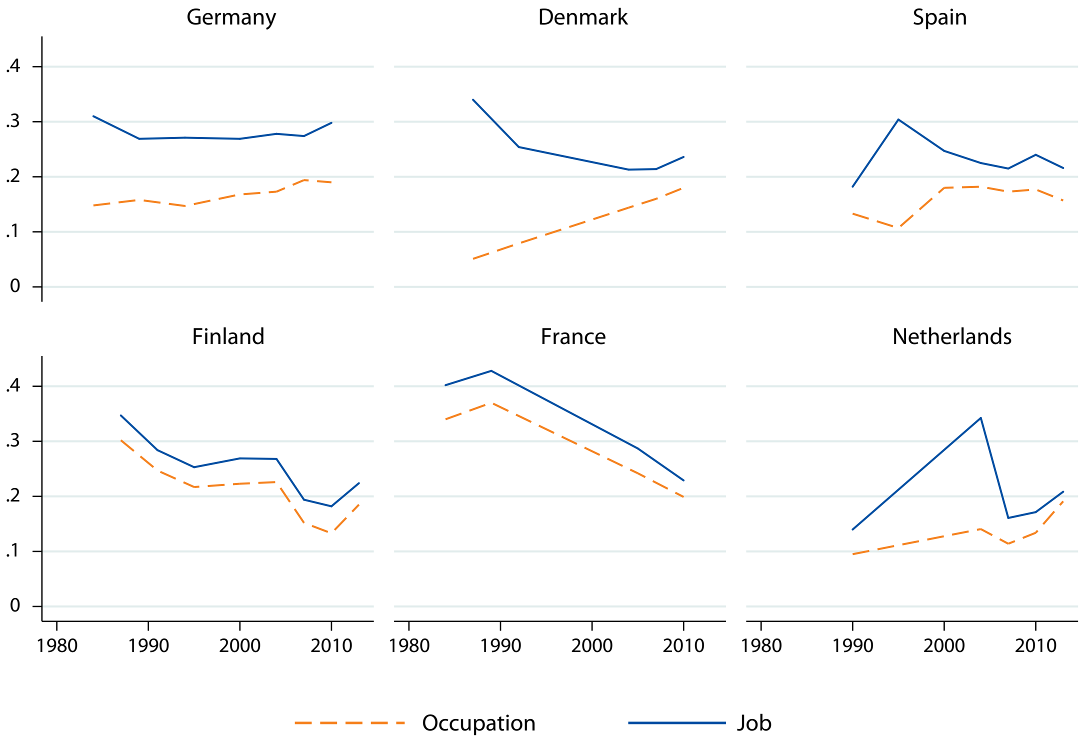
19 For the measure of wages, the LIS variable PILE (personal paid employment income) is used, which cannot be adjusted by hours of work because it has many missing values and countries. ISCO and NACE are both measured at the one-digit level. In some countries and years, there is a higher level of detail, but it is impossible to provide consistent trend analysis beyond one digit.

Figure A3: Share of variance explained by job and occupation, wages not logged, six Member States



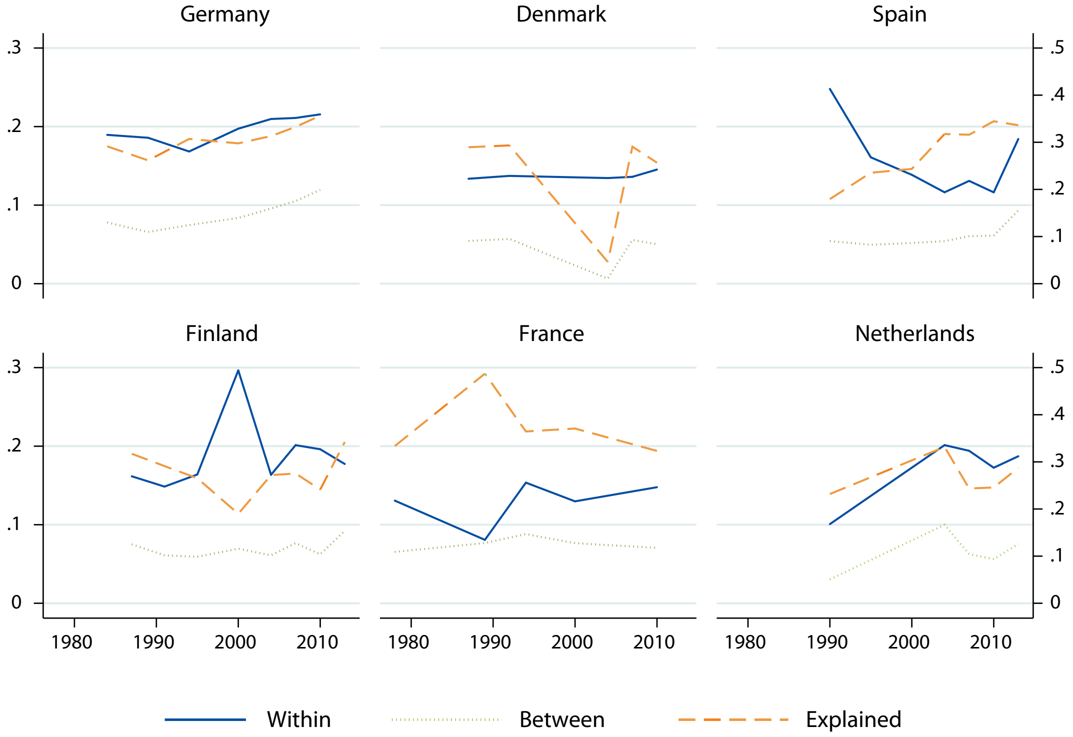
Source: *LIS database (authors' analysis)*

Figure A4: Share of variance explained by job and occupation, wages logged, six Member States



Source: *LIS database (authors' analysis)*

Figure A5: Theil decomposition of paid employment income by occupation, six Member States



Note: *The 'Explained' indicator is plotted on the right-hand axis.*
Source: *LIS database (authors' analysis)*

Figure A5 illustrates a Theil index decomposition approach. As with earlier in the report, the Theil index (itself an indicator of wage inequality) is broken down into a within and a between component, also displaying the share that the between component represents in the total Theil ('explained'). This 'explained Theil' indicator is comparable to the trends in the variance explained shown in Figures A3 and A4. As already discussed in the report, Figure A5 shows that the between-jobs component of wage inequality is much more stable than inequality within jobs. If between-jobs differentials were driving wage inequality developments, the between-component should be growing while the within-component should remain stable or decline. There are two cases where this happens more or less consistently over the period: Germany and Spain. In Spain, within-job wage inequality actually declines until 2010, whereas between-job inequality remains stable or even increases slightly. In Germany, although within-job and between-job inequality develop similarly, the latter grows faster than the former. Consequently, in both cases, according to this approximation using LIS data, occupational wages contributed positively to growing wage inequalities. In France, the exact opposite is observed after 1989, with declining between-job inequality and expanding within-job inequality (in the 1980s, occupational wage differentials also grew in France, according to this approach). In the three remaining countries, there are large shifts, suggesting data problems again, but overall the between-job component is more stable or runs in parallel to within-job inequalities, indicating that it did not play a significant role in overall developments.

Annex 7: Detailed examination of occupations and wage inequality in Spain

The analysis that follows endeavours to contrast the findings of this report with those obtained using a national-level register dataset from Spain, the Continuous Sample of Working Life (Muestra Continua de Vidas Laborales, MCVL). The MCVL is an administrative dataset built upon the computerised records of the Spanish Social Security, the Continuous Municipal Register and the tax data of the National Revenue Agency. Since 2004, this database has provided annual information on more than one million people who have had some kind of work relationship with the Social Security, regardless of the duration or the nature of the relationship (for further details about this dataset, see Arranz and García-Serrano, 2011 and 2014).

Table A5 presents a variance decomposition approach (of log daily wages in real terms, with base 2011) for Spain to explain wage inequality by differences between and within jobs during the last decade. This table is similar to Table 3 in Chapter 5 (constructed using the SES 2010 dataset). Column 1 contains the year, Column 2 contains the number of observations (individuals) available each year in this dataset, and Column 3 contains the number of jobs that corresponds to one-digit occupation level[20] combined with one-digit sector level (16 categories of NACE). The number of these jobs varies between 193 and 206 over the period 2005–2014. The percentage of variance of log daily wages explained by occupation only is in Column 4; by sector, in Column 5; by occupation and sector (not combined), in Column 6; and by jobs (the combination of occupation and sector), in Column 7.

Table A5 shows that, as already discussed in the report, occupation is a very important factor structuring wage inequality, more so than sector, accounting for 20%–30% of total wage inequality in the years shown. Second, although occupation is more important, crossing it with sector (generating the base classification of 'jobs') contributes significantly to the explanatory power of the classification. Between-jobs wage differentials account for 40%–45% of the total variance in log daily wages, increasing until 2011 and decreasing afterwards. The percentage of variance explained by jobs in wage inequality is 44% in 2010, very similar to the value of 40% estimated earlier using SES data for Spain. The small differences could be due to the measure used in the databases for wages: daily wages in the MCVL and wage per hour in the SES.

There is a very significant drop in the share of variance explained by jobs between 2011 and 2012, which is very probably a statistical artefact, a result of a change in the classification of occupations. Discounting such obvious discontinuity, the general trend is one of remarkable stability, especially if one considers how complex this period was in terms of labour market developments, first with very fast employment creation until 2008, then with a massive expansion of unemployment. These

Table A5: Impact of occupation on (logged) wage inequality

			% of variance of log daily wages explained by:				Human capital approach	
1. Year	2. No.of observations	3. No. of jobs	4. Occupation only	5. NACE only	6. Job category + NACE	7. Jobs	8.Variance explained by a model with education and tenure	9.Wages net of education and tenure, variance explained by jobs
2005	571,687	204	27.2	21.4	39.0	**40.7**	14.6	29.5
2006	594,780	206	26.8	20.0	37.9	**39.7**	15.1	27.9
2007	615,374	202	26.8	19.7	37.6	**39.4**	12.9	29.3
2008	617,846	200	27.4	21.2	38.8	**40.5**	15.0	27.8
2009	589,555	200	29.1	25.9	41.8	**43.5**	17.2	29.0
2010	576,550	198	29.7	27.1	42.8	**44.5**	18.0	29.1
2011	567,423	195	29.6	26.5	42.1	**43.8**	18.0	28.4
2012	519,144	197	21.5	10.6	28.5	**30.2**	15.9	18.0
2013	508,605	193	21.3	10.9	28.5	**30.2**	16.3	17.6
2014	516,092	194	20.9	10.6	28.0	**29.8**	16.4	17.1

Source: *MCVL, 2005–2014*

20 The occupational classification of MCVL is similar but not identical to ISCO at one-digit level. There are 10 categories: 1. Engineers and graduates; 2. Technical engineers and other skilled workers; 3. Chief and departmental heads; 4. Other semi-skilled workers; 5. Skilled clerks; 6. Auxiliary workers; 7. Semi-skilled clerks; 8. Skilled labourers; 9. Semi-skilled labourers; 10. Unskilled labourers.

results are roughly consistent (though with small differences in magnitudes) to those detected with the EU-SILC and LIS databases for Spain.

In a further analysis, the human capital approach (a hypothesis reviewed previously with SES data) was tested, and results are shown in Columns 8 and 9. First, Column 8 shows the share of the variance of log wages that can be explained by a model using education and tenure as predictors. This approach accounts for a significant amount of the total wage variance over the period, although it is far below the results for jobs (approximately two or three times lower). The variance decomposition analysis by job is repeated using a variable net of the effect of education and tenure[21] in Column 9. Although the share of variance explained decreases in all years, between-job differentials still account for a significant share of the wage inequality between wages net of differences in human capital (28%–29% in 2005–2011 and 17%–18% in 2012–2014). As discussed in Chapter 5, human capital differences explain part of the role played by occupations, but wage differentials cannot be reduced to differences in human capital.

21 The residuals from the predicted values of the model shown in Column 8 (as described in Chapter 5, Table 3 for the SES dataset).

TJ-AN-17-001-EN-N

In 2016, somewhat later than in other developed economies, the EU recovered all the net employment losses sustained since the global financial crisis. Employment growth since 2013 has been only modestly skewed towards well-paid jobs; growth has been robust in low-paid and mid-paid jobs too. Newer jobs are increasingly likely to be full time rather than part time. Part 1 of this sixth annual European Jobs Monitor report takes a detailed look at shifts in employment at Member State and EU levels from 2011 Q2 to 2016 Q2. Part 2 examines the role that occupations play in structuring European wage inequality. It finds that occupations have their own effect on wage inequality as well as mediating other factors such as human capital and social class. It also finds that occupational dynamics did not drive wage inequality developments in the last decade, a period of intense structural change in European labour markets.

The European Foundation for the Improvement of Living and Working Conditions (Eurofound) is a tripartite European Union Agency, whose role is to provide knowledge in the area of social, employment and work-related policies. Eurofound was established in 1975 by Council Regulation (EEC) No. 1365/75, to contribute to the planning and design of better living and working conditions in Europe.

Publications Office

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Dräger

GS01 (wireless)
Detection of flammable gases and vapors

The GS01 is a wireless infrared gas transmitter for continuous monitoring of flammable hydrocarbon gases and vapors in the oil and gas industry. The intrinsically safe and SIL-rated transmitter features completely wireless signal transmission and power supply. This makes the GS01 a flexible and cost efficient solution for plant expansions, upgrades, and new greenfield projects.

Infrared sensor with MEMS technology, ultrasound sensor to support the low-power operation

Radio antenna with a range of up to 500 m

D-2542-2018

Rugged stainless steel case with bracket for simple 2-bolt installation

Battery operating time up to 24 months

Benefits

Installations in demanding conditions

On offshore platforms or FPSOs, at tank farms and refineries - safety-related measuring points are everywhere in the oil and gas industry. Some of these measuring points are extremely difficult if not impossible to monitor using wired gas detection devices. The GS01 wireless transmitter requires no cable installation, either for signal transmission or for its power supply. As such, installation is easy and uncomplicated and the transmitter sends its signal to the access point up to 1640 feet away.

No cable conduits are required for the power supply or for signal transmission. Plus, the GS01-EA product variant with separate antenna can be installed inside the buildings where signal transmission is impossible due to shielding.

For temporary applications, such as maintenance work on petrochemical plants or exploratory drilling, the GS01 offers you maximum flexibility. It can be seamlessly integrated into your existing safety features. Even technically complex installations, such as on the rotating tower of an FPSO, can now be carried out without hassle.

Saving time and money throughout the project

The project costs with GS01 can be significantly lower than those for wired installations; as example the installation cost can be reduced up to 60 to 80%. Wireless communications and battery power decrease the need for cables, junction boxes, and control cabinets. Site installation work is significantly reduced with the ability to pre-configure all devices in advance. Additionally, planning, configuration and documentation of the system is minimised.
This is made possible by the intelligent design of the GS01. The transmitter draws less than 5 milliwatts of power. That means that depending on the ambient conditions, it can run for up to 2 years without the batteries needing to be replaced. The intrinsically safe design allows the battery pack to be replaced easily, even in the hazardous area.

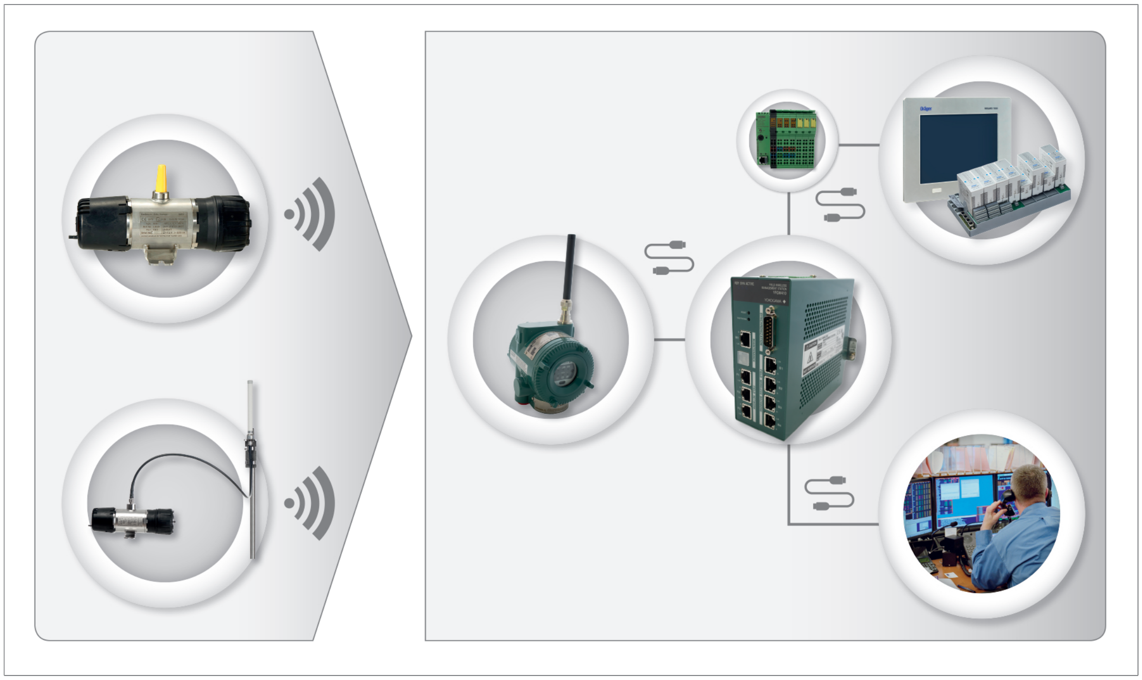
Saving time and money during operation

Infrared sensor technology is taken to the next level using patented MEMS (Micro Electromechanical System) optical filters. MEMS remains stable for a long period of time and eliminates the need for re-calibration, which directly reduces the maintenance costs. The infrared detection with MEMS operates at three different wavelength and includes heated optics to prevent condensation in the sensor.

Safe, wireless communication

The SIL2-capable GS01 uses the ISA100.11a wireless standard for wireless communication. A great benefit of this object-based standard is the possible embedding of foreign protocols, including the SIL3-certified safety protocol PROFIsafe. In combination with GasSecure's patented SafeWireless™ communication concept for fast and secure transfer of measurement data, this enables easy integration of the GS01 into safety instrumented systems (SIS) with a fully SIL2-capable signal chain. Furthermore, the open ISA100.11a standard supports easy integration of other field devices into the wireless network.

Presenting a GS01 System



The GS01 transmits its detection signal wirelessly to the access point. From there, the signal is transferred to the gateway. This feeds the control unit directly via Modbus or with the PROFINET® protocol. For analogue analyser units, a D/A converter can alternatively be used.

System Components

D-11979-2017

Yokogawa Access Point

The Yokogawa access point enables the user to access the wireless ISA100.11a network.

This product is manufactured by the company of Yokogawa.

System Components

D-11978-2017

Yokogawa Gateway

The Yokogawa gateway manages the wireless ISA100.11a network.

This product is manufactured by the company of Yokogawa.

D-6806-2016

Dräger REGARD® 7000

The Dräger REGARD® 7000 is a modular and highly expandable analysis tool. Suitable for gas warning systems with various levels of complexity and numbers of transmitters, the Dräger REGARD® 7000 is exceptionally reliable and efficient.

D-11980-2017

Phoenix Contact 4-20 mA Converter

The Phoenix Contact 4-20 mA converter is a digital-analogue converter for connecting to control units with conventional 4-20 mA input channels.

This product is manufactured by the company of Phoenix Contact.

Accessories

D-996-2016

External antenna

The external antenna allows the GS01-EA to be used even if radio transmission is restricted, e.g. by a Faraday cage.

D-11973-2017

Sun and weather shield

The sun and weather shield protects the GS01 from direct sunlight and adverse weather conditions.

Services

D-19072-2016

Dräger Service

When your operation's safety equipment is backed by over 125 years of experience and supported by the same team that engineered it, you can rely on service and rental solutions that are tailored to meet your unique needs. With Dräger's safety solutions, you get complete peace of mind, budget security, and full-service support that you can count on every step of the way. That's the Dräger Service Advantage.

Related Products

D-14983-2010

Dräger Polytron® 8700 IR

The Dräger Polytron® 8700 IR is an advanced explosion proof transmitter for the detection of combustible gases in the lower explosion limit (LEL). It uses a high performance infrared Dräger PIR 7000 sensor, which will quickly detect most common hydrocarbon gases. Besides a 3 wire 4 to 20 mA analogue output with relays, it also offers Modbus and Fieldbus making it compatible with most control systems.

D-4649-2019

Dräger Polytron® 6100 EC WL

The Dräger Polytron 6100 EC WL is a wireless transmitter for continuous monitoring of toxic gases and oxygen. The instrinsically safe and SIL2-rated transmitter features completely wireless signal transmission and power supply. The internal battery pack allows the transmitter to operate continually for up to 24 month. This makes the Polytron 6100 a flexible and cost efficient solution for plant expansions, upgrades, and new installations.

Technical Data

General	Measuring principle	Infrared single beam, triple wavelength	
	Detectable gases	ATEX / IECEx:	0 to 100 % LEL (Methane, Propane)
		FM:	0 to 100 % LEL (Methane)
			0 to 80 % LEL (Propane)
	Calibration	Factory-set, no field calibration	
Performance	Response time	≤5 seconds	
	Accuracy	±3 % LEL or ±10 % of measured value, each the higher value (refers to Methane)	
	Zero-point stability	±3 % LEL (lifelong)	
Electrical Data	Battery type	Lithium-Thionyl Chloride	
	Average power	5 mW	
	Battery lifetime	Up to 2 years (depending on the environmental conditions)	
	RF power	GS01: <12 dBm EIRP GS01-EA: <16 dBm EIRP	
Communication	Type	IEEE802.15.4 in 2.4 GHz ISM Band	
	Protocol	ISA100 Wireless™	
	Gateway output	Standard: Modbus TCP/RTU, OPC	
		Optional: PROFINET® (SIL2)	
Environmental Conditions	Operating temperature	-30 degrees C/-22 degrees F to + 55 degrees C/131 degrees F (if higher temperature ranges up to +65 °C are required please contact Dräger)	
	Storage temperature	-40 degrees C/ -40 degrees F to + 65 degrees C/149	
	Humidity	0 to 100 % RH	
	Protection Class	IP66 and IP67	
Housing	Dimensions	11.81" x 4.33" x 6.70"	
	Weight	6.17 lbs (incl. Battery)	
	Mounting	With bracket for 8 mm or 5/16" bolts	
Approvals	ATEX / IECEx	II 2G Ex ib IIC T4 Gb (-30 degrees C/-22 degrees F to + 55 degrees C/131 degrees F.)	
	FM	Class I, Zone 1 AEx ib IIC T4 Gb (-30 degrees C/-22 degrees F to + 55 degrees C/131 degrees F.)	
		Class I, Div 2 Group A, B, C, D (-30 degrees C/-22 degrees F to + 55 degrees C/131 degrees F.)	
	Performance Approval	Compliant with EN 60079-29-1	
	Safety Integrity Level	SIL2 IEC 61508, Ed.2.0	

PROFINET® is a registered trademark of PROFIBUS and PROFINET International (PI).

The ISA100 Wireless™ is a trademark of ISA100 Wireless Compliance Institute.

Ordering Information

GS01 wireless IR Gas Detector FM	AL20735
GS01-EA wireless IR Gas Detector-5m FM	AL20737

Ordering Information

GS01-EA wireless IR Gas Detector-10m FM	AL20738
GS01-EA wireless IR Gas Detector-20m FM	AL20739
GS01 Battery pack FM (without cells)	AL20713
GS01 Battery cell type SL-2780/S	AL20706
GS01 Battery cover	AL20708
GS01 Weather cap	AL20709
GS01 Serial adapter	AL20710
GS01 Sunshade / weather protection	AL20711

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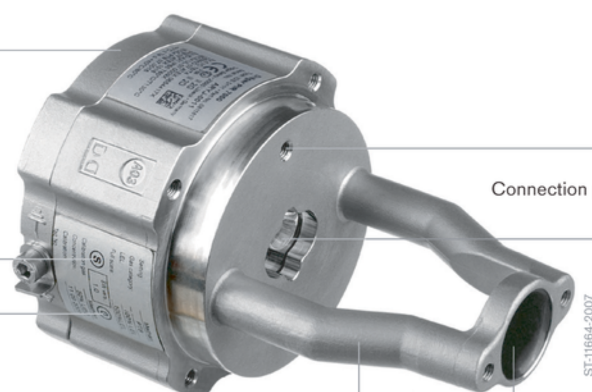
Dräger PIR® 7000
Flammable Gas Detection Transmitter

Constant monitoring of flammable gases and vapors is essential for a safe workplace. The Dräger PIR® 7000 is an explosion-proof point gas detection transmitter that uses infrared (IR) technology to continuously monitor flammable gases and vapors. With its stainless steel SS 316L enclosure and drift-free optics, this detector is built for the harshest industrial environments, including offshore installations.



Dräger. Technology for Life®

Benefits

Accurately detects a wide range of flammable substances

Two models of the Dräger PIR 7000 are available—type 334 and type 340. Each model works with a different measuring wavelength, thus detecting the broadest possible range of flammable substances with superior accuracy.

Advanced signal stability

Following the success of the most stable point infrared gas detector worldwide—the Dräger Polytron IR—Dräger has introduced the PIR 7000, which encompasses the latest in revolutionary technology.

Based on patented innovations, the Dräger PIR 7000 combines a maximum light collecting construction with a 4-beam signal stabilizing system. The total optical system uses no light beam split, simply a set of various reflectors. This double-compensating optical system is very resistant to accumulation of dirt on the optical surface, as well as known influences such as dust, fog and insects, which are frequently found in the measuring cuvette. Due to its non-imaging construction, the measuring signal is not affected by a partial beam block.

This innovative optical system ensures that the Dräger PIR 7000 fulfills the customer requirements of no false alarms, longer service intervals, and a drift-free signal output.

Early detection enables fast response

For optimal safety, it is essential to be informed about a potential hazard as early as possible. A reliable gas monitor that detects leakages at the earliest stage allows you to initiate safety measures on site.

To support fast response, the Dräger PIR 7000 offers a configurable response mode that lets you choose between “normal” or “high speed” response, subject to the application. By using the “high speed” option, and combining it with the lowest feasible alarm threshold, the Dräger PIR 7000 shortens the reaction time in case of an alarm. Leakages can be detected at the earliest stage of their existence.

Multiple configuration capabilities

The Dräger PIR 7000 has a maximum number of default settings, but remains fully flexible to meet your needs on an application-by-application basis—whether you want to reduce measuring ranges, configure special signals (fault, beam block warning, maintenance), or adjust LEL values that are different across regions, all coupled with the configurable gas library (for other substances to be monitored). All these features of the Dräger PIR 7000 enable you to set up every device exactly to your specific needs and preferences.

Standards-based design ensures high safety and reliability—SIL 2 certified

Almost two decades of experience with infrared technology has enabled Dräger to continuously enhance product quality. With the Dräger PIR 7000, the entire product—hardware and software—has been developed according to the Functional Safety standard EN 61508.

Benefits

The International Electrotechnical Commission's (IEC) standard IEC 61508 defines Safety Integrity Level (SIL) using requirements grouped into two broad categories: hardware safety integrity and systematic safety integrity. A device or system must meet the requirements for both categories to achieve a given SIL.

The Drager PIR 7000 not only fulfills but exceeds SIL 2 requirements.

Additional advantages

- Configurable gas library—methane, propane and ethylene fixed, up to 10 additional substances can be uploaded
- Multiple mounting and configuration capabilities (signals acc. to NAMUR NE 43)
- Precise and stable measurement
- Response of less than 1 second
- Beam block warning in case of dirty optics for preventive maintenance
- Long maintenance intervals
- Extended temperature range of up to +77°C/+170°F
- Double-compensating, non-imaging optics (using 4-beam technology)
- Single cable multidrop capability using HART® communication
- Conventional 4 to 20 mA analog signal output
- Hermetically sealed SS 316L enclosure
- Integrated tag holder for individual labelling
- No moving parts
- Resistant to shock and vibration up to 4 G
- Continuous self-testing in the context of the IEC/EN 61508 standard
- Developed and manufactured according to the SIL guidelines, SIL 2 certified by TÜV
- Ex approvals for worldwide application: ATEX, IECEx, UL, CSA
- Dust approval for zones 21 and 22
- Typical lifetime greater than 15 years

System Components

D-6806-2016

Dräger REGARD® 7000

When you need to monitor and analyze a number of various gases and vapors, the Dräger REGARD® 7000 is a modular and highly expandable analysis tool. Suitable for gas warning systems with various levels of complexity and numbers of transmitters, the Dräger REGARD® 7000 is exceptionally reliable and efficient. An additional benefit is the system's backward compatibility with legacy REGARD® controllers.

D-27777-2009

Dräger REGARD® 3900

The Dräger REGARD® 3900 is a standalone control system for the detection of toxic gases, oxygen levels, and Ex hazards. The control system is fully configurable between 1 and 16 channels, depending upon the type and quantity of input/output boards installed.

ST-335-2004

Dräger REGARD®-1

The Dräger REGARD®-1 is a standalone single-channel control system for the detection of toxic and Ex hazards and oxygen levels. The control system is fully configurable for a single input from either a 4 to 20 mA transmitter or a Dräger Polytron® SE Ex measuring head.

Accessories

ST-11673-2007

Mounting Set

This set lets you mount the transmitter on flat or curved surfaces, is vibration-resistant up to 4 G, and swings 90° in any direction.

Part number: 68 11 648

ST-5732-2006

Duct Mount Kit

This set lets you mount the transmitter directly in the pipes, remaining air-tight even under positive pressure. Optional accessory parts are available for functional checks and remote calibration.

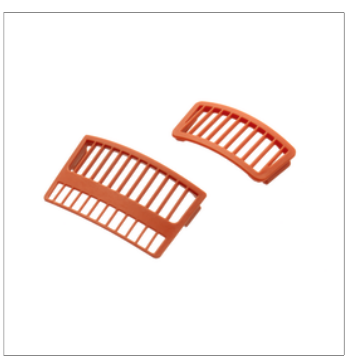
Part number: 68 11 850

ST-11679-2007

Splash Guard

This unit protects the measuring cuvette against dirt and dust, provides quick gas exchange through a “chimney effect”, and has reflective fluorescent strips.

Part number: 68 11 911



ST-11706-2007

Insect Guard

This UV-resistant guard protects against spiders or other insects that might block the gas inlet or outlet apertures of the splash guard.

Part number: 68 11 609

Accessories

ST-11689-2007

Hydrophobic Filter

This filter protects the measuring cuvette against dirt and dust, and can be combined with other accessory parts.

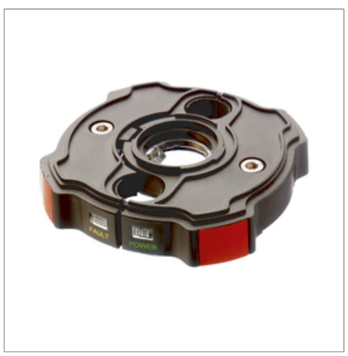
Part number: 68 11 890

ST-11681-2007

Calibration Adapter

Mountable with one hand, this adapter lets you calibrate a transmitter (with mounted splash guard), up to a wind force of 55 mph.

Part number: 68 11 610



ST-11695-2007

Status Indicator

The status indicator permanently displays the measuring mode or disruption with a green or yellow light signal, and can be combined with other accessory parts.

Part number: 68 11 625

ST-11695-2007

Flow Cell

Suitable for process applications, this flow cells lets you perform function tests and calibrations of the transmitter in high wind forces and/or high test gas concentrations, and includes a status display.

Part number: 68 11 490

Accessories


ST-5679-2006

Remote Test Adapter

This adapter lets you perform function tests and calibrations of the transmitter remotely with the usual test gas concentrations, and includes a status display.

Part number: 68 11 630


ST-11687-2007

Process Adapter

Constructed of conductible POM, this adapter is designed for sampling and process applications, and provides fast response due to minimum inner volume.

Part number: 68 11 915


D-16965-2014

Process Cuvette SGR

Designed for sampling or process applications, this stainless steel unit provides fast response due to a minimum inner volume.

Part number: 68 13 219

ST-5673-2006

Magnetic Wand

This device enables simple and fast calibration (zero-point and sensitivity) of the transmitter, providing feedback through status lights.

Part number: 45 43 428

Accessories

D-34526-2009

Dräger Polysoft

Dräger Polysoft is configuration and calibration software for the following stationary gas detection systems: Dräger PIR 7000, Dräger PIR 7200, Dräger Polytron® 8000, and includes status and diagnostic functions.

Part number: 83 23 405

Services

D-19072-2016

Dräger Service

When your operation's safety equipment is backed by over 125 years of experience and supported by the same team that engineered it, you can rely on service and rental solutions that are tailored to meet your unique needs. With Dräger's safety solutions, you get complete peace of mind, budget security, and full-service support that you can count on every step of the way. That's the Dräger Service Advantage.

Related Products

ST-11660-2007

Dräger PIR 7200

When looking for a carbon dioxide monitor you can trust, consider the Drager PIR 7200. This explosion-proof point gas detection transmitter uses the latest infrared (IR) technology to provide early detection of toxic gas. Designed for a wide variety of industrial environments, the transmitter offers drift-free optics. Due to its robust design and engineering, the PIR 7200 can be operated in harsh industrial environments.

ST-743-2006

Dräger Polytron® IR

The Dräger Polytron® IR is an explosion-proof infrared gas detector for continuous monitoring of combustible gases and vapors. With its stainless steel body and drift-free optics, this gas detector is built for harsh offshore environments.

ST-3932-2005

Dräger Polytron® Pulsar 2

The Dräger Polytron® Pulsar 2 represents the latest infrared technology in open path gas detection. Equipped with all the same functions as the standard Dräger Pulsar, Dräger Pulsar 2 is fitted with an ABS molded cover and comes with either a junction box or certified connector to provide installation flexibility.

Technical Data

Dräger PIR 7000		
Type	Explosion-proof gas detection transmitter with infrared sensor technology	
Principle of operation	Temperature-compensated infrared absorption, 4-beam technology	
Gases and ranges	Methane, propane, ethylene	0 to 20...100 %LEL
	Methane	0 to 100 % vol.
	Further substances and measuring ranges on request	
Measuring performance (type 334, methane, 0 to 100 %LEL)	Digital resolution	0.5 %LEL
	Repeatability	≤ ±1 %LEL
	Response time $t_{0...90}$	≤ 4 seconds (“normal response”)
		< 1 second (“fast response”)
	Long-term drift	≤ ± 1 %LEL after 12 months
Electrical data	Output signals	4 to 20 mA, HART®
	Fault signal	≤ 1.2 mA (configurable)
	Beam block warning signal	2 mA (configurable)
	Maintenance signal	3 mA (configurable)
	Power supply	13 to 30 V DC, 3-wire
	Power consumption	5.6 W (typical)
Ambient conditions	Temperature	-40 to +77 °C/-40 to +170 °F (operating)
		-40 to + 85 °C/-40 to +180 °F (storage)
	Humidity	0 to 100 %RH
	Pressure	700 to 1,300 hPa/23.6 to 32.5 inch Hg
Enclosure	Material	Stainless steel SS 316L
	Connecting thread	M25 or 3/4" NPT
	Weight	2.2 kg (without accessories)
	Dimensions	160 mm x Ø 89 mm / 6.3" x Ø 3.5"
	Ingress protection	IP66 and IP67, NEMA 4X
Approvals	ATEX	II 2G Ex d(e) IIC T6/T4
		II 2D Ex tD A21 IP65 T80 °C/T130 °C
	IECEx	Ex d IIC T6/T4
		Ex tD A21 IP65 T80 °C/T130 °C
	UL (Classified)	Class I, Div. 1, Groups A, B, C, D
		Class II, Div. 1, Groups E, F, G
	CSA (C-US)	Class I, Div. 1, Groups B, C, D
		Class II, Div. 1, Groups E, F, G
	Safety Integrity Level	SIL2 certified by TÜV (EN 61508, EN 50402)
	CE mark: electromagnetic compatibility (directive 89/336/EEC)	

Ordering Information

Dräger PIR 7000	
Dräger PIR 7000 type 334 (NPT) HART®	68 11 552
Dräger PIR 7000 type 334 (M25) HART®	68 11 550
Dräger PIR 7000 type 334 (M25) HART®, complete set	68 11 817
Dräger PIR 7000 type 340 (NPT) HART®	68 11 562

Ordering Information

Dräger PIR 7000 type 340 (M25) HART®	68 11 560
Dräger PIR 7000 type 340 (M25) HART®, complete set	68 11 819

The complete set contains an Ex e junction box, splash guard, status indicator and mounting set, already pre-assembled.

Accessories	
Mounting Set	68 11 648
Duct Mount Set	68 11 850
Splash Guard	68 11 911
Insect Guard	68 11 609
Hydrophobic Filter	68 11 890
Calibration Adapter	68 11 610
Status Indicator	68 11 625
Flow Cell	68 11 490
Bump Test Adapter	68 11 630
Process Adapter	68 11 915
Process Cuvette	68 11 415
Magnetic Wand	45 43 428
USB PC Adapter	68 11 663

Polytron and REGARD are trademarks of Dräger.
HART® is a registered trademark of the HART® Communication Foundation.

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Dräger PointGard 2700
Detection of flammable gases and vapors

The Dräger PointGard 2700 is a self-contained gas detection system for the continuous area monitoring of flammable hydrocarbon gases and vapors in ambient air. PointGard 2700's rugged, water-resistant housing comes complete with a horn and strobes, a built-in power supply, and external relays. It is compatible with a remotely mounted Dräger PIR 7000 Type 334 or Type 340 infrared gas sensor.

D-0982-2020.tif

Dräger. Technology for Life®

Benefits

Uses the high performance Dräger PIR 7000 infrared sensor

With its stainless steel 316L enclosure and drift free optics, the Dräger PIR 7000 is built for the harshest industrial environments such as offshore installations. The unique 4 beam signal stabilizing system makes the sensor resistant to dust or dirt deposits on the optical surfaces. Environmental and ageing effects are largely compensated ensuring long term, drift free operation. The integrated gas library with more than 70 gases provides a high degree of application flexibility. Each of the gases listed there can be picked from the menu and automatically cross-calibrated with a standard calibration gas such as methane or propane.

Waterproof stainless steel IR sensor

Thanks to its innovative splash guard and waterproof enclosure, the PIR 7000 sensor is ready for extreme conditions such as areas with daily high-pressure wash-downs and extreme temperature and humidity levels. It is available with an aluminum or 316L stainless steel junction box.

Flexible communications

PointGard can accommodate additional external alarm devices through its three built-in relays. In addition, a 4–20 mA signal with HART® output allows integration into a larger gas detection system.

Rugged and compact housing

PointGard's glass fiber reinforced polyester housing is water and dust resistant with a 4X/IP66 rating. Its compact size allows it to easily fit most applications. Built-in cable glands make it easy to install.

Advanced display with diagnostics

The large, illuminated backlit graphic display shows status information clearly and in a format that's easy to use. The measured gas concentration, selected gas type, and measuring unit are displayed during normal operation. Colored LEDs (green, yellow, and red) provide additional alarm and status information. Advanced diagnostics log events and gas readings, which can be displayed and a graph created on the display.

Monitor remote areas up to 30 meters (98 feet) away

The Dräger PIR 7000 sensor is designed to be installed in Zone 1 classified hazardous areas remotely from the PointGard 2700 with a four-conductor shielded cable up to 30 meters (98 feet) long. The cable and Dräger PIR 7000 sensor must be ordered separately from the PointGard 2700.

Accessories

D-0985-2020

Remote sensor Dräger PIR 7000 (NPT) complete set

The Drager PIR 7000 can be placed up to 30 meters (98 feet) from the PointGard 2700. The Ex d type of protection allows operation in hazardous areas (see approvals). Please note that the shielded four-wire cable is not included.

Related Products

D-7353-2016

Dräger PointGard 2100

The Dräger PointGard 2100 series is a self-contained gas detection system for the continuous area monitoring of toxic gases in ambient air. PointGard 2100's rugged, water-resistant housing comes complete with a horn and strobes, a built-in power supply, and reliable DrägerSensor®.

D-11949-2016

Dräger PointGard 2200

The Dräger PointGard 2200 series is a self-contained gas detection system for the continuous area monitoring of flammable gases and vapors in ambient air. PointGard 2200's rugged, water-resistant housing comes complete with a horn and strobes, a built-in power supply, and reliable DrägerSensor®.

Technical Data

Dräger PointGard 2700 IR		Hydrocarbons in the ambient air	
Type		Self-contained gas monitor with alarm devices for general-purpose applications	
Gases and measuring ranges		Methane, propane, ethylene	0 – 20...100 % LEL
		Methane	0 – 100 Vol.- %
		Other substances and measuring ranges on request	
Display and controls	LCD display	Graphic LC-Display 75 mm/3 inch with backlight	
		Red or green backlight selectable, alphanumeric	
	Indicator	3 status LEDs (green/yellow/red), 85 dB - 100 dB adj. piezo horn	
	Operation	Through three front mounted push buttons	
	Security	Separate passwords for maintenance and configuration menu	
	Functions	Event and data logger with a capacity of up to 35,000 records	
		Warning and error messages displayed in plain text	
		Passwordless bump-test mode inhibits alarms	
		Automatic calibration mode for zero and span	
Electrical data	Signal output analog	Normal operation	4–20 mA
		Maintenance	Constant 3.4 mA or 4 mA ±1 mA 1 Hz modulation (adjustable)
		Fault	<1.2 mA
	Power supply AC version	Operating voltage	100–240 VAC 50–60 Hz
		Nominal power	12 W
		Operating current (max)	0.5 A
		Inrush current	Max. 40 A at 230 VAC 50 Hz
	Power supply DC version	Operating voltage	8–30 VDC
		Nominal power	12 W
		Operating current (max)	2.5 A
	Electrical certification	CE rating, IEC/EN 61010-1	
		Complies with UL 61010-1	
		Class B device, residential use compliant with ICES-3(B)/ NMB-3(B)	
	Relay specification	2 alarm relays and 1 fault relay	
		SPDT contact 5 A @ 230 VAC, 5 A @ 30 VDC, resistance bound	
		Alarm reset through front-mounted push button	
	Alarm devices	Variants with amber and red LED strobes activate on 2 alarm levels independently	
		Variants with green steady light activate red strobe on 1 common alarm level. Green steady light turns off during alarm or fault condition; optional blue LED strobe	
		85-105 dB adjustable-volume buzzer with continuous and pulsating tone	
Environmental conditions (see Dräger PIR 7000 data sheet)		Temperature (storage)	-20 to +65 °C/-4 to +149 °F
		Temperature (operation)	-20 to +50 °C/-4 to +122 °F
		Humidity	0 to 95% r. h., noncondensing
		Pressure	20.7 to 38.4" Hg/700 to 1,300 hPa
Housing		Material	Glass fiber reinforced polyester (GFRP)
		Mounting	Wall mount with internal screws or optional SS mounting brackets
		Housing protection type	IP66 (pending); indoor or outdoor use
		Housing certification	UL 508A/50/50E; CSA C22.2 94.1/94.2/14–13
		Cable entry point	3 cable glands, 1/2" NPT

Technical Data

	Size (L x W x D)	10 x 11 x 4.7" (255 x 280 x 120 mm)
	Weight	5 lbs (2.3 kg)

Ordering Information

Dräger PointGard 2700 IR (Order Dräger PIR 7000 sensor separately)	
Dräger PointGard 2700/2720 IR AC Remote	37 06 858
Dräger PointGard 2700/2720 IR DC Remote	37 06 859
Dräger PointGard 2700/2720 IR AC Remote w/ green light	37 06 860

Dräger PointGard 2700 IR compatible Sensors	
Dräger PIR 7000 Type 334 (NPT) HART®, complete Set (Stainless Steel)	68 13 035
Dräger PIR 7000 Type 340 (NPT) HART®, complete Set (Stainless Steel)	68 13 045
Dräger PIR 7000 Type 334 (NPT) HART®, complete Set (Aluminum)	68 13 030
Dräger PIR 7000 Type 340 (NPT) HART®, complete Set (Aluminum)	68 13 040
The complete set includes the Ex d junction box, the splash guard, and the status indicator, already pre-assembled.	

Dräger PointGard 2000 Series Common Accessories	
Mounting Bracket Set (not included in Dräger PointGard)	83 26 497
IR Connection Kit for PC configuration and upgrades	45 44 197
LED status light green w/ interface cable	83 26 489
LED strobe light, blue	83 26 472
AC Power Cable USA	83 26 451
HART® is a registered trademark of the HART Communication Foundation.	

Notes

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Dräger Polytron® 5200 CAT
Detection of flammable gases and vapors

The Dräger Polytron® 5200 CAT is a cost effective explosion proof transmitter for the detection of flammable gases in the lower explosion limit (LEL). It uses a catalytic bead DrägerSensor® Ex ... DD, which will detect most flammable gases and vapors. A 3 wire 4 to 20 mA analog output with relays makes it compatible with most control systems.

Benefits

Fast and stable – the DrägerSensor Ex ... DD

The latest generation type DD gas sensor is based on the proven catalytic bead principle. Innovative dual active elements result in good long-term zero stability. Dräger has raised the bar yet again for poison resistance. The resulting long service life provides low ownership costs. Measuring performance has also been improved. The innovative gas inlet allows the sensor to respond to gas within a matter of seconds.

Same design, same operating principle

Polytron 5200 belongs to the Dräger Polytron 5000 series. All transmitters in this series have the same design and user interface. This allows for uniform operation with reduced training and maintenance requirements.

The backlit display shows status information clearly with quick access to functions using a non-intrusive magnetic wand. The gas concentration and measurement unit are displayed during normal operation. Colored LEDs (green, yellow and red) provide additional alarm and status information.

Three relays for controlling external equipment

Upon request, the Dräger Polytron 5200 can also be supplied with three integrated relays. This enables you to use it as an independent gas detection system with two arbitrarily adjustable concentration alarms and one fault alarm. Audio alarms, signal lights, or similar devices can thus be controlled locally without an additional cable between the transmitter and central controller.

Safe, robust housing for every application

Polytron 5200 features a Class I, Div. 1 rated explosion proof enclosure made from aluminum or stainless steel, making it suitable for a wide range of environmental conditions. A protection type “e” version includes a convenient docking station which allows installation in hazardous atmospheres without running conduit (where approved).

Make the impossible possible with the remote sensor

An available remote sensor condulet housing allows the sensor to be installed up to 30 meters (100 feet) away from the Polytron transmitter. The sensor splash guard with integrated tubing nipple permits one person to perform a full calibration of a remote mounted sensor from the transmitter.

System Components

D-27777-2009

Dräger REGARD® 3900

The Dräger REGARD® 3900 is a standalone control system for the detection of toxic gases, oxygen levels, and Ex hazards. The control system is fully configurable between 1 and 16 channels, depending upon the type and quantity of input/output boards installed.

ST-335-2004

Dräger REGARD®-1

The Dräger REGARD®-1 is a standalone single-channel control system for the detection of toxic and Ex hazards and oxygen levels. The control system is fully configurable for a single input from either a 4 to 20 mA transmitter or a Dräger Polytron® SE Ex measuring head.

Accessories

D-85369-2013

Splash guard

The Splash guard protects the sensor against splash water and dirt.

Accessories

D-85345-2013

Duct mount kit

The duct mount kit enables gas monitoring inside ventilation ducts while keeping the transmitter outside.

D-85363-2013

Magnetic Wand

The magnetic wand is used to access and navigate the menu on the Polytron explosion proof detectors.

D-85362-2013

Pipe Mount Kit

The pipe mount kit is used to mount the Polytron explosion proof transmitters on pipes if there is no room to mount them elsewhere or if the pipes are going to be the source of gas leaks.

Technical Data

Dräger Polytron® 5200 CAT			
Type	Explosion proof / flameproof enclosed transmitter (“d”) or combined with increased safety (“d/e”)		
Gases	flammable gases and vapors		
Measuring ranges	DD	0 to 100% LEL	
	LC	0 to 10% LEL	
Display	Backlit graphic LCD; 3 Status LEDs (green/yellow/red)		
Electrical data	Signal output analog	Normal operation	4 to 20 mA
		Maintenance	Constant 3.4 mA or 4 mA ±1 mA 1 Hz modulation; (adjustable)
		Fault	< 1.2 mA
	Power supply	10 to 30 V DC, 3-wire	
	Power consumption (max.)	w/o relay, non-remote	95 mA at 24 V
		w/ relay, remote	145 mA at 24 V
	Relay specification (option)	2 alarm relays and 1 fault relay, single-pole two-way contact 5 A @ 230 VAC, 5 A @ 30 VDC, resistance-bound	
Environmental conditions (see sensor data sheet)	Temperature	-40 to 80°C (-40 to 176°F) without relay -40 to 70°C (-40 to 158°F) with relay	
	Pressure	20.7 to 38.4 inch Hg / 700 to 1,300 mbar	
	Humidity	0 to 100% r. h., non-condensing	
Housing	Transmitter housing	Epoxy coated copper-free aluminum or stainless steel SS316 L	
	Sensor housing	Stainless steel 303	
	Enclosure protection type	NEMA 4X & 7, IP65/66/67	
	Cable entry point	3/4" NPT threaded holes or M20 cable gland	
	Dimensions (H x W x D), approx.	w/o docking station	11.0" x 5.9" x 5.1" / 280 x 150 x 130 mm
		w/ docking station	11.0" x 7.1" x 7.5" / 280 x 180 x 190 mm
	Weight, approx.	w/o docking station Aluminum	4.9 lbs / 2.2 kg
		w/o docking station SS316 L	8.8 lbs / 4.0 kg
		w/ docking station Aluminum	7.7 lbs / 3.5 kg
		w/ docking station SS316 L	11.9 lbs / 5.4 kg
Approvals*	UL	Class I, Div 1, Groups A, B, C, D; Class II, Div 1, Groups E, F, G; Class I, Zone 1, Group IIC; T-Code T6/T4	
	CSA	Class I, Div 1, Groups A, B, C, D; Class I, Zone 1, Group IIC; T-Code T6/T4 CSA C22.2 No. 152	
	IECEx	Ex db IIC T6/T4 Gb, -40 ≤ Ta ≤ +40/+80°C; ‘d’ version Ex db e IIC T6/T4 Gb, -40 ≤ Ta ≤ +40/+80°C; ‘e’ version Ex tb IIIC T80/130°C Db	
	ATEX	II 2G Ex db IIC T6/T4 Gb, -40 ≤ Ta ≤ +40/+80°C; ‘d’ version II 2G Ex db e IIC T6/T4 Gb, -40 ≤ Ta ≤ +40/+80°C; ‘e’ version II 2D Ex tb IIIC T80/130 °C Db	
	CE markings	ATEX (Directive 2014/34/EU) Electromagnetic Compatibility (Directive 2014/30/EU) Low Voltage (Directive 2014/35/EU)	
	Performance approval (for DD sensor only)	BVS 15 ATEX G 001 X	

* All docking station versions are only ATEX/IECEx approved

Ordering Information

Dräger Polytron® 5200 CAT

Dräger Polytron® 5200 CAT DD d A	83 44 150
Dräger Polytron® 5200 CAT DD d A relay	83 44 151
Dräger Polytron® 5200 CAT DD e A (incl. Docking Station)	83 44 154
Dräger Polytron® 5200 CAT DD e A relay (incl. Docking Station)	83 44 155
Dräger Polytron® 5200 CAT DD d S	83 44 152
Dräger Polytron® 5xx0 Kit (Custom configuration e. g. stainless steel housing)	83 44 500

Accessories

Magnetic wand		45 44 101
Pipe mount bracket		45 44 198
Duct mount kit		68 12 725
IR Connection Kit Polytron® 5000/8000		45 44 197
PolySoft		83 23 405
PolySoft premium		83 23 411
Splash guard		68 12 510
Gassing adapder	PE incl. tubing	45 09 314
Calibration adapter Viton®		68 10 536
Process adapter (Stainless steel) for DD		68 12 470
Prozess adapter (Stainless steel) for LC		68 12 465

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90 41 423 | 17.04-3 | HQ | PP | Subject to modifications

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Locate your Regional Sales Representative at: www.draeger.com/contact

Dräger Polytron® 5700 IR
Detection of flammable gases and vapors

The Dräger Polytron® 5700 IR is a cost effective explosion proof transmitter for the detection of flammable gases in the lower explosion limit (LEL). It uses a high performance infrared Dräger PIR 7000 sensor, which will quickly detect most common hydrocarbon gases. A 3 wire 4 to 20 mA analog output with relays makes it compatible with most control systems.

Benefits

Efficient, stable and robust – the Dräger PIR 7000

With its stainless steel 316L enclosure and drift free optics, the Dräger PIR 7000 is built for the harshest industrial environments such as offshore installations. The unique 4 beam signal stabilizing system makes the sensor resistant to dust or dirt deposits on the optical surfaces. Environmental and aging effects are compensated ensuring long term, drift free operation. The integrated gas library with up to 100 gases provides a high degree of application flexibility. Each of the gases listed there can be picked from the menu and automatically cross-calibrated with a standard calibration gas such as methane or propane. No need to consult the factory when applications change.

Same design, same operating principle

Polytron 5700 belongs to the Dräger Polytron 5000 series. All transmitters in this series have the same design and user interface. This allows for uniform operation with reduced training and maintenance requirements.

The backlit display shows status information clearly with quick access to functions using a non-intrusive magnetic wand. The gas concentration and measurement unit are displayed during normal operation. Colored LEDs (green, yellow and red) provide additional alarm and status information.

Three relays for controlling external equipment

Upon request, the Dräger Polytron 5700 can also be supplied with three integrated relays. This enables you to use it as an independent gas detection system with two arbitrarily adjustable concentration alarms and one fault alarm. Audio alarms, signal lights, or similar devices can thus be controlled locally without an additional cable between the transmitter and central controller.

Safe, robust housing for every application

Polytron 5700 features a Class I, Div. 1 rated explosion proof enclosure made from aluminum or stainless steel, making it suitable for a wide range of environmental conditions. A protection type “e” version includes a convenient docking station which allows installation in hazardous atmospheres without running conduit (where approved).

Make the impossible possible with the remote sensor

An available remote sensor condulet housing allows the PIR sensor to be installed up to 30 meters (100 feet) away from the Polytron transmitter. A special calibration flow cell accessory permits one person to perform a full calibration of a remote mounted sensor from the transmitter.

System Components

D-27777-2009

Dräger REGARD® 3900

The Dräger REGARD® 3900 is a standalone control system for the detection of toxic gases, oxygen levels, and Ex hazards. The control system is fully configurable between 1 and 16 channels, depending upon the type and quantity of input/output boards installed.

ST-335-2004

Dräger REGARD®-1

The Dräger REGARD®-1 is a standalone single-channel control system for the detection of toxic and Ex hazards and oxygen levels. The control system is fully configurable for a single input from either a 4 to 20 mA transmitter or a Dräger Polytron® SE Ex measuring head.

Accessories

ST-11679-2007

Splash guard

The Splash guard protects the sensor against splash water and dirt.

Accessories

D-85345-2013

Duct mount kit

The duct mount kit enables gas monitoring inside ventilation ducts while keeping the transmitter outside.

D-85363-2013

Magnetic Wand

The magnetic wand is used to access and navigate the menu on the Polytron explosion proof detectors.

Technical Data

Dräger Polytron® 5700 IR

Type	Explosion proof / flameproof enclosed transmitter (“d”) or combined with increased safety (“d/e”)		
Gases	flammable gases and vapors		
Measuring ranges	Methane, propane, ethylene		0 to 20 ... 100 % LEL
	Methane		0 to 100 vol. %
	Further substances and measuring ranges upon request		
Display	Backlit graphic LCD; 3 Status LEDs (green/yellow/red)		
Electrical data	Signal output analog	Normal operation	4 to 20 mA
		Maintenance	Constant 3.4 mA or 4 mA ±1 mA 1 Hz modulation; (adjustable)
		Fault	< 1.2 mA
	Power supply	10 to 30 V DC, 3-wire	
	Power consumption (max.)	w/o relay, non-remote	300 mA at 24 V
		w/ relay, remote	350 mA at 24 V
	Relay specification (option)	2 alarm relays and 1 fault relay, single-pole two-way contact 5 A @ 230 VAC, 5 A @ 30 VDC, resistance-bound	
Environmental conditions (see sensor data sheet)	Temperature	-40 to 77°C (-40 to 170°F) without relay -40 to 70°C (-40 to 158°F) with relay	
	Pressure	20.7 to 38.4 inch Hg / 700 to 1,300 mbar	
	Humidity	0 to 100 % r. h., non-condensing	
Housing	Transmitter housing	Epoxy coated copper-free aluminum or stainless steel SS316 L	
	Sensor housing	Stainless steel SS316 L	
	Enclosure protection type	NEMA 4X & 7, IP65/66/67	
	Cable entry point	3/4" NPT threaded holes or M20 cable gland	
	Dimensions (H x W x D), approx.	w/o docking station	11.0" x 5.9" x 5.1" / 280 x 150 x 130 mm
		w/ docking station	11.0" x 7.1" x 7.5" / 280 x 180 x 190 mm
	Weight, approx.	w/o docking station Aluminum	8.6 lbs / 3.9 kg
		w/o docking station SS316 L	12.6lbs / 5.7 kg
		w/ docking station Aluminum	11.5 lbs / 5.2 kg
		w/ docking station SS316 L	15.7 lbs / 7.1 kg
Approvals*	UL	Class I, Div 1, Groups B, C, D; Class II, Div 1, Groups E, F, G; Class I, Zone 1, Group IIC; T-Code T6/T4	
	CSA	Class I, Div 1, Groups B, C, D; Class II, Div 1, Groups E, F, G; Class I, Zone 1, Group IIC; T-Code T6/T4 CSA C22.2 No. 152	
	IECEx	Ex db IIC T6/T4 Gb, -40 ≤ Ta ≤ +40/+80°C; “d’ version Ex db e IIC T6/T4 Gb, -40 ≤ Ta ≤ +40/+80°C; ‘“e” version Ex tb IIIC T80/130°C Db	
	ATEX	II 2G Ex db IIC T6/T4 Gb, -40 ≤ Ta ≤ +40/+80°C; “d’ version II 2G Ex db e IIC T6/T4 Gb, -40 ≤ Ta ≤ +40/+80°C; “e” version II 2D Ex tb IIIC T80/130°C Db	
	CE markings	ATEX (Directive 2014/34/EU) Electromagnetic Compatibility (Directive 2014/30/EU) Low Voltage (Directive 2014/35/EU)	

Technical Data

	Performance approval	BVS 15 ATEX G 001 X
* All docking station versions are only ATEX/IECEx approved		

Ordering Information

Dräger Polytron® 5700 IR	
Dräger Polytron® 5700 IR 334 d A	83 44 220
Dräger Polytron® 5700 IR 334 d A relay	83 44 221
Dräger Polytron® 5700 IR 334 e A (incl. Docking Station)	83 44 224
Dräger Polytron® 5700 IR 334 e A relay (incl. Docking Station)	83 44 225
Dräger Polytron® 5700 IR 340 d A	83 44 240
Dräger Polytron® 5700 IR 340 d A relay	83 44 241
Dräger Polytron® 5700 IR 340 e A (incl. Docking Station)	83 44 244
Dräger Polytron® 5700 IR 340 e A relay (incl. Docking Station)	83 44 245
Dräger Polytron® 5700 IR 334 d S	83 44 222
Dräger Polytron® 5xx0 Kit (Custom configuration e. g. stainless steel housing)	83 44 500

Accessories	
Magnetic wand	45 44 101
Pipe mount bracket	45 44 198
Duct mount kit	68 12 300
Duct mount kit Flow Cell for PIR 7x00	68 11 945
Duct mount kit Bump Test Adapter for PIR 7x00	68 11 990
Status indicator for PIR 7000	68 11 625
Splash guard for PIR 7000	68 11 911
Flow Cell for PIR 7000	83 23 405
Bump Test Adapter for PIR 7000	68 11 630
Insect guard for PIR 7x00	68 11 609
Hydrophobic filter for PIR 7x00	68 11 890
Calibration adapter for PIR 7x00	68 11 610
Process adapter for PIR 7x00, POM (Polyoxymethylene)	68 11 915
Process adapter for PIR 7x00, stainless steel	68 11 415
Aluminum junction box for remote sensor ‘d’	45 44 099
Stainless steel junction box for remote sensor ‘d’	45 44 098
Spacer	68 12 617
Dräger PIR 7000 334 for remote sensor ‘e’ variant	68 11 825
Dräger PIR 7000 340 for remote sensor ‘e’ variant	68 11 819

Notes

Notes

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Locate your Regional Sales Representative at: www.draeger.com/contact

Dräger Polytron® 8200 CAT
Detection of flammable gases and vapors

The Dräger Polytron® 8200 CAT is an advanced explosion proof transmitter for the detection of flammable gases in the lower explosion limit (LEL). It uses a catalytic bead DrägerSensor® Ex ... DD, which will detect most flammable gases and vapors. Besides a 3 wire 4 to 20 mA analog output with relays, it also offers Modbus and Fieldbus protocols making it compatible with most control systems.

Benefits

Fast and stable – the DrägerSensor® Ex … DD

The latest generation type DD gas sensor is based on the proven catalytic bead principle. Innovative dual active elements result in very good long-term zero stability. Dräger has raised the bar yet again for poison resistance. The resulting long service life provides you with low ownership costs. Measuring performance has also been improved. The innovative gas inlet allows the sensor to respond to gas within a matter of seconds.

Easy device management via digital communication

The Dräger Polytron 8200 is equiped with digital interfaces allowing for quick and easy remote interrogation of the transmitter's state. Integration with existing asset management systems such as PACTware™ is possible via DTM.

In addition to the common HART® communication system, the fieldbus interfaces PROFIBUS® PA, FOUNDATION fieldbus™ H1, and Modbus RTU are also available.

Same design, same operating principle

The Dräger Polytron 8200 belongs to the Polytron 8000 series. All transmitters in this series have the same design and user interface. This allows for uniform operation with reduced training and maintenance requirements.

The large graphic backlit display shows status information clearly and in an easy to use format. The measured gas concentration, selected gas type, and measuring unit are displayed during normal operation. Colored LEDs (green, yellow and red) provide additional alarm and status information.

The Polytron 8200 is operated by means of a magnetic wand over contact surfaces.

Three relays for controlling external equipment

Upon request, the Dräger Polytron 8200 can also be supplied with three integrated relays. This enables you to use it as an independent gas detection system with two arbitrarily adjustable concentration alarms and one fault alarm. Audio alarms, signal lights, or similar devices can thus be controlled locally without an additional cable between the transmitter and central controller.

Safe, robust housing for every application

Polytron 8200 features a Class I, Div. 1 rated explosion proof enclosure made from aluminum or stainless steel, making it suitable for a wide range of environmental conditions. A protection type "e" version includes a convenient docking station which allows installation in hazardous atmospheres without running conduit (where approved).

Benefits

Make the impossible possible with the remote sensor

An available remote sensor condulet housing allows the sensor to be installed up to 30 meters (100 feet) away from the Polytron transmitter. The sensor splash guard with integrated tubing nipple permits one person to perform a full calibration of a remote mounted sensor from the transmitter.

Data logger

The Polytron 8200 has a data logger, which records measuring and event data from prior years.

System Components

D-27777-2009

Dräger REGARD® 3900

The Dräger REGARD® 3900 is a standalone control system for the detection of toxic gases, oxygen levels, and Ex hazards. The control system is fully configurable between 1 and 16 channels, depending upon the type and quantity of input/output boards installed.

ST-335-2004

Dräger REGARD®-1

The Dräger REGARD®-1 is a standalone single-channel control system for the detection of toxic and Ex hazards and oxygen levels. The control system is fully configurable for a single input from either a 4 to 20 mA transmitter or a Dräger Polytron® SE Ex measuring head.

Accessories

D-85369-2013

Splash guard

The Splash guard protects the sensor against splash water and dirt.

D-85345-2013

Duct mount kit

The duct mount kit enables gas monitoring inside ventilation ducts while keeping the transmitter outside.

D-85363-2013

Magnetic Wand

The magnetic wand is used to access and navigate the menu on the Polytron explosion proof detectors.

D-85362-2013

Pipe Mount Kit

The pipe mount kit is used to mount the Polytron explosion proof transmitters on pipes if there is no room to mount them elsewhere or if the pipes are going to be the source of gas leaks.

Technical Data

Dräger Polytron® 8200 CAT

Type	Explosion proof / flameproof enclosed transmitter (“d”) or combined with increased safety (“d/e”)		
Gases	Flammable gases and vapors		
Measuring ranges	DD	0 to 100% LEL	
	LC	0 to 10% LEL	
Display	Backlit graphic LCD; 3 Status LEDs (green/yellow/red)		
Electrical data	Signal output analog	Normal operation	4 to 20 mA
		Maintenance	Constant 3.4 mA or 4 mA ±1 mA 1 Hz modulation; (adjustable)
		Fault	< 1.2 mA
	Signal output digital	HART®, PROFIBUS® PA, FOUNDATION fieldbus™ H1 and Modbus RTU	
	Power supply	10 to 30 V DC, 3-wire	
	Power consumption (max.)	DrägerSensor® Ex ... DD, w/o relay, non-remote	105 mA at 24 V
		DrägerSensor® Ex ... DD, w/ relay, remote	145 mA at 24 V
		DrägerSensor® Ex LC, w/o relay, non-remote	130 mA at 24 V
		DrägerSensor® Ex LC, w/ relay, remote	165 mA at 24 V
	Relay specification (option)	2 alarm relays and 1 fault relay, single-pole two-way contact 5 A @ 230 VAC, 5 A @ 30 VDC, resistance-bound	
Environmental conditions (see sensor data sheet)	Temperature	-40 to 80°C (-40 to 176°F) without relay -40 to 70°C (-40 to 158°F) with relay	
	Pressure	20.7 to 38.4 inch Hg / 700 to 1,300 mbar	
	Humidity	0 to 100% r. h., non-condensing	
Housing	Transmitter housing	Epoxy coated copper-free aluminum or stainless steel SS316 L	
	Sensor housing	Stainless steel 303	
	Enclosure protection type	NEMA 4X & 7, IP65/66/67	
	Cable entry point	3/4" NPT threaded holes or M20 cable gland	
	Dimensions (H x W x D), approx.	w/o docking station	11.0" x 5.9" x 5.1" / 280 x 150 x 130 mm
		w/ docking station	11.0" x 7.1" x 7.5" / 280 x 180 x 190 mm
	Weight, approx.	w/o docking station Aluminum	4.9 lbs / 2.2 kg
		w/o docking station SS316 L	8.8 lbs / 4.0 kg
		w/ docking station Aluminum	7.7 lbs / 3.5 kg
		w/ docking station SS316 L	11.9 lbs / 5.4 kg

Approvals*

UL		Class I, Div 1, Groups A, B, C, D; Class II, Div 1, Groups E, F, G; Class I, Zone 1, Group IIC; T-Code T6/T4
CSA		Class I, Div 1, Groups A, B, C, D; Class I, Zone 1, Group IIC; T-Code T6/T4 CSA C22.2 No. 152
IECEx	4-20-mA HART®	Ex db IIC T6/T4 Gb, -40 ≤ Ta ≤ +40/+80°C; “d” version

Technical Data

		Ex db e IIC T6/T4 Gb, -40 ≤ Ta ≤ +40/+80°C; “e” version; Ex tb IIIC T80/130°C Db
	PROFIBUS® & FF	Ex db ia IIC T6/T4 Gb, -40 ≤ Ta ≤ +40/+80°C; “d” version Ex db e ia IIC T6/T4 Gb, -40 ≤ Ta ≤ +40/+80°C; “e” version; Ex tb IIIC T80/130°C Db
ATEX	4-20-mA HART®	II 2G Ex db IIC T6/T4 Gb, -40 ≤ Ta ≤ +40/+80°C; “d” version II 2G Ex db e IIC T6/T4 Gb, -40 ≤ Ta ≤ +40/+80°C; “e” version II 2D Ex tb IIIC T80/130°C Db
	PROFIBUS® & FF	II 2G Ex db ia IIC T6/T4 Gb, -40 ≤ Ta ≤ +40/+80°C; “d” version II 2G Ex db e ia IIC T6/T4 Gb, -40 ≤ Ta ≤ +40/+80°C; “e” version II 2D Ex tb IIIC T80/130°C Db
CE markings		ATEX (Directive 2014/34/EU) Electromagnetic Compatibility (Directive 2014/30/EU) Low Voltage (Directive 2014/35/EU)
Shipping approvals (for DD sensor only)		DNV GL, ABS
MED approval B (for DD sensor only)		Certificate no. 61549/ 50 – 13 HH
MED approval D (for DD sensor only)		Certificate no. 12031 – 10 HH
Performance approval (for DD sensor only)		Certificate no. BVS 13 ATEX G 001 X
SIL 2 certified by TUEV Sued		Certificate no. Z10 1207 53474 013
* All docking station versions are only ATEX/IECEx approved		

Ordering Information

Dräger Polytron® 8200 CAT	
Dräger Polytron® 8200 CAT DD d A 4-20/HART®	83 44 439
Dräger Polytron® 8200 CAT DD d A 4-20/HART® relay	83 44 440
Dräger Polytron® 8200 CAT DD e A 4-20/HART® (incl. Docking Station)	83 44 457
Dräger Polytron® 8200 CAT DD e A 4-20/HART® relay (incl. Docking Station)	83 44 458
Dräger Polytron® 8200 CAT DD d S 4-20/HART® Relay	83 44 449
Dräger Polytron® 8xx0 Kit (Custom configuration e. g. stainless steel housing)	83 44 800

Accessories	
Magnetic wand	45 44 101
Pipe mount bracket	45 44 198
Duct mount kit	68 12 725
IR Connection Kit Polytron® 5000/8000	45 44 197
PolySoft	83 23 405
PolySoft premium	83 23 411
Splash guard	68 12 510

Ordering Information

Gassing adapder	PE incl. tubing	45 09 314
Calibration adapter Viton®		68 10 536
Process adapter (Stainless steel) for DD		68 12 470
Prozess adapter (Stainless steel) for LC		68 12 465

HART® is a registered trademark of the HART Communication Foundation.
FOUNDATION fieldbus™ is a registered trademark of the Fieldbus Foundation™.
PROFIBUS® is a registered trademark of PROFIBUS and PROFINET International (PI).
PACTware™ is a registered trademark of Pepperl+Fuchs GmbH.
Viton® is a registered trademark of the DuPont company.

Notes

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Dräger Polytron® 8700 IR
Detection of flammable gases and vapors

The Dräger Polytron® 8700 IR is an advanced explosion proof transmitter for the detection of combustible gases in the lower explosion limit (LEL). It uses a high performance infrared Dräger PIR 7000 sensor, which will quickly detect most common hydrocarbon gases. Besides a 3 wire 4 to 20 mA analog output with relays, it also offers Modbus and Fieldbus making it compatible with most control systems.

Benefits

Efficient, stable and robust—the Dräger PIR 7000

With its stainless steel 316L enclosure and drift free optics, the Dräger PIR 7000 is built for the harshest industrial environments such as offshore installations. The unique 4 beam signal stabilizing system makes the sensor resistant to dust or dirt deposits on the optical surfaces. Environmental and aging effects are compensated ensuring long term, drift free operation. The integrated gas library with up to 100 gases provides a high degree of application flexibility. Each of the gases listed there can be picked from the menu and automatically cross-calibrated with a standard calibration gas such as methane or propane. No need to consult the factory when applications change.

Easy device management via digital communication

The Dräger Polytron 8700 is equipped with digital interfaces allowing for quick and easy remote interrogation of the transmitter's state. Integration with existing asset management systems such as PactWare is possible via DTM.

In addition to the common HART® communication system, the fieldbus interfaces PROFIBUS PA, FOUNDATION Fieldbus H1, and Modbus RTU are also available.

Same design, same operating principle

The Dräger Polytron 8700 belongs to the Polytron 8000 series. All transmitters in this series have the same design and user interface. This allows for uniform operation with reduced training and maintenance requirements.

The large graphic backlit display shows status information clearly and in an easy to use format. The measured gas concentration, selected gas type, and measuring unit are displayed during normal operation. Colored LEDs (green, yellow and red) provide additional alarm and status information.

The Polytron 8700 is operated by means of a magnetic wand over contact surfaces.

Three relays for controlling external equipment

Upon request, the Dräger Polytron 8700 can also be supplied with three integrated relays. This enables you to use it as an independent gas detection system with two arbitrarily adjustable concentration alarms and one fault alarm. Audio alarms, signal lights, or similar devices can thus be controlled locally without an additional cable between the transmitter and central controller.

Safe, robust housing for every application

Polytron 8700 features a Class I, Div. 1 rated explosion proof enclosure made from aluminum or stainless steel, making it suitable for a wide range of environmental conditions. A protection type "e" version includes a

Benefits

convenient docking station which allows installation in hazardous atmospheres without running conduit (where approved).

Make the impossible possible with the remote sensor

An available remote sensor condulet housing allows the PIR sensor to be installed up to 30 meters (100 feet) away from the Polytron transmitter. A special calibration flow cell accessory permits one person to perform a full calibration of a remote mounted sensor from the transmitter.

Data logger

The Polytron 8700 has a data logger, which records measuring and event data from the past years.

System Components

D-27777-2009

Dräger REGARD® 3900

The Dräger REGARD® 3900 is a standalone control system for the detection of toxic gases, oxygen levels, and Ex hazards. The control system is fully configurable between 1 and 16 channels, depending upon the type and quantity of input/output boards installed.

System Components


ST-335-2004

Dräger REGARD®-1

The Dräger REGARD®-1 is a standalone single-channel control system for the detection of toxic and Ex hazards and oxygen levels. The control system is fully configurable for a single input from either a 4 to 20 mA transmitter or a Dräger Polytron® SE Ex measuring head.

Accessories


ST-11679-2007

Splash guard

The Splash guard protects the sensor against splash water and dirt.


D-85345-2013

Duct mount kit

The duct mount kit enables gas monitoring inside ventilation ducts while keeping the transmitter outside.

Accessories

D-85363-2013

Magnetic Wand

The magnetic wand is used to access and navigate the menu on the Polytron explosion proof detectors.

Technical Data

Dräger Polytron® 8700 IR

Type	Explosion proof / flameproof enclosed transmitter (“d”) or combined with increased safety (“d/e”)		
Gases	Flammable gases and vapors		
Measuring ranges	Methane, propane, ethylene		0 to 20 ... 100% LEL
	Methane		0 to 100 vol. %
	Further substances and measuring ranges upon request		
Display	Backlit graphic LCD; 3 Status LEDs (green/yellow/red)		
Electrical data	Signal output analog	Normal operation	4 to 20 mA
		Maintenance	Constant 3.4 mA or 4 mA ±1 mA 1 Hz modulation; (adjustable)
		Fault	< 1.2 mA
	Signal output digital	HART®, PROFIBUS® PA, FOUNDATION fieldbus™ H1 and Modbus RTU	
	Power supply	10 to 30 V DC, 3-wire	
	Power consumption (max.)	w/o relay, non-remote	330 mA at 24 V
		w/ relay, remote	350 mA at 24 V
	Relay specification (option)	2 alarm relays and 1 fault relay, single-pole two-way contact 5 A @ 230 VAC, 5 A @ 30 VDC, resistance-bound	
Environmental conditions (see sensor data sheet)	Temperature	-40 to 77°C (-40 to 170°F) without relay -40 to 70°C (-40 to 158°F) with relay	
	Pressure	20.7 to 38.4 inch Hg / 700 to 1,300 mbar	
	Humidity	0 to 100% r. h., non-condensing	
Housing	Transmitter housing	Epoxy coated copper-free aluminum or stainless steel SS316 L	
	Sensor housing	Stainless steel SS316 L	
	Enclosure protection type	NEMA 4X & 7, IP65/66/67	
	Cable entry point	3/4" NPT threaded holes or M20 cable gland	
	Dimensions (H x W x D), approx.	w/o docking station	11.0" x 5.9" x 5.1" / 280 x 150 x 130 mm
		w/ docking station	11.0" x 7.1" x 7.5" / 280 x 180 x 190 mm
	Weight, approx.	w/o docking station Aluminum	8.6 lbs / 3.9 kg
		w/o docking station SS316 L	12.6lbs / 5.7 kg
		w/ docking station Aluminum	11.5 lbs / 5.2 kg
		w/ docking station SS316 L	15.7 lbs / 7.1 kg

Approvals*

UL		Class I, Div 1, Groups B, C, D; Class II, Div 1, Groups E, F, G; Class I, Zone 1, Group IIC; T-Code T6/T4
CSA		Class I, Div 1, Groups B, C, D; Class II, Div 1, Groups E, F, G; Class I, Zone 1, Group IIC; T-Code T6/T4 CSA C22.2 No. 152
IECEx	4-20-mA HART®	Ex db IIC T6/T4 Gb, -40 ≤ Ta ≤ +40/+80°C; “d” version Ex db e IIC T6/T4 Gb, -40 ≤ Ta ≤ +40/+80°C; “e” version; Ex tb IIIC T80/130°C Db

Technical Data

	PROFIBUS® & FF	Ex db ia IIC T6/T4 Gb, -40 ≤ Ta ≤ +40/+80°C; “d” version Ex db e ia IIC T6/T4 Gb, -40 ≤ Ta ≤ +40/+80°C; “e” version; Ex tb IIIC T80/130°C Db
ATEX	4-20-mA HART®	II 2G Ex db IIC T6/T4 Gb, -40 ≤ Ta ≤ +40/+80°C; “d” version II 2G Ex db e [ia] IIC T6/T4 Gb, -40 ≤ Ta ≤ +40/+80°C; “e” version II 2D Ex tb IIIC T80/130°C Db
	PROFIBUS® & FF	II 2G Ex db ia IIC T6/T4 Gb, -40 ≤ Ta ≤ +40/+80°C; “d” version II 2G Ex db e ia [ia] IIC T6/T4 Gb, -40 ≤ Ta ≤ +40/+80°C; “e” version II 2D Ex tb IIIC T80/130°C Db
CE markings		ATEX (Directive 2014/34/EU) Electromagnetic Compatibility (Directive 2014/30/EU) Low Voltage (Directive 2014/35/EU)
Shipping approvals		DNV GL, ABS
MED approval B		Certificate no. 61549/ 50 – 13 HH
MED approval D		Certificate no. 12031 – 10 HH
Performance approval		Certificate no. BVS 13 ATEX G 001 X
SIL 2 certified by TUEV Sued		Certificate no. Z10 1207 53474 013
* All docking station versions are only ATEX/IECEx approved		

Ordering Information

Dräger Polytron® 8700 IR	
Dräger Polytron® 8700 IR 334 d A 4-20/HART®	83 44 601
Dräger Polytron® 8700 IR 334 d A 4-20/HART® relay	83 44 602
Dräger Polytron® 8700 IR 334 e A 4-20/HART® (incl. Docking Station)	83 44 619
Dräger Polytron® 8700 IR 334 e A 4-20/HART® relay (incl. Docking Station)	83 44 620
Dräger Polytron® 8700 IR 340 d A 4-20/HART®	83 44 637
Dräger Polytron® 8700 IR 340 d A 4-20/HART® relay	83 44 638
Dräger Polytron® 8700 IR 340 e A 4-20/HART® (incl. Docking Station)	83 44 655
Dräger Polytron® 8700 IR 340 e A 4-20/HART® relay (incl. Docking Station)	83 44 656
Dräger Polytron® 8700 IR 334 d S 4-20/HART®	83 44 610
Dräger Polytron® 8700 IR 334 d S 4-20/HART Relay	83 44 611
Dräger Polytron® 8xx0 Kit (Custom configuration e. g. stainless steel housing)	83 44 800

Accessories	
Magnetic wand	45 44 101
Pipe mount bracket	45 44 198
Duct mount kit	68 12 300

Ordering Information

Duct mount kit Flow Cell for PIR 7x00	68 11 945
Duct mount kit Bump Test Adapter for PIR 7x00	68 11 990
Status indicator for PIR 7000	68 11 625
Splash guard for PIR 7000	68 11 911
Flow Cell for PIR 7000	83 23 405
Bump Test Adapter for PIR 7000	68 11 630
Insect guard for PIR 7x00	68 11 609
Hydrophobic filter for PIR 7x00	68 11 890
Calibration adapter for PIR 7x00	68 11 610
Process adapter for PIR 7x00, POM (Polyoxymethylene)	68 11 915
Process adapter for PIR 7x00, stainless steel	68 11 415
Aluminum junction box for remote sensor ‘d’	45 44 099
Stainless steel junction box for remote sensor ‘d’	45 44 098
Spacer	68 12 617
Dräger PIR 7000 334 for remote sensor ‘e’ variant	68 11 825
Dräger PIR 7000 340 for remote sensor ‘e’ variant	68 11 819

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PROFIBUS® is a registered trademark of PROFIBUS and PROFINET International (PI).
PACTware™ is a registered trademark of Pepperl+Fuchs GmbH.

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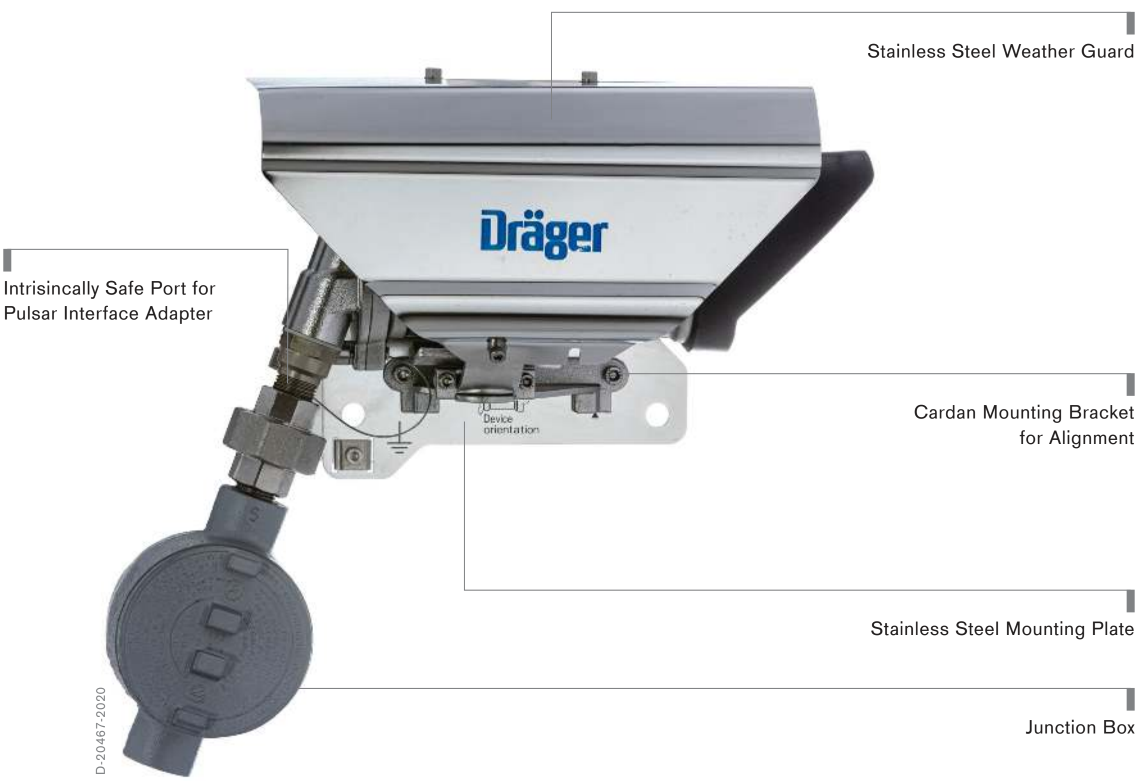
Dräger Pulsar 7000 Series
Detection of flammable gases and vapors

The Dräger Pulsar 7000 Series are stationary open path gas detectors. They detect explosive hydrocarbons in gases. The robust design and the extremely rapid response of the sensor make the Dräger Pulsar 7000 Series a dependable solution for your requirements in the oil and gas industry, as well as the chemical industry.



Benefits

Reliable and quick measuring

The Pulsar 7000 Series detects a wide range of gaseous hydrocarbons. These include methane, propane and ethylene. An accumulation of these gases in critical concentration can be measured at a distance of up to 200 metres within two seconds. To do this, the system enters a specific mode with increased frequency. Status LEDs in the transmitter and receiver indicate the operational readiness of the respective device even over a greater distance. The continuous self-monitoring of the Pulsar 7000 series offers additional security. If the signal strength is insufficient, due to dirty optics or other non-operationally critical impairments, a configurable alarm signal will be issued to indicate the need for maintenance. However, the system remains ready for use and can continue to detect gases. In addition to increased operational readiness, there is the benefit of being able to plan maintenance and avoid unexpected downtime. The Pulsar 7000 Series is suitable for safety-related applications up to SIL 2.

Reliable even in adverse weather conditions

With the Pulsar 7000, reliability is not at risk even when the weather is not ideal. For fog, mist, heavy rain or snow, the Pulsar 7000 Series has a mode with increased frame flash rate and light intensity. Thus, increased IR absorption caused by environmental factors is consented for. In addition, the heated optics prevent condensation or ice forming on the lens.

Easy to align, configure and commission

The alignment of the transmitter and receiver and the subsequent commissioning of the system can be easily done by a single person, without the need for an additional telescope or alignment mirror. After an initial rough alignment by eye, the exact alignment of transmitter and receiver is carried out using a handheld terminal. The alignment is displayed either in a coordinate system with target optics or in the form of numeric coordinates. The built-in calibration feature in the Pulsar 7000 Series does not require manual adjustment or test gas. After alignment, an automatic zero point adjustment starts, which completes the commissioning of the system. All parameters are stored and later used to detect misalignments or deposits on the lenses.

On site diagnostics

The handheld terminal can be used for predictive maintenance and on-the-spot troubleshooting. In addition to alignment and zeroing support, the handheld terminal also provides configuration and diagnostic features. Comprehensive diagnostics are possible with the PC software program Dräger PolySoft.

Documented security – protocol and integrated data

An integrated data logger stores the most recent errors, warnings and events. These include, for example, events such as blockages of the signal path, gas alarms, warning signals, or problems with the alignment or with the supply voltage. The data logger is supplemented by an hourly log of the values measured in this time.

Benefits

This includes essential data such as gas reading, signal strength and temperature, which are available for the last ten weeks of operation. Even after that, information is available as a weekly summary of the last ten years of operation.

The right model for any job

The Pulsar 7000 Series offers suitable models for the most diverse applications. The offshore models are equipped with stainless steel junction boxes and cable glands. This makes them particularly robust and able to withstand the harsh environmental conditions. You can use the cross-duct model to detect gas buildup in supply or exhaust ducts. The system is specially designed for shaft installations.

Accessories

D-7364-2016

Weather shield

The weather shield protects the system from adverse weather conditions such as snow and rain. Material: stainless steel 316L (incl. for each transmitter and receiver in the Dräger Pulsar 7000 Series)

D-17784-2017

PIA – Pulsar interface adapter

The Dräger Pulsar Interface Adapter (PIA) is a rugged, weatherproof unit that is certified for use in hazardous areas. The PIA offers two interfaces for communication with the Pulsar 7000 series via an intrinsically safe connection. It can be used in combination with a HART® handheld terminal or with a PC with PolySoft via the IR interface as protocol converter. This allows you to align and calibrate the transmitter and receiver of the Pulsar.

Services

D-19074-2016

Dräger Service

Minimize risk and maximize your plant's safety and performance with Dräger service solutions. With service and rental options customized for your business operations, Dräger Services offer seamless support, less downtime, and more budget security. When your devices are serviced by the same team of experts that engineered them and are back by over 125 years of experience, you get complete peace of mind. That's the Dräger Service Advantage.

Related Products

D-6806-2016

Dräger REGARD® 7000

The Dräger REGARD® 7000 is a modular and highly expandable analysis tool. Suitable for gas warning systems with various levels of complexity and numbers of transmitters, the Dräger REGARD® 7000 is exceptionally reliable and efficient.

D-14983-2010

Dräger Polytron® 8700 IR

The Dräger Polytron® 8700 IR is an advanced explosion proof transmitter for the detection of combustible gases in the lower explosion limit (LEL). It uses a high performance infrared Dräger PIR 7000 sensor, which will quickly detect most common hydrocarbon gases. Besides a 3 wire 4 to 20 mA analog output with relays, it also offers Modbus and Fieldbus making it compatible with most control systems.

Technical Data

Type		Expolsion-proof open-paths gas detector based on infrared absorbation spectroscopy	
Gases		Wide range of hydrocarbons, including the alkane series from methane to hexane, propylene	
Measuring range		Min. 0 to 4 LEL m, max. 0 to 8 LEL m	
Gas category		IEC, NIOSH or PTB; selectable	
Factory calibration		Methane, propane or ethylene, selectable	
Operating range		4 to 60 m, 30 to 120 m or 100 to 200 m (distance between transmitter and receiver)	
Signal output	Analogue	Measuring	4 to 20 mA (source and sink)
		Pre-warning	3.5 mA (eg. dirty lens or misalignment), configurable
		Maintenance	3 mA
		Beam block warning	2 mA
		Faults	< 1 mA
	Digital	HART® 7	
Power consumption		< 5 W receiver, < 9 W transmitter	
Operating voltage		18 to 32 VDC (24 VDC nominal)	
Response time t_{90}		< 2 s (under normal operating conditions when using the digital link)	
Skew tolerance		+/- 0.6°	
Ambient conditions	Temperature	-40 to + 60 °C, -40 to +140 °F	
	Pressure	800 to 1,100 hPa	
	Air humidity	0 to 100% rel. humidity, non-condensing	
Housing	Material	Stainless steel AISI 316L "Marine Grade"	
	Protection class	IP66/IP67	
	Weight (approx.)	9 kg (19.84 lbs), each transmitter and receiver incl. backplate and weather shield	
Approvals		Tamb = -55 °C to +40 °C/+60 °C*	
	Performance approval	FM Class 6325	
		ANSI/ISA-12.13.04	
	Safety Integrity Level	SIL 2 SC3 Certification by TÜV Nord (EN 61508)	
	UL /CSA	Class I, Div. 1, Groups C, D Class II, Div. 1, Groups E, F, G, H Class I, Zone 1, AEx db [ia Ga] IIC T6...T5 Gb	

* -40 °C for Heavy Duty/Offshore model

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Ordering Information

Dräger Pulsar 7000 Complete Set	
Pulsar 7000 Short Range 4m – 60m (13ft – 196ft) CSA & UL	NA 10340
Pulsar 7000 Medium Range 30m – 120m (98ft – 393ft) CSA & UL	NA 10341
Pulsar 7000 Long Range 100m – 200m (328ft – 656ft) CSA & UL	NA 10342
Pulsar 7000 Short Range 4m – 60m (13ft – 196ft) CSA & UL-Ethylene	NA 10343
Pulsar 7000 Medium Range 30m – 120m (98ft – 393ft) CSA & UL-Ethylene	NA 10344

Ordering Information

Dräger Pulsar 7000	
Dräger Pulsar 7000 TX S Range CSA & UL	68 51 728
Dräger Pulsar 7000 TX L Range CSA & UL	68 51 729
Dräger Pulsar 7900 RX S Range CSA & UL-Ethylene	68 51 732
Dräger Pulsar 7700 RX S Range CSA & UL	68 51 733
Dräger Pulsar 7700 RX L Range CSA & UL	68 51 734
Both TX & RX will come with a mounting plate and a weather shield.	

Duct Mount	
Dräger Pulsar 7700 Duct Mount CSA & UL Complete (TX & RX)	68 51 739
Dräger Pulsar 7000 Duct Mount TX CSA & UL	68 51 730
Dräger Pulsar 7700 Duct Mount RX CSA & UL	68 51 731

Mounting Parts	
2" / 50mm Pipe mount kit	23 07 003
Pulsar 7000 duct wall mounting plate kit	23 50 450

Communication & Maintenance	
Pulsar Interface Adapter (PIA), single unit	68 51 565
Pulsar Interface Adapter set for Standard variant	68 51 630
Pulsar Interface Adapter set for Ethylene variant	68 51 631
Pulsar Interface Adapter set for Duct Mount	68 51 632
Lens cleaning fluid LCF01	23 50 291

Calibration Kits	
Gas test sheets for Dräger Pulsar 7900 (Ethylene)	23 50 520
Gas test sheets for Dräger Pulsar 7700 (Methane/Propane)	23 50 521
Gas test sheets for Dräger Pulsar 7700 Duct Mount	23 50 451
Gas cell kit, single pass (Propane)	23 50 514
Gas cell kit, single pass (Methane)	23 50 516
Gas cell kit, single pass (Methane and Propane)	23 50 518

Notes

Notes

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