European Foundation for the Improvement of Living and Working Conditions

Drivers of recent job polarisation and upgrading in Europe

European Jobs Monitor 2014

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Acronyms and initialisms

EPL	employment protection legislation
ESS	European Social Survey
EU-LFS	European Union Labour Force Survey
EWCS	European Working Conditions Survey
ILO	International Labour Organization
ISCO	International Standard Classification of Occupations
ISCED	International Standard Classification of Education
NACE	Nomenclature statistique des activités économiques dans la Communauté européenne (Statistical Classification of Economic Activities in the European Community)
OECD	Organisation for Economic Co-operation and Development
O*NET	Occupational Information Network
PIAAC	Programme for the International Assessment of Adult Competencies
SBTC	skill-biased technical change
SES	Structure of Earnings Survey
RBTC	routine-biased technical change
UNESCO	United Nations Educational, Scientific and Cultural Organization

Executive summary

Introduction

European labour markets added nearly 30 million new jobs in a golden age of employment creation prior to the onset of the Great Recession in 2008. These labour markets subsequently shed six million jobs, and unemployment peaked at 11% in 2013, its highest rate in well over a decade.

This third annual European Jobs Monitor report looks in detail at recent shifts in employment at Member State and European Union level in the two years from the second quarter of 2011 to the second quarter of 2013. It applies a jobs-based approach, which ranks jobs according to wage and then groups them into five categories of equal size (quintiles) ranging from lowest-paid to highest-paid. The net employment change between the starting and concluding periods (in terms of people employed) for each quintile in each country is summed to establish whether there has been net gain or loss. This analytic approach enables employment shifts to be described quantitatively (how many jobs were created or destroyed) and qualitatively (what sectors and occupations were most affected).

The report also examines some of the likely drivers of recent shifts in the employment structure: technological advances, as measured by the cognitive and routine task content of jobs; globalisation and trade, measured as the offshorability of tasks or direct international trade; and labour market institutions.

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 goal of the earlier Lisbon agenda – 'more and better jobs'. More jobs are needed to address the problem of lengthening unemployment queues. But Europe also needs better, more productive jobs if it is to succeed once again in increasing living standards for its citizens in an expanding, integrated global economy.

The European Commission's 2012 Employment Package identifies some sectors in which employment growth is considered most likely – health services, information and communications technology (ICT), 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 both growing and declining sectors and occupations.

The jobs-based approach has been used, in particular, to assess the extent to which the employment structures of developed economies are polarising, leading to a 'shrinking' of middle-paid jobs, or upgrading (growth in high-skilled, high-paid jobs) 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

Recent shifts in the employment structure

- Employment levels in the EU28 declined by around 1.3 million during the period 2011–2013. The majority of net employment losses continued to occur in middle-paid and low-to-middle-paid jobs in construction and manufacturing.
- Employment growth remained resilient in high-paid, high-skilled jobs. There was net employment growth only in jobs in the top quintile of the wage distribution.
- The service sector now accounts for more than 70% of employment. Knowledge-intensive services have been the main source of employment growth. The two jobs with the greatest employment growth were well-paid (top quintile) jobs in this category: health professionals working in the health sector and ICT professionals working in computer programming, consultancy and related activities.

- Recent employment shifts have been less polarising than those of the peak crisis period of 2008–2010. The aggregate shift pattern in 2011–2013 was one of upgrading with some polarisation, compared to one of polarisation with some upgrading in 2008–2010.
- Women account for a larger share of recent employment growth in the top quintile. By contrast, men account for a greater share of employment decline in middle-paid jobs and of growth in low-paid jobs. Employment shifts for men have been clearly polarising, while for women they have been more upgrading.
- Strong recent growth in the part-time share of employment has been the main factor contributing to the longer-term trend of destandardisation of the employment relationship. Although part-time employment has been traditionally dominated by women, recent growth has been equally split between men and women. New part-time employment for women has been more likely to be in well-paid jobs, while for men it has been likely to occur in low-paid jobs.

Drivers of structural change

- During the long period of economic expansion from 1995 to 2007, the most common pattern of structural change in employment across Europe was one of upgrading, and it was strongly associated with the cognitive content of jobs. In other words, employment expanded most consistently across Europe in recent years for jobs that are most intensive in information-processing tasks.
- Contrary to previous research in this area, a clear association was not found between the routine content of jobs and the polarisation of job structures. While it is true that routine content was negatively associated with employment growth (jobs with a high level of routine tended to grow less than those with a low level), this effect tended to contribute to upgrading rather than polarisation.
- In some cases, the offshorability of jobs seemed to be more significantly associated with polarisation. Jobs that require less social interaction are often found in the middle of occupational structures; these jobs expanded relatively less than other jobs during the period studied here.
- However, to a significant extent, cases of job polarisation remain unexplained by either the key factors of technological change or globalisation. This points to a third factor: labour market policies and related institutions. This is much more difficult to test empirically than the other two factors.

Introduction

This report describes recent structural shifts in employment in European labour markets and explores some of the explanatory hypotheses that have been developed to explain changes in the labour markets of developed economies.

The research uses a jobs-based methodology to identify how net employment shifts at Member State and EU level have been distributed across jobs in different quintiles of the wage distribution. In this analysis, a job is understood as a given occupation in a given sector. The principal criterion for ranking jobs is the wage. Alternative job rankings based on the average educational attainment of job holders and a multidimensional measure of non-pecuniary job quality derived from Eurofound's European Working Conditions Survey (EWCS) have also been developed (Eurofound, 2013).

In the first, primarily descriptive, part of the report, the emphasis is on monitoring the most recent changes in the employment structures of the 28 EU Member States, based on data available at the time of writing (covering the period from 2011 Q2 to 2013 Q2). It describes, for example, the extent to which recent ongoing losses in aggregate EU employment continue to be concentrated in the manufacturing and construction sectors and shows the continuing relative resilience of employment in the service sectors, especially in higher-paid service sector jobs.

The second part of the report takes a more analytical approach and engages with existing theoretical explanations of what may be driving the changes in employment structure that we observe in developed economies. The role of some factors is more or less clear and uncontested, for example:

- the tendency of technological change to increase relative demand for higher-skilled workers, known as 'skill-biased technological change';
- the increased share of employment in services combined with declining shares in manufacturing and agriculture;
- on the supply side, the increased integration of female workers into the paid labour market and the narrowing of gender employment gaps.

There is evidence in some countries, for given periods, of a polarising shift in employment, meaning greater relative growth not just at the top of the wage distribution but also at the bottom relative to a declining middle. In practice, the polarisation that has been observed is generally asymmetrical, with a strong skew to higher-paid and higher-skilled jobs. It is not clear that this represents anything as broadly occurring as the other trends noted. Previous research from Eurofound (Eurofound 2011, 2013), other European researchers (Oesch and Rodrigues, 2012) as well as the American researchers most identified with the 'job polarisation' diagnosis in the United States (Autor, 2010) suggest that polarisation has occurred in specific countries in specific periods rather than being a prevalent form of structural change occurring across time and across developed economy labour markets. Previous Eurofound work has pointed to the prevalence of two main identifiable country patterns – upgrading and polarisation – rather than pervasive polarisation. The second part of the report draws on the existing literature to see the extent to which important factors such as technological change, trade and labour market institutions might contribute to the different patterns of structural change observed in Europe in the period 1995–2007.

Labour market context

It has been an unprecedentedly dismal five years for EU labour markets in aggregate. There were nearly six million fewer people in paid employment in the EU28 in the second quarter of 2013 (2013 Q2) compared with the second quarter of 2008 (2008 Q2). This decline in employment is largely a result of the economic crisis that followed the global financial crisis of 2008–2009. Five of the six million net decline in employment occurred before 2010 Q2. The subsequent period has been marked by a modest resumption of employment growth in 2010–2011, followed by renewed declines coinciding with the sovereign debt and euro zone crisis, widespread retrenchment of public spending ('austerity') and linked bouts of recession. In the period covered by the descriptive summary that follows (2011 Q2 to 2013 Q2), employment levels dropped further by just over 1.3 million.

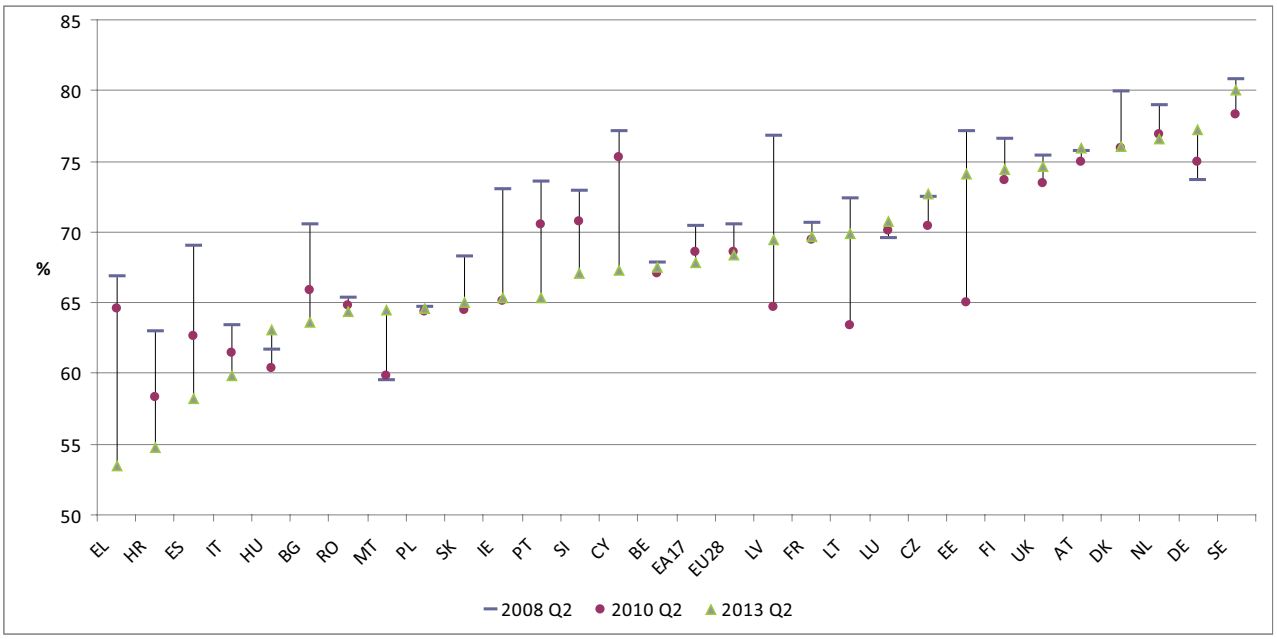
In a labour market of some 220 million people, this may not seem unduly negative but it should be seen in context. Between 1998 and 2007, EU labour markets tended to add, on average, around two million new jobs every year. Including foregone growth, the crisis may have cost as many as 18 million jobs in the EU. There are now over 26 million unemployed in the EU28.

The recent decline in employment has coincided with a shift in fiscal policy in the EU, from post-crisis stimulus to austerity and retrenchment. New measures for economic policy coordination have been put in place, notably in the euro zone countries, most premised on the necessity for balanced budgets and public debt reduction. Labour market performance has been significantly better in the other major developed economies – Japan and the US – during the same period, where policy has remained more growth-oriented. Whether this superior performance comes at a cost of unsustainably large deficits, immoderate inflation or other macroeconomic weaknesses, time will tell. For the moment, prospects for European growth are largely dependent on external demand, both from these other developed economies as well as the faster-growing developing economies.

Within the EU28, there remains a large variation in national labour market performances. Aggregate employment declines are attributable in large part to developments in some euro zone countries, where the combination of financial sector and sovereign debt problems and the policy measures adopted to tackle them has led to stagnant or sharply declining output (in Greece, for example) and negative labour market dynamics. Employment levels have declined by over 3.5 million in Spain, around 1 million in Greece and Italy, and 700,000 in Portugal. Of the countries with more robust public finances, only Germany accounts for a comparable contribution on the positive side of the balance sheet. There, over 2.3 million net new jobs have been created since mid-2008. By contrast, both Finland and the Netherlands saw reductions in their employment rates, of about 2.5%, between 2008 and 2013.

The Europe 2020 strategy has an overarching employment objective of a 75% employment rate amongst those aged 20–64 years by 2020. As highlighted in Figure 1, the recession and its aftermath have set back progress towards this target. The overall EU employment rate declined from 70.5% in 2008 Q2 to 68.4% in 2013 Q2.

Figure 1: *Employment rates in the EU28 (20–64-year-olds), 2008 Q2, 2010 Q2 and 2013 Q2*



Note: EA17 refers to the 17 Member States that comprise the euro zone.
Source: *EU-LFS*

The negative employment effects of the Great Recession and its aftermath have also varied sharply by country. Ireland and the Baltic states experienced greater hardship at the outset in 2008–2009, while Spain sustained more or less consistent employment losses throughout the recession. In Cyprus, Greece and Portugal, the big reductions in employment occurred mainly after 2010. In the 12 months leading up to 2013 Q2, the sharpest falls (of more than 4%) in employment were recorded in Cyprus, Greece and the newest Member State, Croatia.

The impact of the crisis has been most keenly felt in construction and manufacturing. Together, these two sectors account for over seven million net job losses since 2008, which is more than the aggregate job declines across all sectors. Service sectors account for over 70% of total employment. They contributed some modest positive employment growth from 2008 onwards. After 2010, the rate of this growth increased and shifted from predominantly publicly funded sectors (health and education) early in the crisis to private service sectors, such as professional services, management consultancy and information technology, afterwards. Workers in higher-skilled occupations, especially those with long job tenure, those in the core age group (aged 30 to 49) and older workers have continued to experience much more benign labour market outcomes.

A major revision of the International Standard Classification of Occupations (ISCO) in the EU Labour Force Survey (EU-LFS) in 2011 makes it difficult to track precisely changes in occupation-by-sector shares of employment from 2008 to date (see Annex 1 for details). Table 1 shows a broad comparison of developments in the most recent years of EU-LFS data (2011 Q2 to 2013 Q2) with those during the peak crisis period (2008 Q2 to 2010 Q2).

Table 1: *Employment change by major sectoral and occupational categories, EU28 (% change per annum)*

	2011 Q2–2013 Q2					2008 Q2–2010 Q2				
	White collar		Blue collar		*All occupations*	White collar		Blue collar		*All occupations*
	High skill	Lower skill	High skill	Lower skill		High skill	Lower skill	High skill	Lower skill	
Manufacturing	-0.3	-0.8	-3.0	-0.9	-1.5	-3.3	-3.9	-5.2	-7.3	-5.3
Construction	2.2	-1.2	-4.0	-6.0	-3.1	-1.3	-4.0	-5.7	-8.6	-5.5
Retail	4.7	0.0	2.1	4.6	1.3	-1.5	-1.7	-2.9	-3.3	-2.0
Other private services	2.0	0.1	-3.3	-0.4	0.4	1.5	-0.2	-1.1	-0.5	0.2
Public services	0.9	-0.5	-0.9	-0.1	0.0	2.1	1.9	-2.7	0.0	1.6
All sectors	1.6	-0.3	-2.5	-0.4	-0.3	0.7	-0.3	-3.7	-3.2	-1.2

Notes: The shading represents a scale from most growth (dark green) to least growth (dark red). 'All sectors' includes sectors not individually listed (primary, extractive and utilities sectors). The occupational categories are not consistent across the two periods due to changed ISCO classification. The broad occupational categorisation is based on OECD (1998). Annual average figures for 2011 Q2–2013 Q2 use only one year for Germany (2012–2013) and the Netherlands (2011–2012) due to classification changes.
Public services include health and education services.
Source: *EU-LFS (authors' calculations).*

Although it covers just four full years of data, Table 1 shows that some longer-term trends persisted and, in fact, were sharpened during the economic downturn: blue-collar employment suffered more than white-collar employment; and manufacturing and construction employment suffered more than services employment.

Table 1 also reveals some significant differences between the two periods.

- The manufacturing and construction sectors have continued to shed employment but with a lower intensity, especially in manufacturing, compared with the recession, when both sectors shed an average of 5% of employment per year. Developments in these two sectors are the main factors behind a reduction in the annual employment decline, from -1.2% to -0.3%.
- Austerity-led public spending cuts have led to a stalling of employment growth in the public services, including health and education services. These were the main source of resilience in the labour market during 2008–2010, when employment continued to grow by 1.6% per year.
- Within the broad category of public services, there has been a sizeable 5% decline in staff numbers in public administration and defence, alongside suppressed growth in health and education.
- Private sector service employment (excluding retail) has increased but contributes only modestly (0.4% per annum) to compensate for job losses in other sectors.
- Employment is increasing in the retail sector at a faster rate than in other service sectors; however, retail shed more employment during 2008–2010.
- There has been negative growth of blue-collar jobs during and after the recession across all sectors except retail. High-skilled blue-collar jobs in the manufacturing and construction sectors have been at particular risk, and men have been most affected.
- A process of occupational upgrading is most apparent in the services sector and construction. This is evident in shifts in employment levels within occupational categories, with higher-skilled and white-collar employees clearly favoured.

Jobs-based approach: methodology

The approach in this report is to describe how the structure of employment in Europe changed between 2011 Q2 and 2013 Q2 from the point of view of the sectoral and occupational composition of employment and the implications of these changes for aggregate job quality.[1]

The unit of analysis is the job. Increasingly, EU employment policy is phrased in terms of jobs. 'More and better jobs' was the headline phrase of the Lisbon agenda and the New Skills for New Jobs initiative is central to its successor, Europe 2020.

A 'job' is defined in this report as an occupation in a sector – for example, a secretary in the insurance industry or a doctor in the health sector. This is an intuitively attractive definition and corresponds to what people think of when describing their job or how an employer advertises a new job opening. This definition is also very useful for both theoretical and empirical reasons. The two concepts of occupation and sector correspond to the two fundamental dimensions of the division of labour within and across organisations. The sector classification indicates the horizontal distribution of economic activities across organisations generating different products and services. The occupation classification provides an implicit hierarchy of within-organisation roles – senior managers, line managers, professionals, associate professionals, production staff and so on. Established international classifications of occupation (ISCO, the International Standard Classification of Occupations) and sector (NACE, Nomenclature statistique des activités économiques dans la Communauté européenne) make it relatively easy to operationalise the jobs-based approach using the standard labour market data sources such as the EU-LFS.

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 of the jobs-based analysis, originating in the work of Nobel Laureate Joseph Stiglitz in the 1990s and subsequently refined by Erik Olin Wright and Rachel Dwyer. The analysis that follows relies mainly on a wage-based measure to rank jobs.

[1] In the analysis that follows, the timeframe used is 2011 Q2 to 2013 Q2. Occasionally, shorthand references are made to '2011–2013' and '2012–2013'– in all cases, this refers to second quarter data from the relevant year.

Box 1: Methodological note on the jobs-based approach

The main, simplified steps of the job-based approach are as follows.

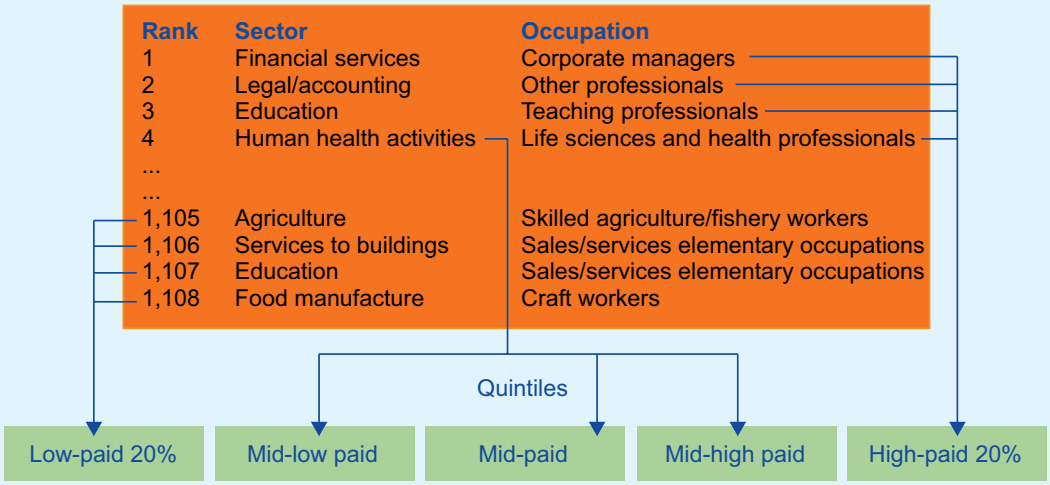
Step 1: Using the standard international classifications of occupation (ISCO-08) and sector (NACE Rev 2.0) at two-digit level, a matrix was created, with the same basic format as Table 1 above but at a much more detailed level of disaggregation. This generated a matrix of 3,784 theoretical job cells, with 88 sectors on the horizontal axis and 43 occupational groups on the vertical. In practice, many of the theoretical job cells do not contain employment. The total of job cells per country varied between around 400 and just over 2,000, and was largely determined by the population size and the size of each labour force survey sample.

Step 2: Jobs in each country were ranked based on some ranking criterion, mainly mean hourly wage.[2] Job-wage rankings were calculated based on different data sources for each period, with varying levels of data quality and coverage (for more detail, see Annex 1). The most recent country-based job-wage rankings were based on combining data from the EU-LFS annual data file for 2011 and aggregated data from the European Union Structure of Earning Survey (SES) for 2010. These sources enabled country job-wage rankings to be produced for 26 Member States. For the remaining countries (Croatia and Sweden), an EU average job-wage ranking based on data from the other Member States was applied.

Step 3: Jobs were allocated to quintiles in each country based on the job-wage ranking for that country. The best-paid jobs were assigned to quintile 5 and the lowest-paid to quintile 1. Each quintile in each country represented as close as possible to 20% of employment in the starting period. Hereafter, the job-to-quintile assignments remained fixed for each country for a given period. The focus then shifted to the EU-LFS employment data, to examine the shift in the stock of employment at quintile level in each country from 2011 Q2 to 2013 Q2.

Figure 2 illustrates in simplified format these three steps, using some of the top-paid and bottom-paid jobs that employ large numbers at EU level as examples. Note that while the jobs are correctly assigned in terms of EU quintile, the individual job-wage ranks (that is, 1–4 and 1105–1108) are for illustrative purposes only.

Figure 2: *Job rankings and quintile assignments carried out for each country*



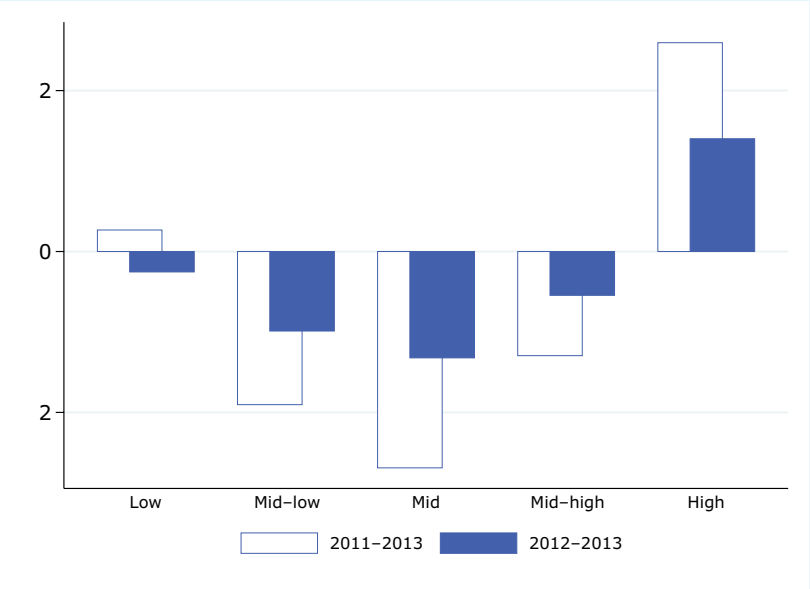
[2] Two further measures of job quality, one based on the average educational attainment of job-holders and the other on a composite index of non-pecuniary job quality attributes, have also been developed as secondary rankings. For a detailed discussion, see Eurofound (2013).

Step 4: The net employment change between the starting and concluding period (in terms of persons employed) for each quintile in each country was then summed to establish whether net job growth had been concentrated in the top, middle or bottom of the employment structure. This generated a series of charts similar to Figure 3.

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.

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 of different pay levels. A similar classification of jobs can be done using job-holders' skills or job quality as a ranking criterion. Figure 3 illustrates employment change in the EU28 from 2011 Q2 to 2013 Q2 using job-wage quintiles. It should be read from the leftmost bar cluster (lowest-paid jobs) to the rightmost (highest-paid jobs). The clear bars show change for 2011–2013, while the dark bars show changes for 2012–2013. Net employment change is represented on the vertical axis; the fact that most of the bars are below the 0 line confirms that this was a period of net job losses, especially in mid-paid jobs, and that employment grew only in the highest-paid jobs.

Figure 3: *Net employment change (%) by job-wage quintile, 2011 Q2 to 2013 Q2, EU28*



Note: Incorporates data adjustments for Germany and the Netherlands to reflect changed occupational classifications in 2012–2013 and 2011–2012 respectively.
Source: *EU-LFS (authors' calculations)*

This method allows these net employment changes to be analysed further by factors such as gender, employment status and working time (full time or part time).

Annex 1 provides a more extensive description of the data-processing used in this report. Further background documentation includes Eurofound (2008b), as well as extensive annex material in Eurofound (2008a) and Eurofound (2011).

Note on occupational classifications

In 2011, the EU-LFS made the transition from the old occupational classification ISCO-88 to the new classification ISCO-08. From 2011 onwards, in nearly all Member States, ISCO-08 has been in use in both quarterly and annual EU-LFS data submissions to Eurostat. However, further revisions were made in Germany, with effect from 2012, in line with changes to the relevant national occupational classification (Klassifikation der Berufe, KldB). As a result, there is a significant break in the German data, both in 2011 and in 2012 as regards the ISCO variable. Though not flagged, a similar revision break appears to have taken place in the data for the Netherlands between 2012 Q4 and 2013 Q1.

These two data breaks have been addressed as follows. Firstly, data for the two countries for a 12-month period (Q2–Q2) that has an unbroken time series was selected. For Germany, data for 2012 Q2 to 2013 Q2 are used, with revised national rankings for the education and job-wage rankings based on EU-LFS 2012 data, and for the Netherlands, data for 2011 Q2 to 2012 Q2 are used. Secondly, for the main EU aggregates for 2011 Q2 to 2013 Q2, the employment change during the 12-month period for which we have unbroken data for each of these two countries is taken to represent change for the full period (2011 Q2 to 2013 Q2). Thirdly, Germany and the Netherlands are omitted from any breakdown of EU aggregates, for example by gender or employment status.

Part 1

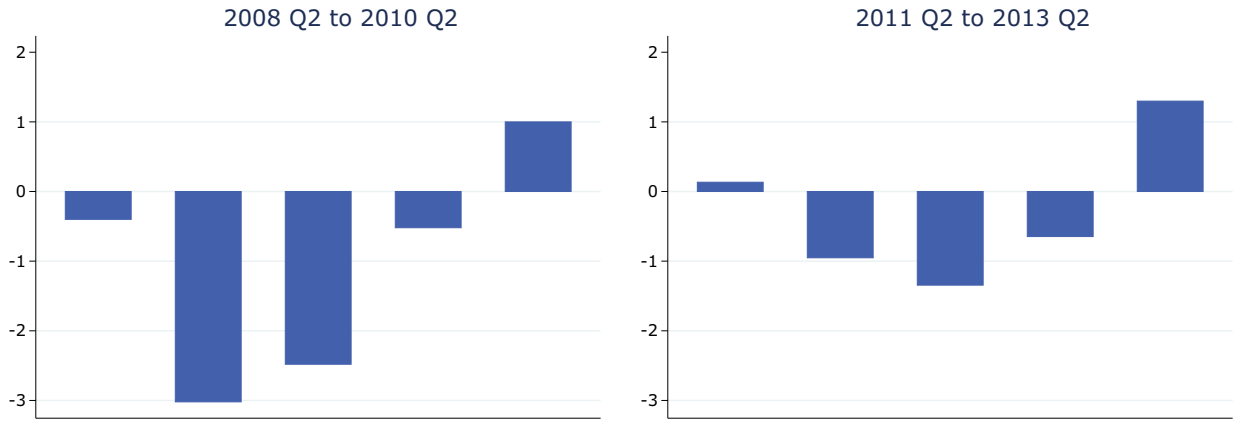
Recent shifts in the employment structure

Employment shifts by wage quintile *1*

Part 1 of this report uses the jobs-based approach to describe employment developments by job-wage quintile during the most recent 24 months for which data are available; that is, 2011 Q2 to 2013 Q2. The analysis looks first at overall EU28 trends before going on to describe the varying patterns of change in individual Member States. Thereafter, employment change is examined more closely in terms of major sectoral aggregations, worker characteristics and employment status. The objective of this analysis 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 growth in part-time work, increasing female participation and the growing role of services.

The two years between 2011 Q2 and 2013 Q2 were a period of renewed employment decline in the EU, with a net loss of some 1.3 million jobs. Very little changed in the pattern of these job losses since the recession period of 2008–2010, as Figure 4 shows. As was the case during the recession, the net loss was concentrated in mid-paid and mid–low-paid jobs and corresponds to the ongoing weakness in the construction and manufacturing sectors already noted. Both of these sectors tend to have a concentration of employment in middle quintiles of the wage distribution.

Figure 4: *Employment change by job-wage quintile, EU27, 2008 Q2–2010 Q2 and 2011 Q2–2013 Q2 (% annual change)*



Notes: Croatia is omitted for comparability. The figure incorporates data adjustments for Germany and the Netherlands to reflect changed occupational classifications in 2011–2012 and 2012–2013 respectively.
Source: *EU-LFS, SES (authors' calculations)*

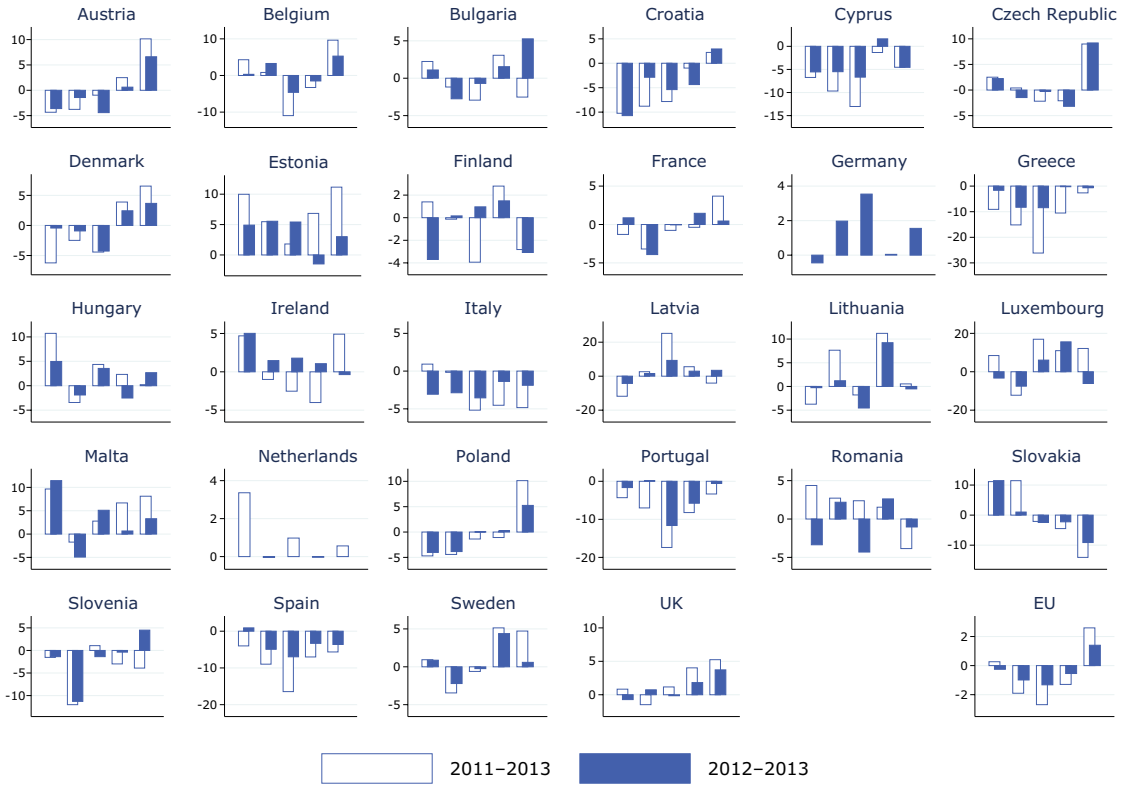
The main features – employment growth in the top quintile, greatest decline in the middle and low–mid-paid quintiles, and more modest decline (2008–2010) or small growth (2011–2013) in the lowest quintile – show a consistency across the two charts, although clearly the intensity of job destruction was greatest in 2008–2010. During that period, there were annual declines of 2.5%–3% on average in employment in the middle and low–mid-paid quintiles of the wage distribution. In more recent years, these moderated to around 1% declines for the same quintiles. Overall, the pattern can be described as one of polarisation, meaning that relative employment growth is greatest at either end of the wage distribution and weakest in the middle. In this case, the polarisation is asymmetrical because it is skewed towards greater growth in the top quintile.

The consistency of the chart patterns confirms that the jobs-based approach applied at this aggregate level across many different national labour markets is identifying actual regularities in the changing employment structure and not artefacts. The observed patterns are also similar to those that emerge if the analysis is extended back in time to the long period of employment expansion in the EU, from 1998 to 2007 (Fernández-Macías et al, 2012). The main difference is that the

very significant net job destruction during the Great Recession generated a sharper polarisation than observed before or afterwards.

Figure 5 presents net employment change between 2011 Q2 and 2013 Q2 by wage quintile for Member States.

Figure 5: *Employment change (%) by job-wage wage quintile in EU28 Member States, 2011 Q2–2013 Q2 and 2012 Q2–2013 Q2*



Notes: Data missing for Germany for 2011 Q2–2012 Q2 due to classification change. Data for the Netherlands refer to 2011 Q2–2012 Q2. EU aggregate data incorporates data adjustments for Germany and the Netherlands to reflect changed occupational classifications in 2012–2013 and 2011–2012 respectively.
Source: *EU-LFS (authors' calculations)*

In previous analyses, polarising and upgrading employment shifts were the two most obvious patterns observed at national level (Eurofound 2008a, 2011, 2013). Upgrading occurs when relative employment growth is greater in higher quintiles, with relatively weaker growth in the middle and especially lower quintiles.

Over the peak crisis period (2008–2010), some countries exhibited signs of downgrading; that is, there was greater growth in lower-paid jobs, accompanied by declining employment in top-paid jobs (Eurofound, 2011). This pattern continued into 2011–2013 in some countries, such as Hungary and Italy, and appeared for the first time in other countries, like Slovakia. As suggested by the year-to-year variation in some of the country charts in Figure 5, there is likely to be some statistical 'noise' in the year-on-year changes that tends to disappear over longer time frames. In an earlier analysis of the period 1998 to 2007, downgrading was not observed in any Member State (Eurofound, 2008a).

With reference to the two-year charts (2011–2013), the most obvious examples of countries experiencing upgrading are Austria, Croatia, Denmark, Poland, Sweden and the UK. In the cases of the Czech Republic and France, employment shifts have also been mainly upgrading, with some degree of polarisation or other offsetting features. With the exception

of Croatia, these Member States have either high employment rates or employment has tended to be more resilient during and after the crisis.

Member States with clear polarising employment shifts include Belgium, Cyprus, Estonia, Greece, Ireland, Portugal and Spain. While it would be unwise to draw any firm inferences from just two years of data, it is suggestive that employment has been polarising in Member States where the crisis or post-crisis period has had the most negative impact on labour market and overall economic performance. All four euro zone Member States that availed of assistance from the EU–IMF–ECB Troika in the wake of sovereign debt funding problems are included on the list, as well as Spain, where employment levels have declined by over 3.5 million. Decline in construction sector employment is one of the main factors contributing to the declining middle quintiles; in each of these Member States, the biggest job losses in the third quintile occurred among building and related trades workers in the construction sector.

In some Member States, the nature of employment shifts across the job-wage distribution changed between 2011–2012 and 2012–2013. In Ireland, the resumption of modest employment growth in 2012–2013 has been polarising, as most net new employment has been strongly skewed towards the bottom quintile, mainly due to an increase in agricultural employment. In Italy, the clear downgrading pattern observed in 2012 has moderated somewhat, because more recent employment loss has predominated in the lower quintiles rather than the top quintiles as before.

Growing and declining jobs

The quintile charts show where employment is being created and destroyed in the job-wage distribution, but they do not identify the specific jobs responsible for the shifts observed. In practice, even though the number of jobs with employment identified using the jobs-based approach ranges from around 400 to 2,000 by country, depending on size, and totals over 3,000 at aggregate EU level, a small number of jobs account for a high share of employment in all countries. Two jobs alone – sales workers in the retail sector and teaching professionals in the education sector – account for nearly 10% of total EU employment, employing nearly 22 million workers between them. One-quarter of EU employment is concentrated in just 10 jobs and one-half in 65 jobs (see Annex 2). In countries with a high share of agricultural employment, such as Greece and Romania, 20 jobs or fewer account for one-half of all people employed.

Table 2: *Top 10 jobs by employment, greatest employment loss and greatest employment gain*

Top 10 jobs by employment, 2011 Q2

Occupation	Sector	Employment (000s)	Quintile		
			Wage	Education	Job quality
Sales workers	Retail trade	12,192.5	1	3	3
Teaching professionals	Education	9,731.5	4	5	5
Market-oriented skilled agricultural workers	Crop and animal production	7,215.6	2	1	2
Health professionals	Human health activities	4,578.3	5	5	4
Building and related trades workers	Specialised construction activities	4,515.5	3	1	2
Personal service workers	Food and beverage service activities	4,040.0	1	2	1
Drivers and mobile plant operators	Land transport	3,995.9	4	2	1
Health associate professionals	Human health activities	3,530.0	3	4	3
Business and administrative associate professionals	Public administration and defence	3,062.7	4	4	5
Building and related trades workers	Construction of buildings	2,530.4	3	1	1

Top 10 jobs by greatest employment loss, 2011 Q2–2013 Q2

Occupation	Sector	Employment (000s)	Quintile		
			Wage	Education	Job quality
Building and related trades workers	Specialised construction activities	-384.4	3	1	2
Building and related trades workers	Building construction	-270.6	3	1	1
Other clerical support workers	Public administration and defence	-138.6	3	3	4
Labourers	Building construction	-136.6	2	1	1
Cleaners and helpers	Household activities	-117.3	1	2	1
Health associate professionals	Human health activities	-114.5	3	4	3
Metal, machinery and related trades workers	Manufacture of fabricated metal products	-111.5	3	2	1
Drivers and mobile plant operators	Land transport	-110.9	4	2	1
Hospitality, retail and other services managers	Food and beverage service activities	-110.5	4	3	3
Market-oriented skilled agricultural workers	Crop and animal production	-103.6	2	1	2

Top 10 jobs by greatest employment gain, 2011 Q2–2013 Q2

Occupation	Sector	Employment (000s)	Quintile		
			Wage	Education	Job quality
Information and communications technology professionals	Computer programming, consultancy and related activities	186.7	5	5	5
Health professionals	Human health activities	135.3	5	5	4
Personal care workers	Household activities	81.2	1	3	2
Cleaners and helpers	Services to buildings and landscape activities	77.5	1	1	1
Personal service workers	Other personal service activities	74.5	1	3	3
Science and engineering associate professionals	Specialised construction activities	65.5	4	4	4
Business and administration professionals	Wholesale trade	63.9	5	5	5
Business and administration professionals	Financial services except insurance and pensions	58.3	5	5	5
Personal care workers	Residential care activities	57.0	2	2	3
Legal, social and cultural professionals	Creative, arts and entertainment activities	55.8	4	5	3

Notes: Data from 28 Member States for top 10 jobs by employment; data from 26 Member States for top 10 jobs by greatest employment loss and greatest employment gain (no data in these cases for Germany and the Netherlands due to data breaks).
Source: *EU-LFS (authors' calculations)*

As Table 2 confirms, employment shifts in these large-employing jobs account for a substantial proportion of the observed shifts in employment at quintile level. Of the top 10 jobs by employment, 5 also appear in the list of top 10 jobs by employment loss, and 1 appears in the list of top 10 jobs by employment gains.

The big contracting jobs are nearly all in the middle quintiles (2–4) and underline why it is here that the greatest net job destruction is seen. Three are in the construction sector – where EU employment has decreased more or less continuously for five years – and one is in agriculture, which is in long-term decline. The appearance in the list of greatest employment loss of health associate professionals in the human health activities sector is surprising as health sector employment had tended to be resilient and to grow throughout the crisis, albeit at a much slower pace than before. One possible explanation is a rebadging or upgrading of occupations within the health sector in some Member States, with associate professionals being recategorised as professionals. The fact that the largest absolute employment growth over the period was for the related occupation of health professionals in human health services lends some support to this possibility.[3]

According to the proponents of pervasive employment polarisation (Goos et al, 2009), the relative decline of middle-ranking jobs is attributable to the routine and codifiable nature of their job tasks. The common examples given are clerical and administrative work in the service sectors and low-skilled or unskilled manufacturing jobs. These have been in long-term decline in developed economies as a result of workers being replaced by technology or jobs being lost because of offshoring and increased global competition. The second part of this report discusses this hypothesis in more detail regarding employment developments between 1995 and 2007.

A short-term outcome is the disproportionate impact of the construction sector on middle-quintile job losses. Construction work is mainly non-routine and requires the presence of the worker on site. It differs from more routine job types, whose decline is considered responsible for employment polarisation. Nonetheless, the decline in EU construction sector employment, ongoing since 2008, has accentuated overall polarisation. In the same way, the expansion of the construction sector in pre-recession booms that occurred in a number of Member States (Ireland, Spain and the UK) may well have disguised underlying patterns of polarisation.

Absolute employment shifts are much more modest in jobs that demonstrated growth over 2011–2013. Only two jobs – health professionals in the health sector and ICT professionals in computer programming – posted net increases of over 100,000 workers, compared to 11 jobs that experienced the same scale of net job losses. These employment-gaining jobs tend to be better paid. The growth in health professionals reflects a long-run increase in health sector employment associated with demographic ageing, increasing wealth and the tendency of wealthier societies to devote an increased share of resources to health provision. It also reflects occupational upgrading within the health sector, noted already. Five of the top 10 growing jobs are in the top quintile and contribute significantly to its positive growth, alone among the quintiles.

The fact that employment shifts were much greater in contracting rather than expanding jobs is due in part to it being a period of recession. It also reflects a greater relative concentration of losses in declining jobs – 28% of total net loss in the list of top 10 employment-losing jobs – as well as a more even spread of gains across growing jobs – 18% of total net growth in the list of top 10 employment-gaining jobs.

Quintile distribution of employment by labour market and demographic variables

The approach used in this report emphasises marginal employment change. That is, it focuses on the difference in a given quantity of employment between one period (for example, 2011 Q2) and a succeeding period (2013 Q2). For the national aggregate shifts already presented, this requires little explanatory background. By construction, employment shares are 20% by quintile in the start period.[4] The fixed allocation of jobs to quintiles is performed in such a way as to generate

[3] The new occupational classification (ISCO-08) only became operational in the EU-LFS in 2011. Some variation can be expected in the application of any classification in its early years of use.

[4] It would be more correct to say *approximately* 20% of employment by quintile because jobs are 'lumpy' in terms of employment, but rarely are the shares more than 22% or less than 18%. Only in those countries with large employment shares in individual jobs (such as skilled agricultural workers in agriculture in Romania) and where those jobs straddle quintile thresholds is there a significantly uneven distribution.

more or less equal starting shares of employment (not jobs) in each country. The marginal change presented in the quintile charts reflects deviations from these more or less equal starting employment levels that occur over two years from 2011 Q2 to 2013 Q2.

The sections that follow, however, will present recent employment shifts for given categories of workers, based on characteristics such as gender and job status. Note that for these shifts, the quintile allocation is not based on a separate job-wage ranking and quintile assignment for each of the individual categories. What is shown instead is a breakdown of shifts in employment by category. So for gender, the analysis shows how much of the overall growth in each quintile corresponds to men and how much to women. This is important as it implies different starting shares of employment in each quintile. For example, figures for men and women are based on employment being unequally shared across the wage distribution by gender and other variables.

Table 3 presents the starting employment shares at aggregate EU level for a selection of the main labour market and demographic variables. It is in relation to these baseline figures that the shifts in the quintile charts outlined later should be understood.

Table 3: *Employment shares by job-wage quintile, EU28, 2011 Q2*

		Job-wage quintile					
		1	2	3	4	5	Total
Gender	Female	29	20	16	19	16	100
	Young (15–29 years)	27	22	21	16	15	100
	Core age (30–49 years)	18	19	20	21	22	100
Age	Older (50–64 years)	19	21	19	21	20	100
	Old (65+ years)	26	29	10	16	20	100
Employment status	Part-time	40	21	15	14	10	100
	Temporary	29	23	20	16	11	100
Nationality	EU	28	19	20	15	17	100
	Non-EU	35	19	17	13	16	100
Education	Primary	37	29	20	10	5	100
	Secondary	22	24	24	18	13	100
	Tertiary	6	8	13	30	43	100
Self-employed	With employees	16	14	14	17	39	100
	Without	22	26	18	16	19	100
Broad sector	Manufacturing	7	22	28	19	24	100
	Construction	4	11	61	10	14	100
	Private knowledge-intensive services	6	12	12	24	47	100
	Public knowledge-intensive services	11	19	22	32	16	100
	Less knowledge-intensive services	44	18	11	15	12	100

Note: Quintiles do not always sum to 100 due to rounding; see Annex 3 for employment distribution by job-education quintile.
Source: *EU-LFS, SES (authors' calculations)*

Table 3 shows the distributional impact of some well-known wage biases – the gender pay gap, the part-time penalty, the wage benefits accruing from education – related in some cases to forms of occupational or sectoral segregation. More female workers are found in the lowest quintile (29%) than in the top quintile (16%). The situation of younger workers (under 30 years) is similar, with 30% in the lowest quintile and 15% in the top quintile. The oldest workers (65 years and over) are also over-represented in lowest-quintile jobs, but in top quintile jobs, their representation is average. Part-time workers, and to a lesser extent those on temporary contracts, are also much more likely to be in jobs in the lowest quintile.

The clearest determinant of a worker's place in the job-wage distribution is their educational attainment. Nearly three-quarters (73%) of working university graduates are in the top two quintiles, compared to 31% of those who completed secondary education only and 15% of those who completed primary education only. The table also gives weight to an explanation of employment polarisation more related to known trends of changing workforce composition than, for example, to the increasingly orthodox routine-biased technical change explanation (see Part 2). Everything else being equal, growing shares of part-time and temporary work tend to raise lower-quintile employment disproportionately. The rising share of private knowledge-intensive services employment boosts the top quintile, while the secular decline in manufacturing and the sharp, more cyclical and recent decline in construction tend to destroy employment in the middle quintiles. Construction sector employment is overwhelmingly concentrated in the middle quintile (61%). Taken together, developments in all of these categories tend to generate employment shifts with a reverse-hump shape, whereby relatively strong growth at the bottom and in particular at the top is accompanied by a declining share in mid-paid jobs.

The sections that follow analyse the recent employment shifts according to different labour market and demographic factors. The employment shifts are presented in terms of absolute numbers for each category and quintile. Account should therefore be taken of unequal starting employment shares by category, and unequal employment distribution across the job-wage quintiles in interpreting the marginal change. This point is most clearly made using gender as an example: bigger absolute increases in top-quintile employment for women than men – as observed in all recent periods – imply even greater relative increases in view of the lower share of women in the starting period, both in terms of overall employment and specifically in the top quintile, as indicated in Table 3.

Patterns of employment change by sector

Construction and manufacturing took the brunt of the recession's impact on the labour market. Employment continues to decline in both. There were 3.5 million fewer construction sector jobs (representing close to a 20% decline) and 4.8 million fewer manufacturing jobs (13% decline) in 2013 Q2 compared to 2008 Q2. The most recent two years of that period have seen net employment losses of over one million jobs in each sector.

The destruction of manufacturing employment was concentrated in the peak recession period of 2008–2009; after 2010, the rate of decline eased somewhat. Despite construction being a more cyclical sector in nature, it has continued to record sharp net job loss throughout the period (relatively higher than manufacturing). Even the period of post-crisis stimulus-led growth between mid-2009 and mid-2011 was insufficient to restore employment growth.

Employment declines in construction have tended to be concentrated in specific countries such as the Baltic states, Bulgaria, Ireland and Spain – countries that experienced a disastrous boom–bust cycle. Manufacturing employment declines have been more evenly spread across countries. Spain, for example, shed approximately one-quarter of its manufacturing jobs since 2008 but 60% of its construction jobs.

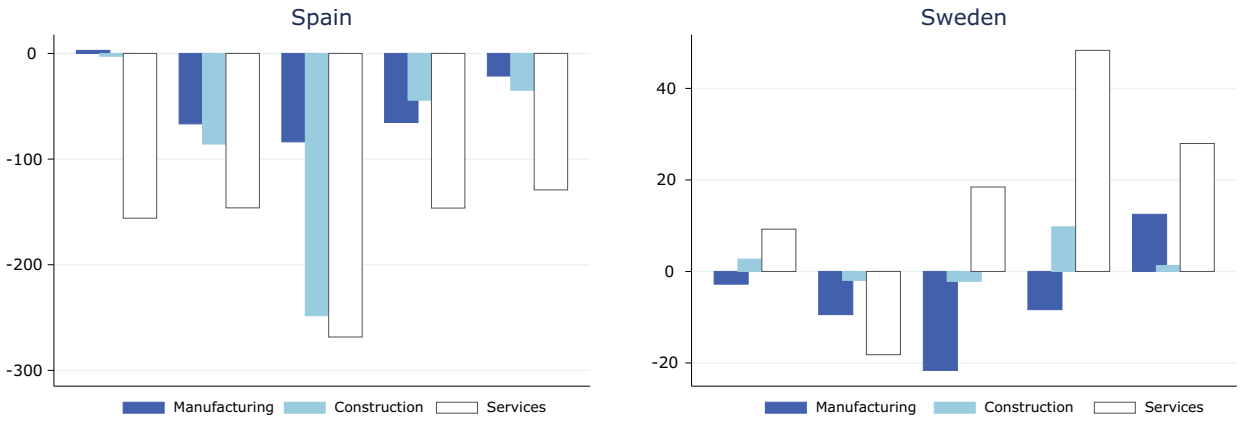
Figure 6: *Employment change (in thousands) by job-wage quintile and broad sector, EU, 2011 Q2 to 2013 Q2*

Note: Data for 26 Member States; Germany and the Netherlands excluded due to data breaks.
Source: *EU-LFS, SES (authors' calculations)*

As Figure 6 confirms, the concentration of net employment decline in mid-paid and low–mid-paid jobs continues to relate primarily to these two sectors. Relatively marginal gains or losses in the top and bottom quintiles for manufacturing and construction reflect their low share of employment in these quintiles, as previously noted.

By contrast, employment in services has continued to grow, albeit modestly by historical standards, both during and after the global financial crisis. This growth has, however, been very much concentrated in well-paid jobs, with nearly one million net new jobs created during 2011 Q2 to 2013 Q2. There has also been some modest growth in bottom-quintile service jobs, but a decline in each of the middle quintiles. In their different ways, each of the three broad sectoral groupings has contributed to the aggregate pattern of employment polarisation.

Figure 7: *Employment change (in thousands) by job-wage quintile and broad sector, Spain and Sweden, 2011 Q2 to 2013 Q2*



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

At country level, some countries show quite divergent patterns. In Spain, service employment declines exceeded those in manufacturing and construction in each of the five quintiles. Even though Spain's employment crisis has been particularly severe, this is still unusual. It is partly explained by public sector retrenchment as a result of austerity – public sector job

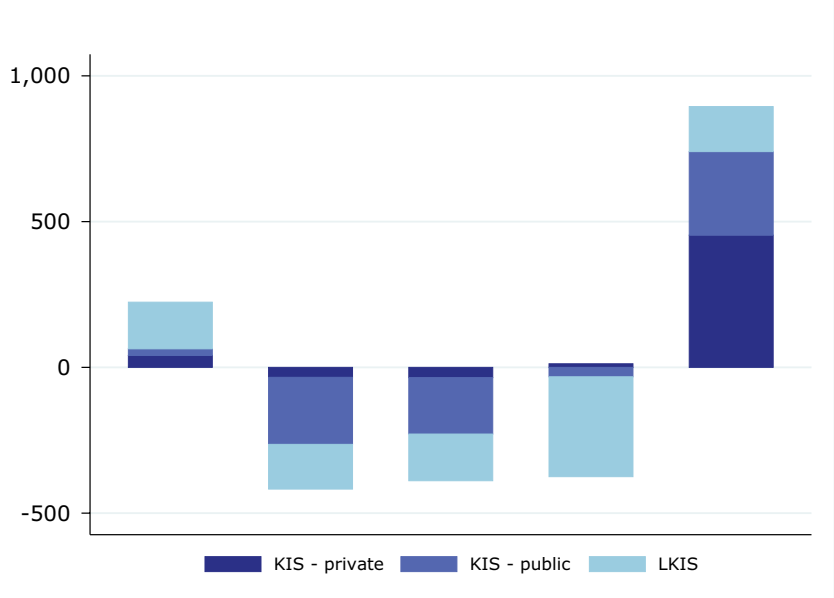
losses accounted for around one-half of net job destruction in the top three quintiles in Spain. The delay in the impact on services of the severe, earlier declines in construction and manufacturing – which as Figure 7 indicates are ongoing – is also a factor.

In Sweden, by contrast, the labour market has recovered from the global crisis better than most other countries. Here, as elsewhere, services have contributed most to net employment growth; this has been most evident in the top three quintiles. Manufacturing employment has declined mainly in the middle quintiles, though there has been some countervailing growth in the top quintile. Construction has recorded employment gains, concentrated in the mid–high-paid quintile (quintile 4).

Service sector developments

The service sector accounts for more than two-thirds of employment in Europe, and its share of overall employment is growing as manufacturing and the primary sector (agriculture and extractive industries) continue to contract. In three Member States – Luxembourg, the Netherlands and the UK – the service sector accounts for over 80% of employment. Only three countries have service employment shares less than 60%; these are the 2004–2007 accession countries: Poland (57%) and Romania (42%), primarily as a result of large agriculture sectors, and the Czech Republic (59%), due to its large manufacturing base.

Figure 8: *Employment change (in thousands) by job-wage quintile and service sector grouping, EU, 2011 Q2 to 2013 Q2*



Note: Data for 26 Member States; Germany and the Netherlands excluded due to data breaks. KIS – private = private knowledge-intensive services; KIS – public = public knowledge-intensive services; LKIS = less knowledge-intensive services.
Sources: *EU-LFS, SES (authors' calculations)*

In a context of coordinated euro zone efforts to balance budgets, public sector spending is being curtailed in many Member States, especially those with substantial debt burdens following years of crisis. The capacity of the public sector to generate new employment to compensate for weak aggregate private sector demand was one hallmark of the peak crisis period (2008–2010), when health and education accounted for most new employment in the EU (Eurofound 2011, 2013). Reduced spending necessarily has an impact on public service employment. This is reflected in Figure 8, which differenti-

ates between three types of services: public knowledge-intensive services, private knowledge-intensive services, and less knowledge-intensive services.[5]

Public knowledge-intensive services, comprising health, education and public administration, added no employment overall during 2011 Q2 to 2013 Q2. Any gains in top-quintile jobs were offset by losses in middle-quintile jobs. In less knowledge-intensive service sectors, such as retail, accommodation and catering, demand tends to be more cycle-sensitive. These services suffered employment declines overall, although they did record an increase in top-quintile employment.

Private knowledge-intensive services comprise a broad range of activities including media, IT, consulting, advertising, financial, legal services and accounting. They have accounted for the majority of top-quintile employment growth. Specific well-paid jobs in this category that are growing include ICT professionals in computer programming as well as business and administrative professionals in sectors such as wholesale, financial services and management consultancies (see Table 3 above).

[5] As there is no specific question in the EU-LFS regarding the public or private status of a respondent's employer, the combined NACE sector categories of public administration, social security and defence, education and human health activities were used as a proxy for public knowledge-intensive services. It is important to acknowledge that this is a very imprecise proxy. For example, estimates from the Irish public sector reform programme indicated a reduction in the number of public service employees from 320,000 to 290,000 since 2008. Over a similar period (2008 Q2 to 2013 Q2), employment in public knowledge-intensive services in Ireland increased from 467,000 to 490,000. Given that there are significant and probably growing shares of private education and health sector workers in many Member States, the more limiting definition of public sector workers as comprising only those working in public administration, compulsory social security and defence could be used instead. In Ireland, between 2008 Q2 and 2013 Q2, employment according to this narrower definition shrank from 102,000 to 95,000. The relative contraction is at least consistent with the Irish government's own estimates of changing public service employment. While Ireland may be an unrepresentative case because of the high share of private employment in education and health compared to other countries, this example still illustrates the difficulty of estimating public sector employment using the NACE sector classification.

2 Patterns of employment change by worker characteristics

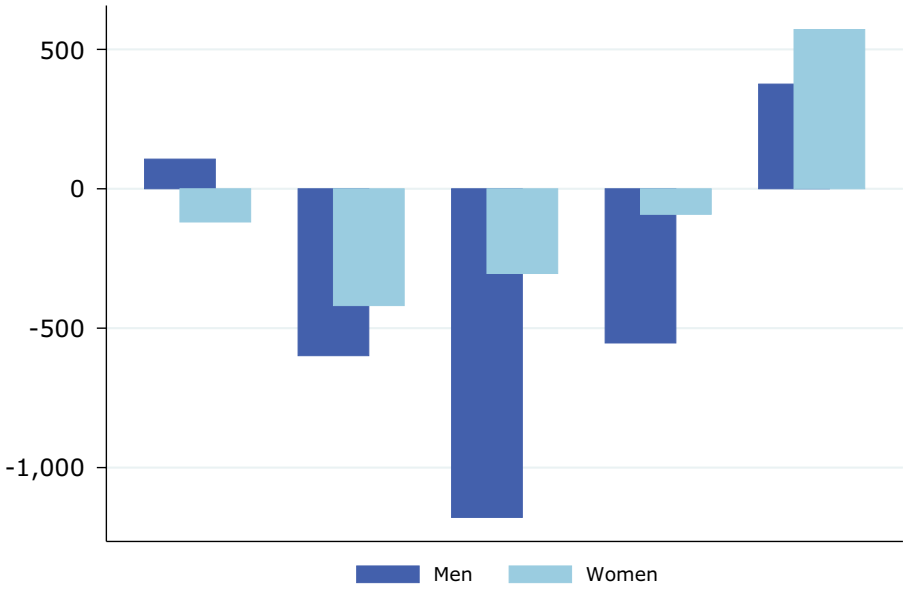
In this chapter, recent employment change (from 2011 Q2 to 2013 Q2) is broken down by job-wage quintile and the following background variables: gender, age, and the employment status dichotomies of full time/part time, self-employment/employee and fixed term/permanent.

Gender

The global financial crisis had a significant impact on the gender employment gap, reducing the differential in the share of men and women in the workforce. In the three Baltic Member States, women outnumber men in the workforce, while at aggregate EU level, women now account for nearly 46% of total employment, a rise of over 2 percentage points since 2000. The economic crisis accelerated this convergence due to its disproportionate impact on male-employing sectors such as construction and manufacturing. While the rate of convergence has since eased off, women are still faring better than men. Since 2011 Q2, female employment in the EU has increased modestly (over 60,000), while male employment has declined (further) by nearly 1.4 million.

Women have benefited most from top-quintile employment growth and have suffered more modest declines in the middle quintiles compared to men. Unequal gender representation in specific sectors and jobs contributes to these patterns. Women are over-represented in the top-quintile job that saw the highest growth – health professionals in the health sector – and are under-represented in the construction and manufacturing jobs, which contributed to most lost employment in the middle quintiles. In the lowest-paid jobs, there was a modest rise in male employment, which relates at least in part to take-up of lower-level service employment by men displaced from the construction and manufacturing sectors. The largest net job losses in the bottom quintile were among cleaners and helpers working for private household employers – a predominantly female job. Another factor behind the declining proportion of women in low-paid employment was a relatively sharp decline in female agricultural employment compared to that for men.

Figure 9: *Employment change (in thousands) by job-wage quintile and gender, EU, 2011 Q2 to 2012 Q2*



Note: Data for 26 Member States; Germany and the Netherlands excluded due to data breaks.
Source: *EU-LFS, SES (authors' calculations)*

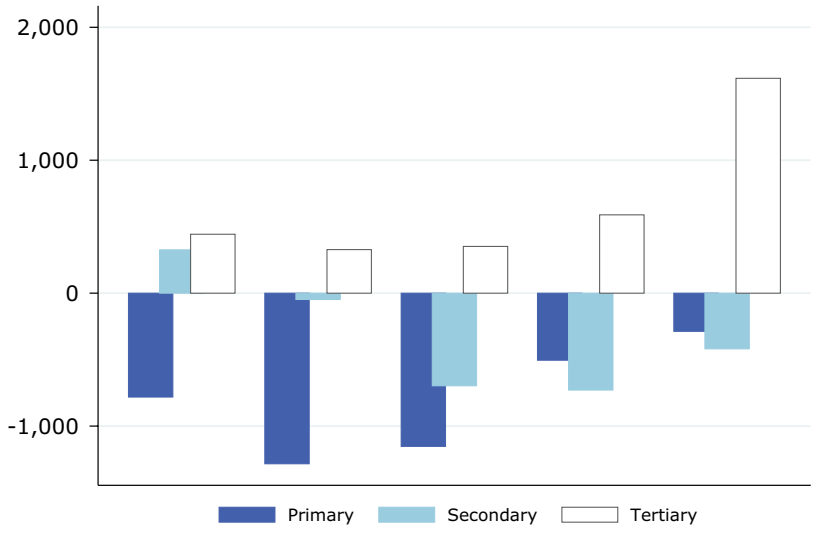
In summary, employment shifts continued to favour women both quantitatively and qualitatively. Women gained more of the growth in top-paid jobs, both in absolute and, especially, in relative terms. Employment shifts for men were more or less symmetrically polarised, with greater relative growth at either end of the wage distribution. For women, the pattern is one of mixed polarisation and upgrading. An important caveat in interpreting this data is that Figure 9 shows marginal change in a short, two-year period; much more time would be required to eliminate existing gender gaps.

Education

The main explanatory hypothesis regarding skills and labour market demand is that of skill-biased technical change (SBTC). According to this hypothesis, technological advance and the organisational changes it brings about generate a relatively greater demand for higher-skilled workers and a relatively weaker demand for lower-skilled workers. The formal education system in modern developed economies is the primary mechanism for supplying the human capital needs of the labour market. For this reason, SBTC requires supply-side reforms to education systems to upgrade skill and education levels and to facilitate lifelong learning (Goldin and Katz, 2008). One of the headline Europe 2020 policy targets is that 40% of those aged 30–34 years are third-level graduates by the end of the decade.

The skill or education composition of the workforce also improves for simple cohort reasons; younger labour market entrants are more likely to have higher levels of education, while departing workers, especially retiring older workers, are more likely to have lower levels of education.

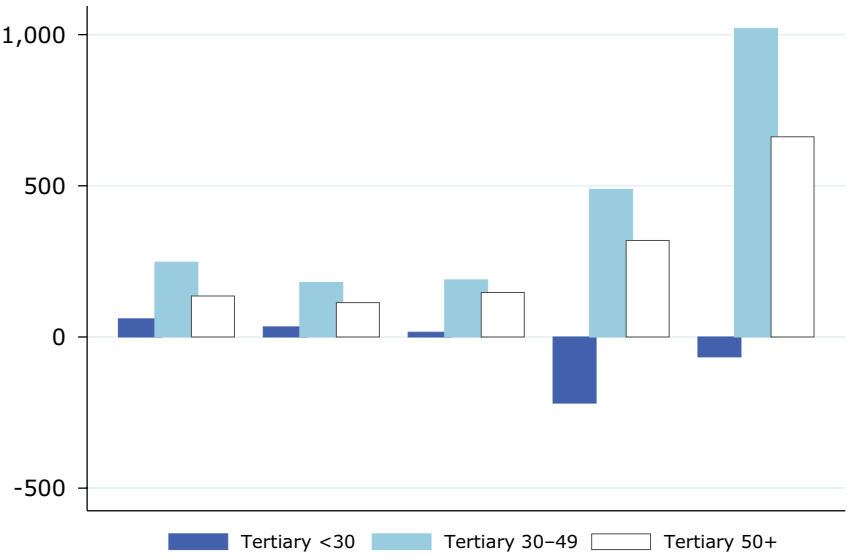
Figure 10: *Employment change (in thousands) by job-wage quintile and educational attainment, EU, 2011 Q2 to 2013 Q2*



Note: Data for 26 Member States; Germany and the Netherlands excluded due to data breaks.
Source: *EU-LFS, SES (authors' calculations)*

As Figure 10 shows, this combination of strong cohort effects and a greater relative demand for higher-skilled workers is a powerful engine for the positive recomposition of the workforce. Levels of graduate employment increased in jobs across the quintiles but mostly in the top quintile, where over 1.7 million new graduate-level jobs were created between 2011 Q2 and 2013 Q2. Third-level graduates even accounted for the biggest share of increased employment in low-paid jobs. Employment declined for those with primary or secondary educational attainment only. Losses for those with primary education were concentrated in jobs at the lower end of the wage distribution, while losses for those with secondary education were mainly in the middle and top quintiles.

Figure 11: *Employment change (in thousands) by job-wage quintile and age for third-level graduates, EU, 2011 Q2 to 2013 Q2*



Note: Data for 26 Member States; Germany and the Netherlands excluded due to data breaks.
Source: *EU-LFS, SES (authors' calculations)*

Most employment growth is accounted for by job reallocation, involving the replacement of workers with non-tertiary education by those who have tertiary education. It may seem that a significant share of this job reallocation, therefore, would have benefited newly qualified younger graduates. This, however, is not the case. As Figure 11 shows, employment declined for graduates aged 15–29 years between 2011 Q2 and 2013 Q2. The main declines were recorded in well-paid jobs in the top two quintiles, while there was some modest growth in the lower quintiles. This pattern is almost the reverse of what happened for core-age workers (30–49 years) and older workers (over 50 years). For these workers, there were net employment gains across the quintiles, and these gains were strongly skewed towards the top quintiles.

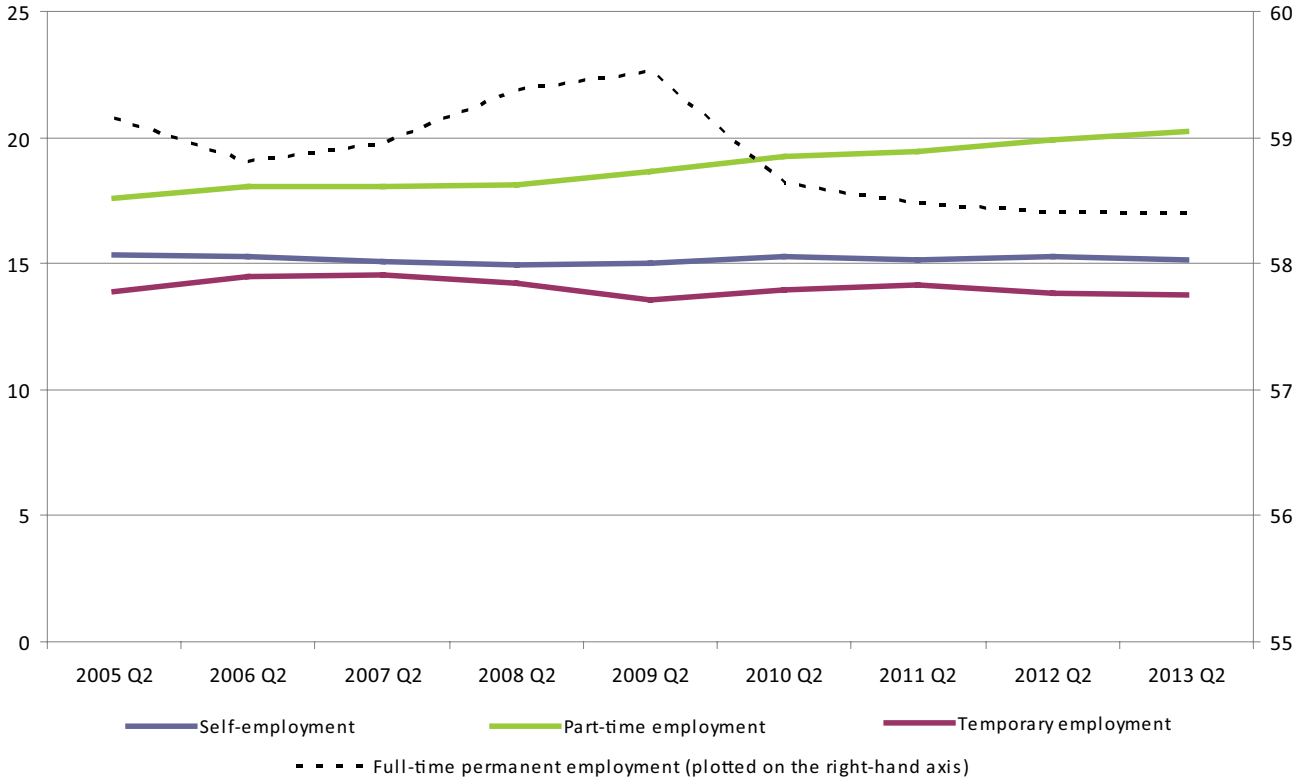
One important contributing demographic factor is that in 2011 Q2, the cohort aged 28–29 years – the outflow cohort – is almost 15% larger than the cohort aged 14–15 years. Another is the relatively greater impact of the crisis on employment chances for younger workers and labour market entrants, a hallmark of all recessions. Nonetheless, it is striking that the most recent graduates make no positive contribution to top-quintile employment in an increasingly knowledge-based economy that is supposed to attach a great premium to freshly acquired skills.

Employment status

A smaller share of European workers are in full-time, permanent employment than in the past, but this category still applied to 58.2% of the workforce in 2013 Q2 (with a decline of around 1 percentage point since the onset of the crisis in 2008). There has been a modest increase in the share of employees in fixed-term or temporary contracts over the last decade, although the recession has tended to reduce this share (primarily as a consequence of the huge destruction of temporary jobs in Spain). Self-employment has remained quite stable over the last decade at around 15% of total employment, although the ratio of sole operators to self-employed people with employees has increased from 2:1 to 2.5:1; that is, there are fewer employing entrepreneurs in relative terms. The main factor behind the recent destandardisation of the

employment relationship has been the rise of part-time work, which in 2013 accounted for over 20% of workers, up from 16% in 2002.

Figure 12: *Changing share of employment (%) in standard and non-standard employment forms, EU, 2002 Q2 to 2013 Q2*

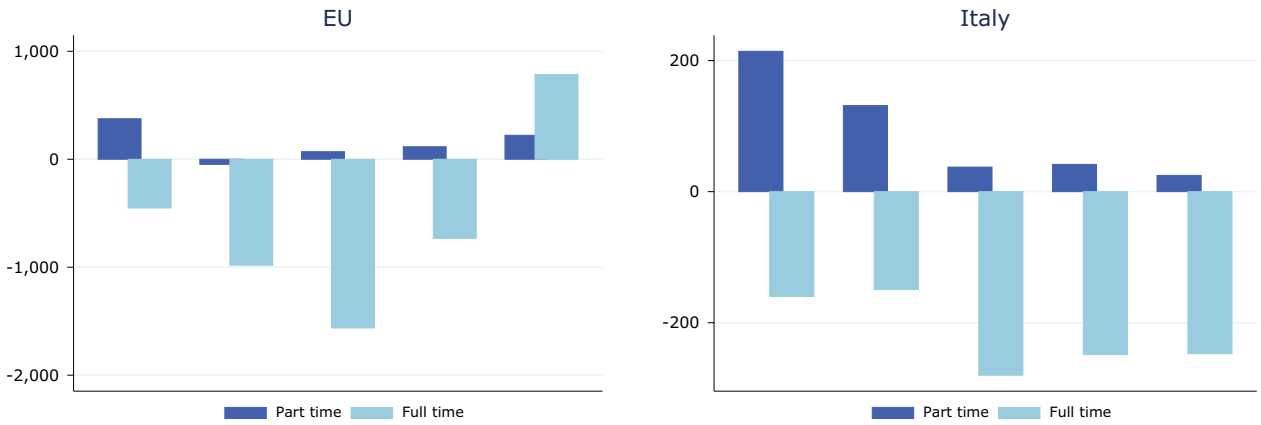


Note: Full-time permanent employment is plotted on the right-hand axis; other variables are plotted on the left-hand axis.
Source: *EU-LFS (authors' calculations)*

Part-time work

Part-time employment grew in four of the five quintiles between 2011 Q2 and 2013 Q2 and grew overall in absolute terms (by 1.5 million workers) while full-time employment levels declined. This category is most strongly represented in the lowest quintile, which has by far the strongest concentration of part-time employment, as shown in Table 3 above. During this period, part-time employment grew significantly in middle-quintile and especially top-quintile jobs as well-paid jobs were increasingly filled on a part-time basis. This can occur at the worker's initiative, for reasons such as work–life balance, or because an employer cuts hours of work in order to retain staff while responding to declining demand. Many mid-paid jobs that shed the highest overall number of workers added part-time workers, which again may suggest that some employers elected to change full-time positions to part-time ones as an alternative to shedding employment.

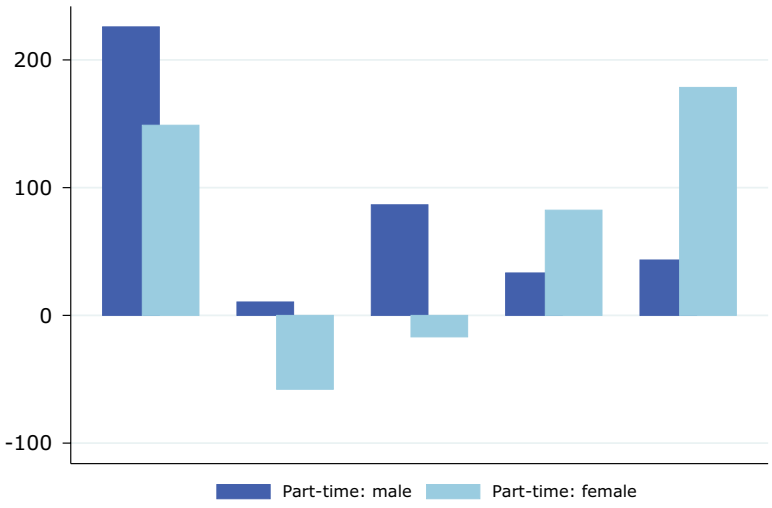
Figure 13: *Employment change (in thousands) by job-wage quintile and full-time or part-time status, EU and Italy, 2011 Q2 to 2013 Q2*



Note: Data for 26 Member States; Germany and the Netherlands excluded due to data breaks.
Source: *EU-LFS, SES (authors' calculations)*

Germany and Italy are the two countries contributing most to recent part-time employment growth in the EU. Each country added around half a million part-time workers between 2011 Q2 and 2013 Q2. In Germany, this coincided with overall employment growth. In Italy, as Figure 13 shows, across the wage distribution all net new employment was in part-time work and all net employment declines were in full-time work. This process of destandardisation also contributed to a relative downgrading of employment; declines in full-time employment were only compensated by countervailing gains in part-time employment in lower-paid jobs, while the concentration of job losses was in full-time jobs in the top quintiles.

Figure 14: *Employment change (in thousands) by job-wage quintile and gender for part-time workers, EU, 2011 Q2 to 2013 Q2*



Note: Data for 26 Member States; Germany and the Netherlands excluded due to data breaks.
Source: *EU-LFS, SES (authors' calculations)*

Since the recession, part-time work has become less dominated by women; net new part-time employment has been filled by men. But whereas most new male part-time employment was strongly skewed towards the lower quintiles, net new female part-time employment was more likely to occur in higher-paying, higher-skilled jobs.

What specific occupations and sectors account for this interesting development? Most (over 60%) of net new male part-time jobs in the bottom quintile were in three typically female-dominated occupational categories – personal care workers, sales workers and cleaners/helpers. One avenue of re-employment for male workers displaced from the construction and manufacturing sectors has been through less well-paid service work in the food and beverage, construction and retail sectors. For women, new part-time employment tended to be in professional and managerial occupations, notably business and administration professionals, health professionals and commercial or administrative managers. These jobs could represent existing full-time jobs being converted to part-time ones, as well as newly created part-time jobs.

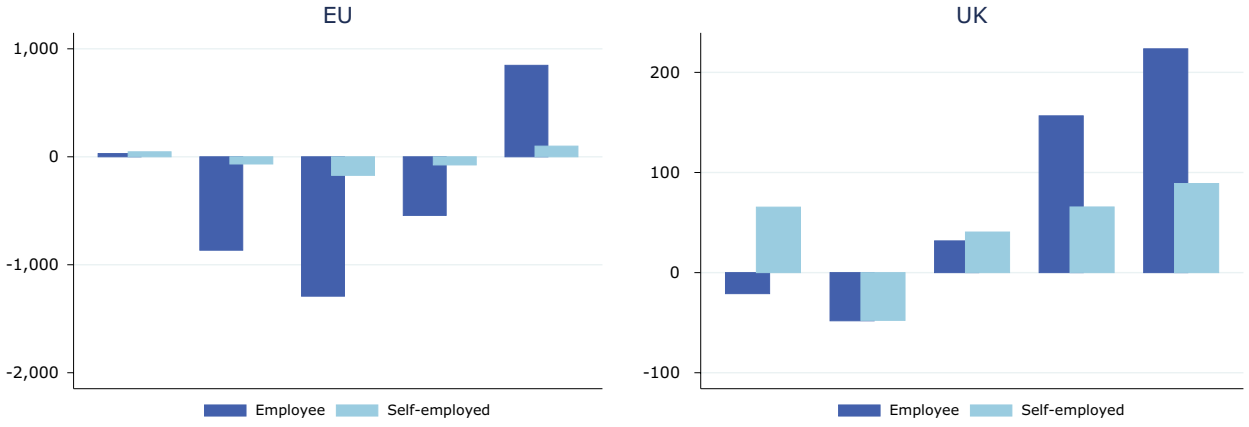
In summary, three trends distinguish recent developments in part-time work.

- Part-time work is becoming increasingly male.
- Male workers are increasingly likely to take on less well-paid, traditionally 'female' jobs.
- An increasing proportion of high-skilled, professional women are performing their jobs on a part-time basis.

Self-employment

The self-employed share of overall employment has remained stable in recent years, but there is evidence that self-employment contributes to overall polarisation by growing more at either end of the wage distribution than in the middle. As Figure 15 indicates, self-employment contributes only modestly to overall employment shifts at aggregate EU level, although in some countries, such as the UK, self-employment has played a more significant role in recent employment growth.

Figure 15: *Employment change (in thousands) by job-wage quintile and employment status, EU and UK, 2011 Q2 to 2013 Q2*



Note: Data for 26 Member States; Germany and the Netherlands excluded due to data breaks.
Source: *EU-LFS, SES (authors' calculations)*

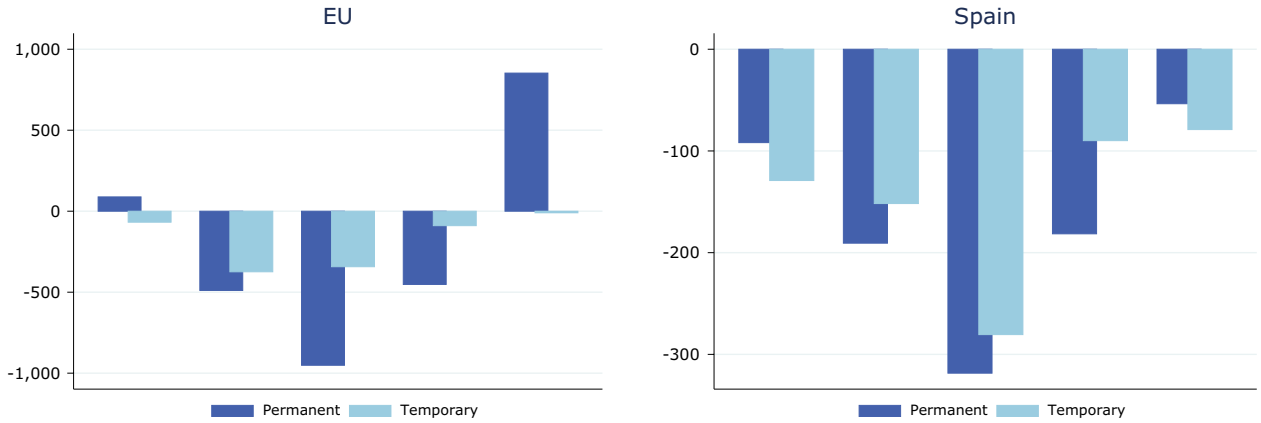
The bottom quintile saw the highest level of sectoral reallocation of self-employment. Big losses in agriculture and retail were more than compensated by net increases in self-employment in food and beverages, services to buildings and personal services. The decline in agriculture and retail self-employment relate to secular trends: the contracting overall share of agricultural employment and accelerating processes of consolidation within the retail sector that are eliminating smaller shop-holders.

In the top quintile, the growth of self-employment reflects trends towards freelancing and independent consultancy among higher-level, experienced professionals. The jobs contributing most to self-employment growth were ICT professionals and business and administrative professionals in management consultancy and head offices. This has contributed to a strong differentiation in self-employment growth by age in the EU; strong gains for the older worker group (including those over 65 years) are counterbalanced by declines of a similar scale among young and core-age groups. It should be of concern to those promoting more dynamic, entrepreneurial economies that workers under 50 years and self-employed people employing others represent a shrinking share of the self-employed population.

Fixed-term employment

Fixed-term or temporary employment is the one form of atypical work to have contracted in the EU during 2011–2013, shedding 800,000 jobs. Developments in one country, Spain, account for nearly all of this aggregate loss. This is due to the high (though sharply declining) share of temporary employment there and the disproportionate impact of the huge recent employment destruction in Spain on temporary workers. Temporary employment in Spain now accounts for a much reduced share (24% of dependent employees compared to 35% in 2006) of a much reduced workforce. Aggregate temporary job losses reflect overall developments in Spain, with a strong concentration in the mid and mid–low quintiles.

Figures 16: *Employment change (in thousands) by job-wage quintile and permanent or temporary status, EU and Spain, 2011 Q2 to 2013 Q2*



Note: Data for 26 Member States; Germany and the Netherlands excluded due to data breaks.
Source: *EU-LFS, SES (authors' calculations)*

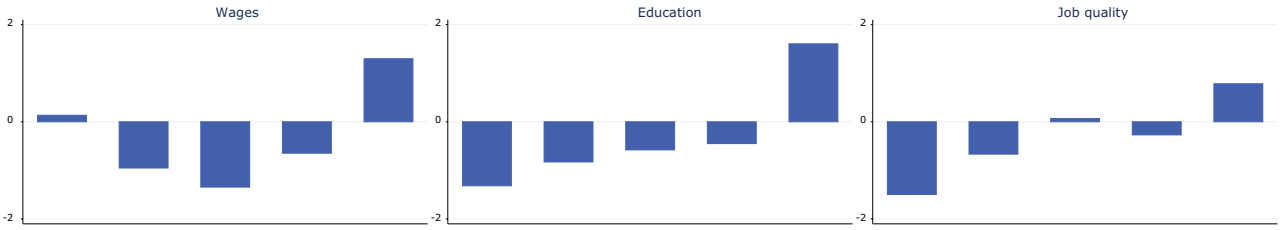
Increasing fixed-term employment was observed in Bulgaria, the Czech Republic, Hungary and Malta (with a strong concentration in lower-quintile jobs). Meanwhile, disproportionate temporary job losses were recorded in two 'programme' countries, Greece and Portugal, primarily in the middle quintiles in Portugal and in the lowest quintiles in Greece. The ongoing woes of the construction sector, especially in the southern European Member States, represented the main contributing factor to declining fixed-term employment (accounting for around one-half of total net losses), although substantial losses, amounting to177, 000 jobs, were also recorded in public administration. All of net EU employment growth in the top quintile came in permanent jobs.

Comparing employment shifts using different job quality measures

It is important to note that the nature of the observed changes in employment depends on the particular job quality criterion used to rank jobs. Most of the analysis both here and in related previous work (Eurofound, 2008a, 2011, 2013) concentrates on the job-wage as the primary ranking criterion. Wages are only one dimension of job quality, but they tend

to be an important one, as they are highly correlated with other relevant aspects of job quality. Wage data are also more widely collected given the importance of this factor in all economic and social outcomes. As Wright and Dwyer (2003) note, earnings are a 'sufficient salient aspect of job quality' to be used as a proxy, even if the concept itself is multidimensional. The use of mean or median wage as the basic ranking criterion has also been the common approach of much of the employment polarisation literature (Autor, 2010; Goos and Manning, 2007). But in this analysis, the use of the job-wage ranking to assign jobs to quintiles tends to generate more polarised patterns of employment change, with greater relative growth at the edges and less in the middle, than other ranking criteria (Eurofound, 2013).

Figure 17: *Employment change (%) by wage, education and job quality quintile, EU28, 2011 Q2 to 2013 Q2*



Notes: Figure incorporates data adjustments for Germany and the Netherlands to reflect changed occupational classifications in 2011–2012 and 2012–2013 respectively.
Source: *EU-LFS, SES (authors' calculations)*

Figure 17 compares observed employment shifts using the job-wage ranking with an education-based ranking and a non-pecuniary job quality ranking. The education ranking is based on the average educational attainment of workers, using the International Standard Classification of Education (ISCED) variable in the EU-LFS. The job quality ranking is based on a multidimensional non-pecuniary job quality indicator based on answers to 38 questions in the 2010 European Working Conditions Survey (see Annex 1 regarding construction of the index).

There are some points of similarity between the three charts, reflecting the high correlation (greater than 0.7) between the different measures of job quality used to rank jobs. The top quintile is growing regardless of the ranking criterion, and job destruction is concentrated in quintiles 1–4 in all three charts. But Figure 17 also shows that the polarisation trend is limited to changes in the job-wage structure. Both in terms of education and non-pecuniary job quality, the pattern instead has been one of occupational upgrading in this period.

The reason for this discrepancy is that a substantial proportion of jobs in the middle of the wage distribution have a relative wage premium; that is, they have a higher relative position in terms of wages than education or non-pecuniary job quality attributes. These jobs, many of which are in construction and manufacturing, have been responsible for a large share of overall job destruction during the crisis. This job destruction is recorded in quintiles 2 and 3 of the job-wage distribution but in quintiles 1 and 2 of the job-education ranking.

Similar studies covering earlier periods, such as 1995–2007 and 2008–2010, and individual countries, show similar patterns (Eurofound, 2013). Employment polarisation, which is more or less asymmetric depending on the period, is observed only when using job-wage to rank jobs. Employment upgrading is observed when using either the education or the job quality rankings.

This is important since much research on employment polarisation tends to proxy skill levels or job quality using wages or simple occupational hierarchies, as if wage and skill or skill and occupational level were strictly correlated. In reality, the correspondence is not so simple. Job-wage hierarchies, in particular, tend to be idiosyncratic compared to those based on education or job quality.

As Green points out, using wages as a proxy for job skill runs up against the problem that 'other factors (regulation, employment relations, gender, labour market competition, location) that have little or no correlation with skill also affect wages' (Green, 2013, p. 46). Using educational attainment as a proxy for job skill is also problematic. Many high- and medium-skilled jobs may not require high educational levels in order to be performed well. On-the-job training and learning are much more important in many skilled construction and manufacturing occupations, for example. Simple ISCED-based measures of completed formal education will tend to underestimate skill levels required to carry out such jobs.

No simple proxy of job skill or job quality is perfect. Each is partial and overlooks dimensions of what are intrinsically multi-dimensional phenomena. But it should at least prompt some caution that the diagnosis of employment polarisation may be reliant on one proxy measure only of job skill: wages. A further caveat is that a ranking measure that is closer to the idea of 'skill', the average educational attainment of workers, characterises employment shifts in a more positive, upgrading light, more in line with the predictions of SBTC (see Part 2 for a more detailed discussion of these issues).

Conclusions 3

Employment levels in the EU28 declined by around 1.4 million during the period 2011 Q2 to 2013 Q2, a second European phase of the global economic crisis that began in 2008. The bulk of net employment losses occurred in mid-paid and mid–low-paid jobs, especially in construction, manufacturing and, more recently, public administration.

Various occupations in the construction sector saw the largest employment declines. The two jobs with the greatest employment growth were well-paid jobs, in the top quintile of the wage distribution, in knowledge-intensive services: health professionals in the health sector and ICT professionals in computer programming, consultancy and related activities. Employment growth remains resilient in high-paid, high-skilled jobs. Private knowledge-intensive services were the main source of employment growth. Net employment growth occurred only in top-quintile jobs. There were net employment declines in all other quintiles, with a concentration in mid-paid and mid–low-paid jobs.

Recent employment shifts have been less polarising than those of the peak crisis period of 2008–2010. The aggregate shift pattern in 2011 Q2 to 2013 Q2 was one of upgrading with some polarisation. By contrast, 2008–2010 saw polarisation with some upgrading.

At Member State level, upgrading patterns were more likely to be observed in countries with more resilient labour markets, such as Austria, Germany and Sweden. Polarisation, characterised by relatively greater losses in the middle quintiles, was a key feature of employment shifts in countries with troubled labour markets, such as Greece, Portugal and Spain.

Continuing recent trends, female employment has fared better in both qualitative and quantitative terms. Women account for a larger share of recent employment growth in top quintiles, while men account for a greater share of employment decline in mid-paid jobs and a greater share of growth in low-paid jobs. Employment changes for men have been clearly polarising, while for women they have been more upgrading.

The crisis has intensified both workforce ageing and educational upgrading. The proportion of younger workers in the workforce has declined, while that of older workers has increased. Meanwhile, the proportion of graduates in employment has increased sharply. This is due to a combination of demographic trends: the retirement of older workers with lower average levels of educational attainment; greater relative demand for higher-skilled, higher-paid workers; and the greater vulnerability to job loss of those with basic educational attainment in a time of accelerated structural change.

Although there has been a marked increase in the share of third-level graduates in the workforce, the employment level of younger university graduates (aged under 30 years) has decreased. This is because of net declines in employment in well-paid jobs for this group, which has been partially offset by increases in low-paid jobs.

Recent, strong growth in the share of part-time employment has been the main contributing factor to the longer-term trend of destandardisation of the employment relationship. Although traditionally dominated by women, recent part-time employment growth has been split equally between men and women. New female part-time employment has tended to be in well-paid jobs, while new male part-time employment has tended to be in low-paid jobs.

Part 2

Testing theories on what drives job polarisation and upgrading

1 Background: Analysing change in the occupational structure

Introduction

It is well established that inequality has increased substantially in most developed economies since the 1980s. This trend may be one of the key factors behind the economic crisis that started in 2008 and whose end is still uncertain in 2014. Some even argue that increasing inequalities may be driving developed economies into a period of secular economic stagnation (Krugman and Wells, 2012; Stiglitz, 2012; Rajan, 2011; for a recent review of the link between inequality and growth, see Ostry et al, 2014).

What are the main drivers behind this increase in inequality? Three factors have been singled out, although there is much debate about the relative importance of each of them: technology, globalisation and institutional change. The main argument regarding technology has been that the information technology revolution has had a 'skills-biased' effect on labour demand, increasing the relative demand for high skills in the labour market and, therefore, their wage premium against the rest (Goldin and Katz, 2008). Globalisation, it has been argued, hugely expands the global supply of low-skilled labour, thereby putting downward pressure on the employment and earnings of low-skilled workers in developed economies (Freeman, 2008). Finally, the reorientation of public policies towards deregulation and a partial dismantling of the welfare model have also been considered as plausible explanations for increasing inequality. For instance, the weakening of industrial relations systems and the reduction of employment protection schemes can undermine the bargaining position of workers and put downward pressure on wages, especially for low-skilled workers (Fortin and Lemieux, 1997; Lemieux, 2008).

The transformation of the occupational structure is one key vector of these large-scale socioeconomic transformations. It is one of the main transmission mechanisms linking the changes in technology, trade and institutions to changes in the distribution of economic resources and life chances. Technology, trade and institutions affect the nature and types of jobs available in the economy; jobs that require particular skills and specialisation, involve different working conditions and give access to economic resources and social status. The increasing levels of economic inequalities must be therefore associated with a particular type of change in occupational structures.

What would be the occupational correlate of the general increase in inequalities in recent decades across most developed economies? What have been the effects of those three main forces (technology, trade and institutions) on occupational structure? The relevant research literature offers a few more or less established facts, and many areas of debate and controversy. In terms of the type and direction of structural occupational change (what types of jobs are growing and declining overall), it seems generally agreed that high-skilled and high-paying occupations have tended to grow faster than other occupations in most countries over the last two or three decades. This fact is coherent with the evidence on increasing wage inequalities. Less clear is the direction and type of change in the rest of the occupational structure. Did low-skilled jobs grow relative to middle-skilled jobs? In other words, did job polarisation occur? Or was there a consistent upwards skill bias in labour demand? To what extent did the developments differ across countries, and what do such differences mean?

The relative importance of technology, trade and institutions in influencing such change and the nature of their impact remains controversial. Is one of the three the dominant driver of recent occupational changes? Are the factors associated with particular patterns of structural change, such as polarisation or upgrading? Do different combinations of these three factors lead to different outcomes in terms of job polarisation or upgrading?

The recent discussion of the drivers behind occupational change has been made difficult by some significant data problems. Despite important advances in recent years, the limited availability of comparable statistical sources measuring occupation-specific attributes, such as task content, social interaction or union density, makes it very difficult to study empirically the effect of such forces. Therefore, in most of the literature on this issue, the connection between the evidence of job upgrading or polarisation and the proposed underlying factors is very difficult to establish empirically. As a result, the conclusions are generally suggestive interpretations based on broad observed associations between different indices. The lack of good sources is also associated with a certain degree of inconsistency between the concepts proposed and their operationalisation. The construction of indices to test the proposed explanations is often relegated to appendices and given little attention, even though it crucially affects the analysis and conclusions. In general, the focus is on modelling and testing, rather than the construction of the indices that operationalise the theoretical concepts.

This report aims to contribute to the ongoing debate about the drivers of job polarisation and upgrading by taking the opposite approach. It focuses on the discussion and operationalisation of the proposed explanations of occupational change, constructing a new set of relatively simple and transparent indices. These indices are used to test some of the implications of the proposed explanations in, again, a simple but transparent way. This is done by analysing the correlation patterns between different indices and by modelling a counterfactual analysis of the patterns of job polarisation and upgrading.

But first the report starts with a brief recapitulation of the evidence regarding the theme of this report: job polarisation and upgrading in Europe.

Recent patterns of structural employment change in Europe

The current debate about job polarisation began in the US in the 1990s as part of a discussion about the quality of jobs created during the big employment expansion of that period. Since then, the US labour market has been the most studied example of job polarisation. According to Wright and Dwyer (2003), the structural trends in the US labour market have significantly changed in the last five decades. A pattern of consistent upgrading in the 1960s (with the highest-paid jobs expanding faster than the rest) had, by the 1990s, become a pattern of polarisation, with job growth concentrated in the top and bottom of the wage structure and a gap in the middle. This trend, according to Autor and Dorn (2013), extended to the 2000s and, according to Jaimovich and Siu (2012), grew even stronger in the aftermath of the financial crisis.[6]

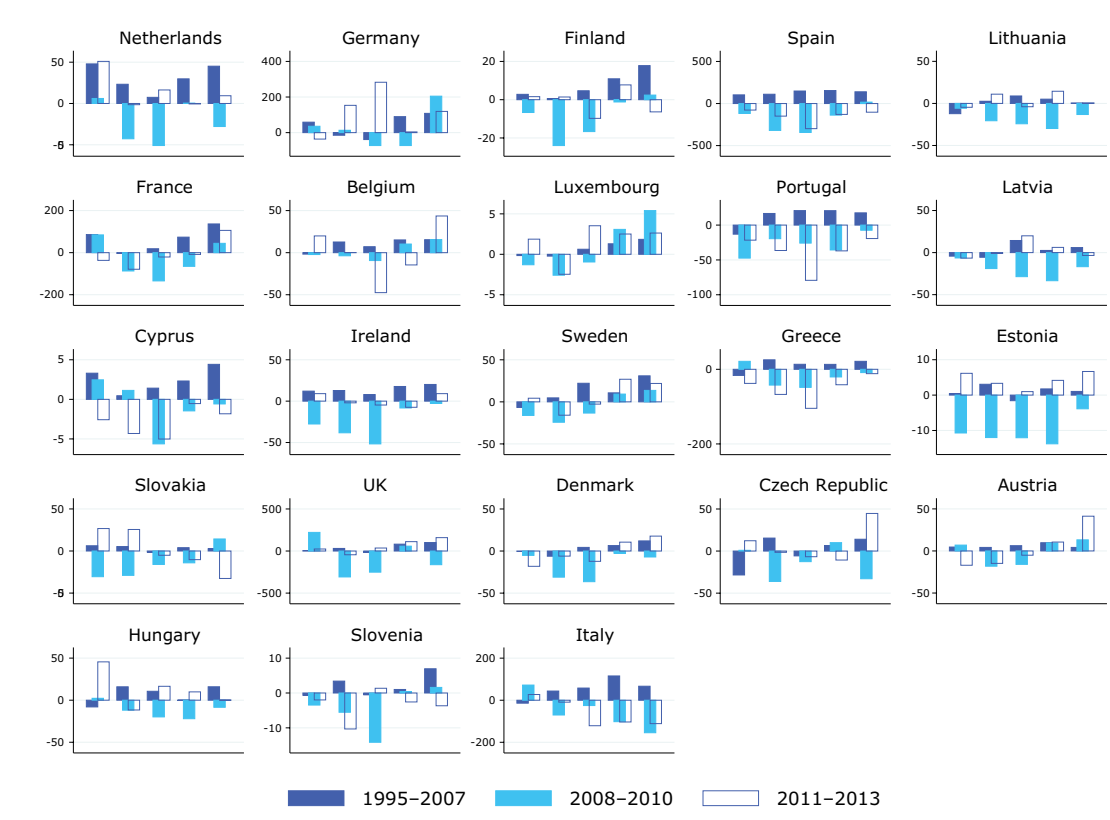
Following a similar approach to these US studies, Goos and Manning (2007) found that in the UK over a similar period, there had been a comparable shift towards a polarising pattern of structural change in employment. In their analysis, they drew from a previous conceptual framework constructed by Autor et al (2003), which did not directly address job polarisation. Goos and Manning's landmark study argued that the main driver behind job polarisation was routine-biased technical change (RBTC), an argument that is discussed in detail in the next section. In a later paper, they expanded the argument to the15 EU Member States prior to the 2004 enlargement, identifying a consistent pattern of job polarisation in the late 1990s and early 2000s in all countries except Portugal (Goos et al, 2009).

[6] However, the finding of job polarisation in the US is being increasingly contested, in particular regarding the most recent period (2000 onwards). For instance, Mishel et al (2013) find no evidence of polarisation but rather a process of structural downgrading in employment after the 2000s, with lower-wage, lower-skilled jobs growing faster than the rest. Autor (2010) shows the same downgrading pattern in the US up to 2007.

Previous analysis of structural employment change in the EU by this author applied the same methodology, although with some important differences (Fernández-Macías, 2012).[7] It showed a significant diversity in the patterns of structural change in employment across the EU between 1995 and 2007. A subsequent analysis of the recession years, which, for methodological reasons had to be split in two sub-periods (2008–2010 and 2011–2013), identified a more generalised polarisation, especially in the first two years of the crisis (Eurofound, 2013). However, it also identified a significant degree of diversity.

Figure 18 shows the patterns of structural change in employment by wage quintiles for the whole period 1995–2013, broken down into three timeframes because of breaks in the underlying data series.[8] The country charts have been arranged in columns according to the dominant pattern of structural change in employment from 1995 to 2007. This period coincides with the long economic expansion that finished abruptly with the financial crisis. The bars represent the yearly average net absolute change in total employment in each of the five wage quintiles. The quintiles were constructed by arranging jobs in each country according to their median hourly wage, and dividing them into five groups (from low to high median job wages), with the same initial share of employment.

Figure 18: *Patterns of structural change in employment in Europe, 1995–2013*



The five countries in the leftmost column and, to a lesser extent, the five countries in the second leftmost column experienced a process of job polarisation during the 1995–2007 period. In this period, most job creation went to the top and bottom quintiles, leading to a gap in the middle. This did not necessarily mean net job destruction for the middle quintiles, since this was a period of overall job growth; only Germany saw a net destruction of middle-paid jobs during this period.

[7] One main difference is the use of country-level wage data to rank and classify the jobs; Goos et al (2009) used UK wage data to classify the jobs of all EU15 countries. Another difference is the use of equal-sized quintiles of wages to represent and evaluate the nature of structural change in employment in all countries; Goos et al used uneven groups of jobs.

[8] The timeframes are defined by sector reclassifications (between 2007 and 2008, the EU-LFS moved from NACE 1.1 to NACE 2) and by occupation (between 2010 and 2011, the EU-LFS moved from ISCO-88 to ISCO-08). In both cases, the data before and after the break cannot be consistently coded. For further detail, see Eurofound (2013).

The third column shows five cases of clear structural upgrading in employment, or upwards wage-biased structural change. Here, most employment growth took place in jobs with higher median wages, and there was very little expansion of the lower tiers of employment; there was even some net destruction.

In the fourth column, there are four cases of structural upgrading, with a significant expansion of the middle layers of employment, alongside lower growth, or even net employment destruction, at the bottom. This pattern also describes the trend in the four countries in the fifth and last column, although less clearly.

The important thing to note is that there was a significant diversity of patterns of structural employment change in Europe between 1995 and 2007. We can identify at least two dominant patterns, one of polarisation and one of structural upgrading, with perhaps a third category of mid-level upgrading.

For the two shorter periods, there was a reduction in the degree of diversity and some convergence towards a polarising pattern. This is clearest in the 2008–2010 period (light blue bar); in 2011–2013 (white bar), this trend reverses somewhat to the earlier 1995–2007 trend. Methodological changes in the EU-LFS make it very difficult to study this recessionary period in detail, because both the sector and occupation classifications have changed, breaking the continuity of the analysis. It is difficult to evaluate the extent to which the accentuation of job polarisation is an intrinsic consequence of the crisis, as argued by Jaimovich and Siu (2012) for the US, or the result of another factor, such as policy responses to the crisis. In any case, the most recent data suggest that a significant degree of diversity remains, concentrated around the two main patterns of upgrading and polarisation.[9]

Drawing on recent relevant literature, this part of the report aims to identify the factors that are most likely to explain the observed patterns of structural change and to operationalise them in order to empirically test their effects. The observed diversity of patterns in Europe makes it a particularly interesting testing field for the hypotheses on occupational change. They might enable the identification of specific factors that underlie specific patterns of structural change, isolating what is particular to individual countries and what is more or less universal.

Hypotheses on structural change in employment

Routine-biased technical change hypothesis

The routine-biased technical change (RBTC) hypothesis[10] is a derivation of the earlier, influential skill-biased technical change (SBTC) hypothesis in labour economics, according to which technical change is biased in favour of high-skilled labour (with which it is complementary) and against low-skilled labour (for which it is a substitute). Therefore, the mechanism behind the effect of technology on employment growth is the complementarity between technology and the different types of skills, which leads to a more or less linear and consistently increasing association between skills and labour demand. In terms of employment structure, this leads to a largely linear upgrading effect, with higher-skilled jobs growing faster. This in turn has a polarising impact on wages, because it tends to expand high wages and simultaneously depress low wages. The main goal of the original SBTC hypothesis was to explain the observed increase in wage inequality since the late 1970s in most developed economies (for a review, see Acemoglu, 2002 and Violante, 2008).

Against this background, the RBTC hypothesis postulates that the effect of technology on labour demand is slightly more complicated, because its bias concerns not only skill requirements but also the amount of routine tasks that jobs involve. This is because the types of human activity that can be more readily automated are those that are strongly routine

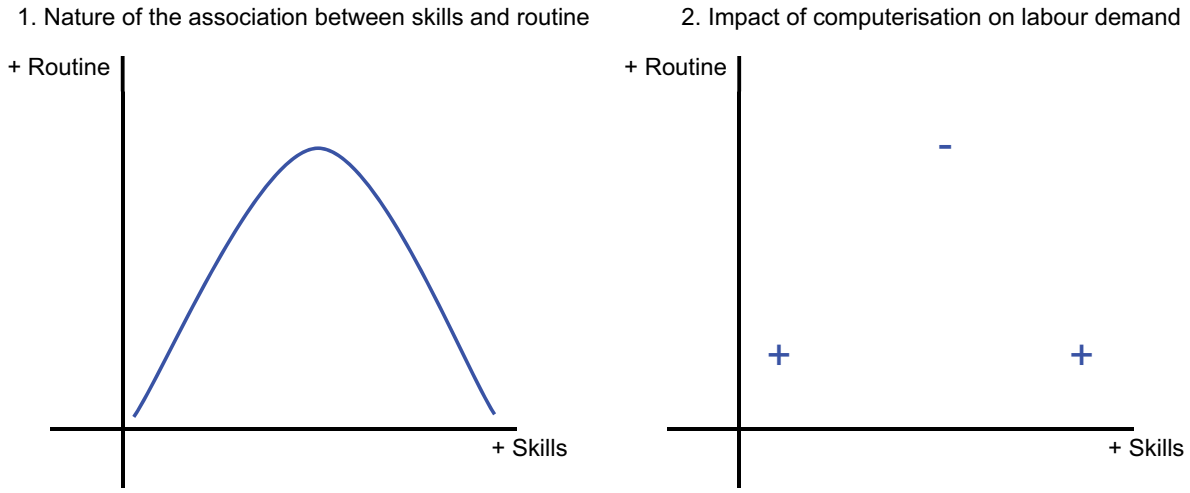
[9] Some recent comparative studies for different European countries have also found a significant diversity of patterns of structural change in employment around the two dominant forms of polarisation and upgrading (see Oesch and Menes, 2011; Oesch, 2013; Nellas and Olivieri, 2012).

[10] In the literature, the same hypothesis is sometimes referred to as ‘task-biased technical change’.

in nature: repetitive tasks that can be codified and programmed into some form of algorithm that can be performed by a machine (Autor et al, 2003). Because of this confounding effect, the effect of technical change on the relationship between skills and labour demand will be, at least apparently, non-linear and of a polarising nature. Jobs requiring middle-skill levels tend to have a higher routine content, and the proportion of these jobs will therefore shrink relative to the extremes of the skill continuum as a result of technological change (Autor et al, 2006; Goos and Manning, 2007).

It is important to note that the argument is not so much that there is a non-linear relationship between skills and labour demand because of computerisation. Rather, it is that the (more or less linear) skill bias in labour demand occurs alongside another (also more or less linear) routine bias in labour demand, which is also the result of computerisation. Figure 19 illustrates this argument: the x-axis classifies jobs in a continuum of low to high skills, and the y-axis classifies the same jobs on a continuum of low to high routine content. As shown in the leftmost diagram, jobs in the middle of the skills axis tend to have a higher routine content than jobs in the high or low extremes of this axis. In addition, both are linearly related to labour demand, albeit in opposite directions: higher skill requirements means higher labour demand, while higher routine means lower labour demand. The association between routine and labour demand is stronger, hence the polarisation pattern. Yet, the skills axis remains positively associated with labour demand, so that asymmetric polarisation is predicted, with high-skilled jobs growing more than low-skilled jobs.

Figure 19: *The RBTC hypothesis*



So if the SBTC hypothesis is unidimensional and predicts a linear upgrading, the RBTC hypothesis is bi-dimensional and predicts a non-linear pattern of asymmetric polarisation.[11] The SBTC argument rests on the idea of complementarity between skills and technology, to which the RBTC argument adds two extra assumptions: that computers are better substitutes for routine tasks (for a given skill level); and that routine tasks are more frequent in middle-skilled jobs than in high-skilled or low-skilled jobs. The latter assumption is particularly important because, according to this hypothesis, it is the source of the polarising effect on labour demand. It must be emphasised that there is nothing in the theory itself that explains why routine tasks should be more frequent in middle-skilled jobs. In other words, it is either an assumption

[11] This is with respect to labour demand, not wages. Because of its bi-dimensionality, the implications of the RBTC hypothesis are less clear in terms of wage developments. While the SBTC hypothesis predicts upgrading in the employment structure and polarisation in wage levels, the RBTC hypothesis predicts polarisation in the employment structure but not necessarily in terms of wage levels. Following the RBTC hypothesis, it seems clear that wages for high-skilled jobs should go up because of the increased demand for high skills, and probably that the wages of middle-skilled jobs should go down because of decreasing demand for them. But in the case of low-paid jobs, wages could either increase or decrease: they would increase to the extent that their demand increased or decrease to the extent that the relative decline of demand for middle-skilled jobs leads to an increase in labour supply, thereby putting downward pressure on wages. In any case, this analysis is restricted to changes in labour demand and the structure of employment. For an exploration of the wage implications of the RBTC hypothesis, see Acemoglu and Autor (2010); for a critique, see Mishel et al (2013).

or an empirical observation, not part of the theoretical argument. If the relationship between skills and routine (depicted in Figure 19) was different, there would be no polarisation. For instance, if skills and routine were negatively correlated, their combined effect would be upgrading (the routine axis would just reinforce the linear effect of skills), not polarisation. In such a case, the RBTC hypothesis would just be a refinement of the SBTC hypothesis, producing no substantially different predictions. This point is very important because, as argued later in this report, there are both theoretical and empirical reasons to expect a more or less linear, negative correlation between skills and routine tasks.

Note that the RBTC hypothesis normally refers to tasks rather than jobs or workers. In fact, this hypothesis has been strongly associated with the 'tasks-based approach to labour markets' (see Box 2). In this approach, the fundamental units of analysis are tasks, rather than skills, workers or jobs (Autor, 2013). It is tasks that can be positioned within the two-axis framework shown in Figure 19; therefore, in the RBTC hypothesis, the skills axis is referred to as 'cognitive tasks', since skills concern workers and not tasks. But this has little practical implication for the purposes of this report, because the tasks-based approach is just a conceptual framework; the actual unit of analysis is always either worker or job, defined as detailed occupational titles or occupation–sector combinations, as done here.[12] Jobs are classified in terms of their 'typical' task content, and it is the evolution of labour demand of the different types of jobs that is analysed in the literature associated with the RBTC hypothesis, as will be done here.

Box 2: A tasks-based or a jobs-based approach to labour markets?

Why speak about tasks rather than jobs? In principle, the goal is to emphasise a production process perspective; it is tasks, rather than jobs or workers, that are an input in the production process. It also enables greater conceptual precision. As mentioned above, lack of data means that, in practice, it is nearly impossible to use tasks as a unit of analysis, so the concept is mostly used as a conceptual tool to classify jobs. But even theoretically the concept has some problems. The underlying assumption is that tasks represent the most adequate unit of analysis of the labour market, rather than jobs. Jobs would be little more than collections or bundles of tasks; tasks involved in a job can be rearranged or reorganised, for instance. But this seems to ignore the social nature of human labour, which is necessary to acknowledge even from the perspective of the production process. For example, although an engineer may use tasks as the smallest unit for the design and organisation of the production process, they have to arrange such tasks into coherent bundles which will have to be performed by people with particular skills and specialisations. These jobs or coherent bundles of tasks will furthermore be associated with a particular social position both inside and outside the production process. The definition of the job and the tasks involved will, therefore, be contested and negotiated by the workers themselves, not just 'designed' and eventually redesigned by management. For instance, the nature and content of jobs are frequent subjects of collective bargaining.

For all these reasons, although the concept of tasks can be a useful tool for understanding the nature of jobs, when analysing the structure and change of labour markets the concept of jobs seems a more adequate unit of analysis. Rather than saying that jobs are just bundles of tasks, they can be seen as being composed of different tasks, which can be differently affected by technology, among other factors, and can change over time, thereby affecting the nature of jobs. As argued by authors as different as Elton Mayo (2003) and Harry Braverman (1998) in their classical critiques of scientific management, labour cannot be broken up into disembodied chips considered as inputs in production (and outputs of households): labour is embodied in workers, requires skills and social organisation, and produces social structures.

As hinted earlier, an important conceptual problem of the RBTC hypothesis is the differentiation between the axis of routine tasks and the axis of cognitive tasks. At least conceptually, such axes should be orthogonal. Otherwise the approach would not work very well, since the addition of the routine axis would be unnecessary, and it would not be possible to classify jobs into combined categories such as non-routine cognitive and routine cognitive. But even conceptually, routine

[12] Sometimes the unit of analysis can be working hours rather than headcounts, but everything is still measured at the worker level.

and cognitive tasks strongly overlap (in reverse): almost by definition, a routine task is one that can be performed with little cognitive effort, while a task that is non-routine requires a higher cognitive effort by the worker. In the classical social sciences literature, the routine and cognitive requirements of jobs have been generally considered opposite extremes within the same continuum, strongly associated (if not necessarily correlated) with the skill requirements of jobs. The traditional debate on the division of labour in capitalism and job quality was largely about this; for instance, both Adam Smith and Karl Marx considered that the detailed division of labour in manufacturing tended, simultaneously and as part of the same process, to routinise and deskill labour, making jobs more alienating and degrading for workers. In essence, Taylorism was an explicit attempt to reduce the cognitive requirements of jobs by increasing the amount of routine and repetitiveness of the tasks through their 'scientific' reorganisation. The proposed relationship between the routine and cognitive contents of tasks in the RBTC hypothesis is different from this 'traditional' view, because it is non-linear, forming an inverted U shape, with routine tasks tending to be in the middle rather than the bottom of the cognitive skills continuum. However, the hypothesis does not provide any strong reason for why that should be the case, despite its crucial importance for the hypothesised effects of technological change.

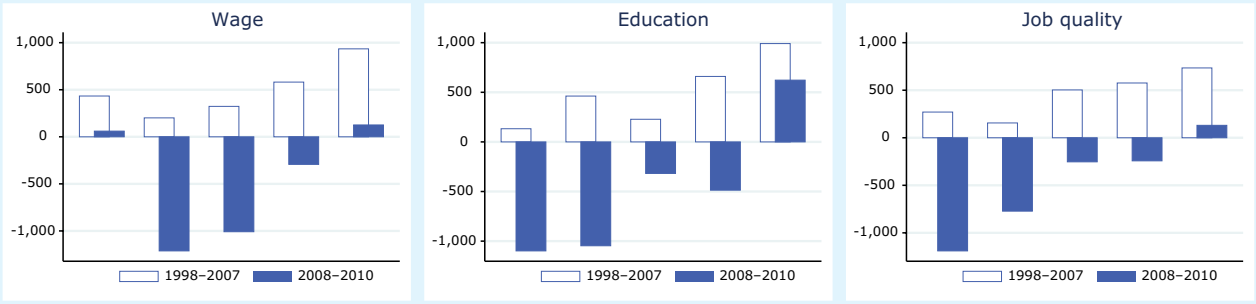
Part of the explanation may lie in the peculiar conceptualisation of the term 'cognitive' in the RBTC hypothesis. Whereas the concept of routine tasks is relatively clear, there is not an equally precise definition of the cognitive tasks axis, probably because it is assumed to be already clear, within the SBTC tradition. But the SBTC argument was about the skills of workers, not about the cognitive content of tasks. Sometimes the cognitive content of tasks seems to be about whether the job involves problem-solving and analytic skills. In this case, the overlap with the routine axis is even stronger; if a task is routine, almost by definition it requires fewer problem-solving and analytic skills. Sometimes it seems to be about whether the job involves information-processing tasks. This would make much more sense, because there is no necessary overlap with the routine axis, while there can obviously be routine information-processing tasks. The latter is the operational definition that is applied to the empirical analysis later in this report.

Box 3: Polarisation of skills, wages or job quality?

The idea of job polarisation, which is strongly associated with the RBTC hypothesis, is sometimes confusing because it is not entirely clear which aspect of a job has a polarising effect. Is it in terms of skills, wages or job quality more generally? Most of the arguments about job polarisation are based on ranking jobs by their average or median hourly wage. But the argument concerns more generally the skills or the quality of the different types of jobs; therefore, wages are used as just a proxy for the latter. This involves the assumption that the ranking of jobs in terms of wages, skills and job quality are fundamentally consistent, to the extent of being interchangeable. Furthermore, in a comparative analysis of job polarisation from this perspective, not only are wages used as a proxy for skills and job quality, but the same wage ranking is applied across different countries. This involves the further assumption that wage structures are roughly the same across developed economies (see for instance Goos et al, 2009). Both assumptions are conceptually and empirically problematic. Conceptually, although wages, skills and job quality are often correlated, they are different attributes of jobs that can, and sometimes do, vary independently or even pull in opposite directions. There are wage–skill mismatches, for instance, or compensating differentials mechanisms, whereby for example bad working conditions are associated with compensating higher pay. As discussed later, there are also systematic differences in wage-setting institutions across countries, which lead to different wage structures and different types of association between wages, skills and job quality.

Previous research has shown that using a different criterion for ranking jobs can lead to different results in terms of structural change in employment. For instance, Figure 20 shows that, for the whole of the EU between 1995 and 2007, job polarisation is apparent only if the jobs are ranked by wages; if they are ranked by their average skill level or by a multidimensional job quality index, the same structural changes produce upgrading only, and not polarisation (for a discussion of the differences in the wage structures across countries, see Fernández-Macías, 2010).

Figure 20: *Patterns of employment change by quintiles, 1995 to 2010, jobs ranked by wage, education and job quality*



Source: *Eurofound, 2013*

Most of this analysis focuses on wages as the main variable for ranking and classifying jobs into quintiles, although other variables are also tested.

A final conceptual problem of the RBTC hypothesis is the recent introduction of a third concept for classifying tasks or jobs, 'service', which is only indirectly related with the core argument. It refers to jobs that involve assisting or caring for others (Autor and Dorn, 2013; Goos et al, 2009). It clearly differs from the other two concepts (the routine and cognitive content of tasks) and would seem to introduce a third axis for the classification of tasks. But in fact, the concept of service seems to be simply a different way of characterising jobs that lie at the bottom of the cognitive continuum, those that were earlier classified as jobs involving non-cognitive, non-routine tasks. This is conceptually quite confusing, because it seems to allude to a different type of explanation than that elaborated in the RBTC framework. Is the social interaction component of those jobs related to their non-routine, non-cognitive nature? Do these jobs grow over time because they are non-routine and non-cognitive or because they involve social interaction? Other researchers have recently argued that the degree of social interaction involved in a job can be an explanatory factor for recent trends of structural change in employment. For instance, Blinder (2009) argues that personal services that require face-to-face interaction are not off-shorable and are therefore relatively protected from the effect of trade. Dwyer (2013) argues that exogenous factors such as increasing female labour force participation and the growth of the welfare provision sector have led to an important expansion of care work, which is crucially defined by its social component. These arguments will be returned to later.

Other hypotheses: trade and institutions

Other hypotheses for the observed patterns of structural change in employment in advanced economies have been proposed. These alternative frameworks can be classified by two broad categories: employment effects of trade and globalisation, and the institutional framework and its changes in recent decades.

Globalisation and trade

If technological arguments are linked to the acceleration of technical change brought about by computerisation in recent decades, the trade arguments are associated with trade liberalisation and increasing economic integration worldwide over the same period. According to this hypothesis, the impact of trade on the jobs structure is biased in a way that is similar to that proposed for technology: because some types of economic activity (or tasks or jobs) are more tradable than others, increasing levels of trade have an uneven effect on the demand for different types of labour. This produces a transformation of the employment structure. Of course, in the context of international commerce, tradability is not the only factor that matters; competitive advantage is also important. If the same activity can be carried out more cheaply elsewhere, it can be offshored, again altering the structures of employment on both sides of the trade exchange.

Which kinds of jobs are more tradable than others? As previously mentioned, Blinder (2009) has argued that the key determinant of the offshorability of the different types of jobs is the extent of direct social interaction that they involve. In general, agricultural and manufacturing jobs involve less social interaction, and have traditionally been more exposed to international trade. Recent technological developments have expanded the category of tradable jobs to many service occupations that require social interaction but not necessarily of a face-to-face nature, such as call centre work. In this sense, the trade argument incorporates technology as a driving force, but in a very different way to the RBTC hypothesis. According to the trade argument, information technologies play the role of expanding the range of jobs that are potentially offshorable, not of directly replacing workers.

Routine tasks and direct social interaction are rather different conceptually, and do not necessarily correlate at the job level; some jobs are highly routine and require face-to-face interaction, and some others do not. However, the general argument is that the effect of trade on the occupational structure is similar to that of RBTC, thus reinforcing the polarisation trend (Goldin and Katz, 2007). This assumes that the most tradable jobs (those that involve less face-to-face interaction) tend to be located around the middle of the employment structure, an assumption very similar to the one discussed earlier for RBTC, which assumed that routine jobs tended to be in the middle as well.

Perhaps the main problem of the trade argument is that, ultimately, it is not so easy to differentiate between it and technological or institutional factors. On the one hand, the process behind such a jobs-biased trade effect is globalisation, itself an institutional process of trade liberalisation and deregulation. In addition, the comparative advantage of different types of labour in different countries can depend on institutional arrangements such as the industrial relations systems. For instance, the typical offshoring of some types of highly unionised manufacturing activities from advanced economies to developing economies is likely to be associated with such political economy factors. On the other hand, as already mentioned, the concept of tradability is also strongly associated with technology used in production: the tradability of manufactured products is itself the result of advances of transport technology in the last couple of centuries, and the tradability of services is continuously increased by current advances in information and communication technologies. To some extent, even the concepts of cognitive and routine tasks are relevant for the tradability of the different types of labour activity: tasks that require less cognitive effort and are easier to routinise can be more easily packaged and offshored to other countries.

Furthermore, the trade argument shares some of the problems of the RBTC argument when it is used to explain polarisation, particularly the fact that it assumes that most tradable jobs are in the middle of the employment structure. The argument may explain why advanced economies' tradable jobs are more likely to be displaced by globalisation, but not why those jobs are more likely to be found in the middle of the employment structure. A possible explanation is that it is the jobs in the middle that are particularly disadvantaged in comparative cost terms with respect to similar jobs in developing economies; that is, the important thing is the comparative advantage rather than tradability. But it remains to be explained why that is the case.

Institutional change

As previously mentioned, it could be argued that the comparative disadvantage of mid-level jobs in advanced economies is related to specific institutional–historical reasons, linked for instance to the industrial relations systems and welfare state institutions. This leads us to the third set of explanations for the observed patterns of change in employment structures in recent years, relating to the effect of institutions. Compared to the other two types of arguments reviewed – RBTC and the effects of trade – this is more difficult to operationalise and model. Nonetheless, it is important to discuss it because this approach seems to provide a better explanation for the simple empirical observation of a diversity in the patterns of structural change across European countries. The other two arguments, by contrast, would anticipate an outcome of pervasive polarisation, which has not been observed.

The gist of the institutional argument is that different employment policies and regulations across countries interact with other factors such as technology and trade to produce both different wage structures and different patterns of structural change in employment. The literature on this issue has referred primarily to three institutional features to explain the presence and absence of employment polarisation: minimum wages, trade unions, and the regulation of employment contracts. Minimum wages directly determine the cost of labour at the bottom of the employment structure and, therefore, can (all else being equal) affect the demand for such labour relative to the rest of the employment structure (Oesch, 2013). Something similar can be said of other wage-setting institutions, such as industrial relations and collective bargaining systems (Nellas and Olivieri, 2012). In the case of employment regulation, it has been argued that a recent process of deregulation of the employment contract has facilitated the expansion of low-paid, low-skilled jobs in some European countries (Fernández-Macías, 2012).

It is important to note that this kind of argument has focused on explaining the variability of labour demand at the middle and bottom of the employment structure. This is because it is in those types of jobs that there has been more variability in recent structural employment trends. Also, labour market institutions have a larger effect on those segments of employment since they are mostly aimed at protecting the most vulnerable workers. Another important point to note is that this kind of argument does not assume that the distribution of wages and skills is similar and more or less homogeneous across countries: the wage structure is itself the outcome of wage-setting mechanisms that can vary across countries and over time. So jobs requiring similar skills do not necessarily receive similar wages in different countries. Therefore, even if the evolution of the employment structure in terms of skills is similar, it can be associated with significantly different evolutions in terms of wage structures.

This feature of the institutional approach to occupational analysis can enrich it considerably. For instance, from this perspective, we can try to answer the question of why routine, tradable jobs are often found in the middle of employment structures, thus producing polarisation by shrinking secularly. Such jobs are often unskilled and semi-skilled manufacturing jobs, which in advanced economies are typically protected by union structures and welfare–corporatist employment regulation. Their position in the wage structure, for these historical–institutional reasons, is often higher than their relative position in the skills structure, which produces the inconsistency between the job structures ranked by wage and skills shown in Box 3. See Eurofound (2013) for a more detailed discussion.

The main difficulty with the institutional argument is operationalising it. It is a much broader and complex explanation than others and is impossible to operationalise in a simple way analogous to the other proposed explanations because this would involve reducing it to some type of dimensionality. No single or even multiple classification or ranking of jobs can encompass the type of historical–institutional complexity of this kind of argument. In addition, the argument operates at a different level to the other ones: in many cases, it refers to society-wide features and policy changes, whereas the other arguments can be operationalised as relatively simple classifications of jobs or tasks. For both reasons, it is extremely difficult to evaluate this kind of explanation through a quantitative-model-based approach such as the one taken in this report. The institutional argument probably requires a more qualitative approach, with historically contextualised comparisons of significant cases. In fact, this has been done by some proponents of this type of explanation, such as Oesch (2013).

A final hypothesis about the recent patterns of structural change can also be classified as an institutional explanation, although it differs significantly from that just discussed. It is the argument that the pattern of polarisation observed in the US in the 1990s was, to a large extent, related to the development of a ‘care economy’ (Dwyer, 2013). For this theory, the underlying institutional–historical mechanism is the large-scale change in gender relations over recent decades, associated with the massive incorporation of women into the labour market, as well as the commodification and formalisation of care services that were previously provided within family and kin networks. As in the previously discussed institutional arguments, this provides both an explanation of the position of jobs within the wage structure and of the patterns of structural change. In terms of the wage structure, many of the care activities that were previously performed within the family get a relatively low market valuation, for different reasons:

- they can still be performed outside the market if considered too costly;
- the standard methods of market valuation of skills are gender biased, if only because of the inertia of the previous arrangements;
- women are still disadvantaged and discriminated against in the labour market.

Some types of care activities, however, have achieved a certain degree of market power through professionalisation strategies. These are what Dwyer (2013) calls 'nurturing' care jobs, as opposed to 'reproductive' ones, and they have a much higher position in the wage structure. In other words, jobs related to the care economy tend to be polarised, more frequently found in the bottom and top job structure levels. Hence, the increase in the demand for this type of activity, which is associated with the massive incorporation of women into the labour force and the marketisation and institutionalisation of care activities, has contributed significantly to polarisation.

Methodology 2

This chapter provides information on how the analysis to test the hypotheses discussed in the previous chapter will be carried out. It begins by documenting an alternative operationalisation of the variables necessary to perform the analysis, and then describes the modelling and analytic strategy that will be followed later.

Problems with the operationalisation of existing hypotheses

The previous chapter included a discussion of some of the conceptual problems associated with the main theoretical hypotheses around job polarisation and upgrading, in particular the problems of the RBTC argument, by far the most popular explanation. These conceptual problems are also associated with some important operational and measurement problems.

Table 4 summarises the operationalisation of the RBTC argument in five key papers. It shows that there is often some degree of inconsistency between the underlying RBTC framework and its operationalisation through a set of indices to be used for statistical analysis. In nearly all cases, there are several attributes of tasks included that do not seem to be justified by the RBTC framework; this is particularly the case regarding indicators of managerial tasks in the 'abstract' or 'cognitive' category, and the inclusion of 'social interaction' tasks in the non-routine, non-cognitive category (sometimes called 'manual', sometimes called 'service'). The performance of managerial tasks, although they certainly require cognitive effort (as do most non-routine tasks), is an aspect of the social organisation of work, not of its technical organisation. By introducing it into the measurement, the RBTC argument inadvertently mixes technical and socioeconomic developments in organisational change. The expansion of 'abstract' jobs could, for instance, be associated with an expansion of supervisory and control functions or simply an inflation of occupational titles.

The same can be said about the inclusion of indicators regarding social interaction and caring for others, in some cases used as the main indicator for identifying the jobs that occupy the bottom level of the polarised pattern. The RBTC argument is supposed to focus on the extent of routine and cognitive demands for different tasks; however, although social interaction may be associated with the category of non-routine, non-cognitive tasks, it is a different concept, relating to different types of mechanisms behind structural shifts in employment (as discussed in the previous section).

Four of the papers use quality control tasks as indicators for routine, which also seems unjustified (see Box 4). Table 4 also shows some inconsistency between different applications of the same RBTC hypothesis. For instance, the category of non-routine manual tasks is measured as 'hand–eye–foot coordination' in the first two papers, as care and social interaction in the fourth (as well as in other recent work by Autor and Dorn (2013)), and as 'time spent doing physical tasks' in the fifth. This is despite the fact that they all refer to the same category of the RBTC framework, which was originally described as 'non-routine, non-cognitive tasks'.

Table 4: *Operationalisation of RBTC in five key papers*

1. Autor et al (2003)	
Typologies	Non-routine analytic, non-routine interactive, routine cognitive, routine manual, non-routine manual
Definitions	Routine: 'tasks that require the methodical repetition of an unwavering procedure'. No definition of analytic or cognitive; only of non-routine cognitive tasks: 'tasks demanding flexibility, creativity, generalized problem-solving and complex communications'.
Variables used	Non-routine analytic: quantitative reasoning requirements Non-routine interactive: direction, control and planning (managerial and interpersonal tasks) Routine cognitive: adaptability to work requiring set limits, tolerances and standards Routine manual: finger dexterity Non-routine manual: eye-hand-foot coordination

Notes	In practice, five categories that do not match the two axes – routine and analytic/cognitive – of the conceptual framework. The measures are not very consistent with the concepts. Non-routine interactive tasks are actually about managerial tasks, measuring the social position of the worker in the organisation, rather than the input in production from a technical point of view. The variables used for routine cognitive and routine manual are not directly measuring routine work, even if they are probably correlated.
2. Goos and Manning (2007) – follows Autor et al (2003)	
3. Autor et al (2006)	
Typologies	Abstract, routine, manual
Definitions	Abstract: 'problem-solving and managerial tasks. These are not well structured and require non-routine cognitive skills' Routine: 'cognitive or physical tasks that follow closely prescribed sets of rules and procedures and are executed in a well-controlled environment' Manual: 'do not require abstract problem-solving or managerial skills but are nevertheless difficult to automate because they require some flexibility in a less than fully predictable environment'
Variables used	Not specified
Notes	Conceptually asymmetric. Abstract and manual tasks are operationalised as two separate indices, but they seem to be two extremes of the same dimension. Can tasks be simultaneously abstract and manual?
4. Goos et al (2010)	
Typologies	Three categories: abstract, routine and service tasks
Definitions	Routine: 'those which computers can perform with relative ease, such as jobs that require the input of repetitive physical strength or motion, as well as jobs requiring repetitive and non-complex cognitive skills' The non-routine dimension is split into abstract and service. No definition of abstract tasks, just examples: 'complex problem-solving' ([such as] … needed by engineers and medical doctors)'. Examples of service tasks are 'caring for others ([such as] … needed by hairdressers and medical doctors)'.
Variables used	Routine: operation monitoring, equipment maintenance, quality control, manual and finger dexterity, arm–hand steadiness. Abstract: managerial tasks, problem-solving, information-processing, technical and data analysis, interaction with computers. Service: assisting and caring for others, social interaction, selling, active listening, working directly with the public.
Notes	As with Autor et al (2003), this includes managerial tasks as part of the 'abstract' (cognitive) measure, which is not really justified by the conceptual framework. The category 'service' is really about the social interaction with customers and clients (not co-workers), which is not justified by the RBTC framework. It is also inconsistent with other applications; the non-routine low-skilled category in Autor et al (2003), Goos and Manning (2007) and Autor et al (2006), for instance, is conceptualised as 'manual' and measured by hand–foot coordination.

5. Autor and Handel (2013)	
Typologies	Abstract, routine, manual
Definitions	Abstract: 'abstract problem-solving, and creative, organisational and managerial tasks' Routine: 'routine, codifiable cognitive and manual tasks that follow explicit procedures' Manual: 'non-routine manual job tasks that require physical adaptability'
Variables used	Abstract: document-reading, mathematics, problem-solving of at least 30 minutes, supervision of other workers Routine: short repetitive tasks, absence of face-to-face interactions with customers Manual: time spent performing physical tasks
Notes	Clearer definitions and operationalisations, but similar problem of differentiating abstract and manual as Autor et al (2006) (two contrasting concepts operationalised as different dimensions). Introduction of managerial tasks as part of abstract. Use of social interaction as a (negative) indicator of routine.

Developing an alternative operationalisation

Most of the reviewed attempts to operationalise the RBTC hypothesis draw from the Dictionary of Occupational Titles or its successor, the Occupational Information Network (O*NET), two American databases containing detailed descriptions of occupational requirements and workers' attributes.[13] Compiled by occupational specialists, rather than from surveys of workers, these databases consist of very detailed information on descriptors associated with different task requirements, as well as workers' attributes and skills; numeric scores are assigned to each descriptor. Most of the job classifications by task content shown in Table 4 were developed by identifying a number of descriptors associated with routine or cognitive tasks and combining them into an aggregate index or indices. Although the RBTC hypothesis focuses on the technical attributes of job tasks, which should be relatively universal in similarly developed economies, it seems a better approach to try to use European data to classify jobs in Europe according to their routine and cognitive content. Data sources like the Dictionary of Occupational Titles or O*NET are not available in Europe, but there are surveys that collect information on the attributes of work, which can be used for this purpose. This report uses these European surveys to construct an alternative operationalisation of the variables needed to test the RBTC hypothesis (see Box 4 for a discussion of the differences between the indices constructed with O*NET data and those used in this report). In this alternative operationalisation, efforts are made to stay faithful to the RBTC framework, while addressing some of the conceptual and operational problems highlighted above.

It is true that jobs can be broken down analytically into tasks and that the concept of tasks can be useful for describing and classifying jobs. Nonetheless, this analysis uses the job as its unit of analysis, defining jobs as relatively homogeneous and stable social positions within the production process requiring the performance of specific tasks, which require specific skills (Fernández-Macías, 2010). Following the RBTC hypothesis, such jobs can be classified across two axes in terms of the types of tasks they typically involve. The first axis refers to the degree of routine involved in the typical performance of the job, which has been defined as follows:

> *In our usage, a task is 'routine' if it can be accomplished by machines following explicit programmed rules. Many manual tasks that workers used to perform, such as monitoring the temperature of a steel finishing line or moving a windshield into place on an assembly line, fit this description. Because these tasks require methodical repetition of an unwavering procedure, they can be exhaustively specified with programmed instructions and performed by machines*
>
> (Autor et al, 2003, p. 1,283)

[13] Autor and Handel (2013) also use the Princeton Data Improvement Initiative, which provides good indicators for the measurement of job tasks, as well as the possibility of studying within-job variability.

The first underlined sentence does not really define routine tasks; rather, this idea that computers can substitute workers in routine tasks is part of the routinisation hypothesis itself. It is the second underlined sentence that can be the basis of a simple yet useful conceptualisation: the idea that the extent to which a job involves the repetition of unchanging procedures determines the degree to which it can be classified as 'routine'.

Box 4: Comparing Eurofound indices with O*NET-derived indices

Operationalising the RBTC hypothesis requires the construction of indices representing tasks performed at work. For this purpose, most studies have used the Dictionary of Occupational Titles and its successor O*NET, both provided by the US Department of Labor (Autor et al, 2003; Goos et al, 2010). Goos et al (2010), for instance, use O*NET's task importance values from 96 work-related variables to generate three indices for the importance of abstract, routine and service tasks in different occupational groups. Abstract tasks include 'complex problem-solving' or 'interacting with computers'. Service tasks include 'social perceptiveness' or 'establishing and maintaining interpersonal relationships'. The routine tasks index is built on the basis of two variable groups that Goos et al judge to pertain to routine-intensive jobs: variables on physical requirements such as 'dynamic strength' and on quality control such as 'operation monitoring'.

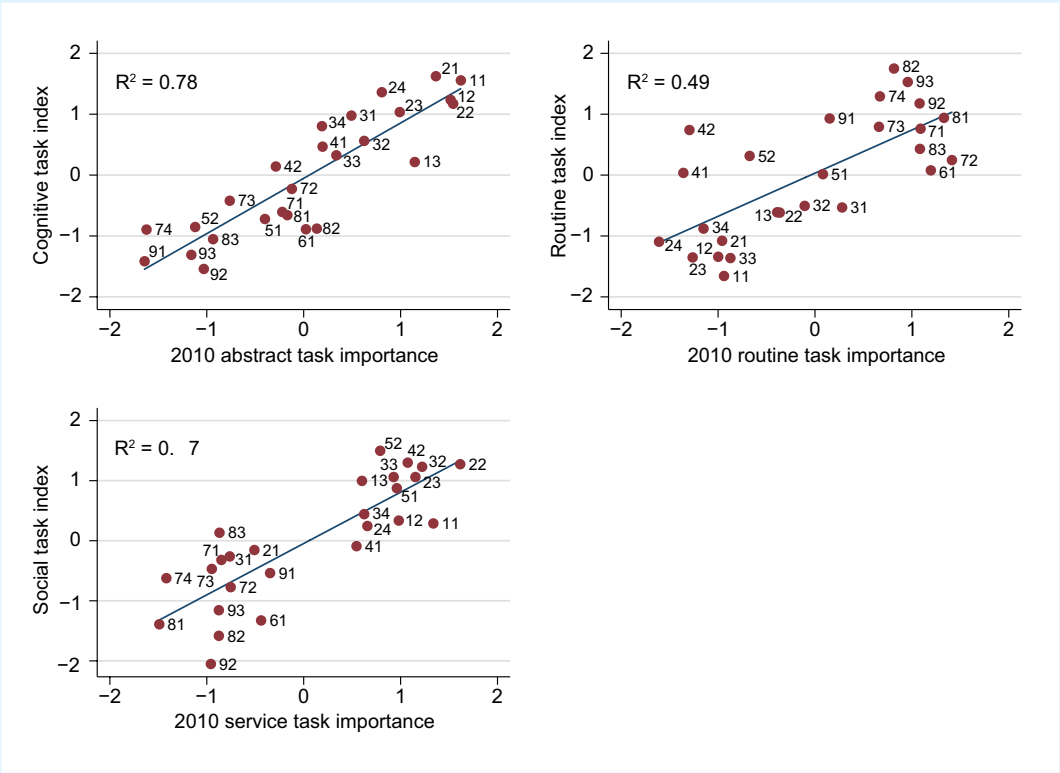
In order to compare the indices constructed for the analysis in this report (the Eurofound indices) with those derived from O*NET, the Goos et al indices were replicated and tested for consistency with the Eurofound indices.[14] Figure 21 shows the correlation between both sets of indices, their R^2 and linear fit, at the two-digit occupational level. It shows that the Eurofound cognitive index produces very similar results to that of Goos et al's abstract task index. This is due to very similar task content variables, even though the Eurofound index is based on only three variables, while the Goos et al index involves an average of 73 single values on abstract tasks. The same is true for the service and social task indices, to a lesser extent (R^2 of 0.7).

A considerably worse fit is evident with respect to the routine task measures (even though an R^2 of 0.49 is not negligible). This larger disparity may be due to the way Goos et al operationalise the level of routine at work, as outlined above. Using physical and quality control variables for the routine task index makes sense if we look at traditional production line jobs that involve mostly manual work and basic tasks with machines. But the routine content of some jobs may be overestimated or underestimated when relying on these two variable categories. For instance, in the Goos et al operationalisation, ISCO groups 41 and 42 (clerical workers) are at the lower end of the routine variable, while the approach employed in this report places these jobs more in the middle of the distribution. The latter outcome seems more plausible since clerical jobs have been particularly affected by computerisation and generally involve many repetitive tasks. But such clerical routine tasks are not likely to be captured by the variables that focus on physical and quality control tasks.

On the other hand, the approach by Goos et al gives a relatively high routine value to practically all higher-skilled occupations in ISCO groups 11 to 24 when compared to the index used in this report. This is due to the fact that these occupations include many monitoring tasks such as 'inspecting equipment, structures or material' or 'estimating the quantifiable characteristics of products, events or information'. Again, this suggests that these tasks are not good measures of routine.

[14] This analysis involves 93 of the 96 variables used by Goos et al (2010). These data are extracted from O*NET v.17. This slight deviation from the original 96 variables should make no practical difference. Translating the initial SOC codes from O*NET into ISCO, we weight by US employment shares as suggested by the authors (see p. 69 and following pages for more details), even though the weighting results in negligible changes. Note also that this analysis uses employment shares for 2012 instead of 2005 as used by Goos et al (2010).

Figure 21: *Comparing task indices*



Notes: Standardised values per ISCO-88 two-digit category; see Annex 4 for the occupations represented by the codes. The y-axis represents the indices used in this report; the x-axis shows those used by Goos et al.

As noted earlier, the concept of a 'cognitive' or 'analytic' task is less clear in the papers listed in Table 4. Although not formally defined, most of the reviewed papers refer to 'abstract problem-solving and managerial tasks' (Autor et al, 2006, theory appendix, p. 2). As shown in Table 4 above, there are two components of this type of task: managerial tasks and information-processing. Only information-processing seems justified by the theoretical framework for the routinisation hypothesis. While these two components are empirically correlated, the extent to which a job involves managerial responsibilities has nothing to do with its cognitive requirements. As previously mentioned, the routinisation hypothesis approaches labour market analysis by regarding production as a technical process; by introducing managerial responsibilities, which are aspects of the social organisation of production, the cognitive dimension becomes a kind of catch-all measure of position within the occupational hierarchy. For these reasons, the definition used here is limited to information-processing; the extent to which a job involves the production or processing of information determines the degree to which it can be classified as 'cognitive' or 'analytic'.

The concept of 'service tasks' is also included in some of the applications of RBTC, replacing the concept of 'manual' or simply 'non-routine, non-cognitive' tasks in the earlier formulations. However, as previously argued, this concept is alien to the RBTC framework in its strict sense. The reason why this kind of job would grow relatively as a result of computerisation is that it involves non-routine tasks, not because it involves social interaction. If social interaction is used as a means of classifying jobs, this may inadvertently introduce job attributes that are related to other mechanisms of structural change in employment, such as offshorability or the formalisation of activities previously provided within households. So although this analysis includes an index of the degree of social interaction in jobs, this does not form part of the operationalisation of the RBTC hypothesis; rather, it is used as a way to test the alternative hypothesis of trade and the service economy as a driver of polarisation or upgrading. For similar reasons, this analysis also uses the following sources to test the institutional hypothesis: indices of actual trade intensity at the sector level; indices of trade union

density at the job level; minimum wages; destandardisation of employment; and employment protection legislation (EPL) at the country level.

Each of the concepts described above will be operationalised as a continuous index, drawing on different variables from recent European surveys or data sources and measured at the job level. That is, each two-digit occupation–sector combination will receive a score on each of those indices. Exceptions are the trade index, which will be measured at the two-digit sector level, and some of the institutional indices, which are measured at the country level. The measures are based on workers' responses to survey questionnaires. The main sources are: the 2010 European Working Conditions Survey (EWCS), the 2005 European Social Survey (ESS) and the 2012 Survey of the Programme for the International Assessment of Adult Competencies (PIAAC).

Indices constructed for the current analysis

The routine index is constructed using data from the EWCS. The variables included identify whether the job involves:

- repetitive hand or arm movements;
- repetitive hand movements of less than 1 or 10 minutes;
- monotonous tasks;
- dealing with unforeseen problems (with reverse scoring used here).

As discussed in Box 4, variables measuring quality control tasks are excluded because even if these variables may be correlated, they are not part of the definition of a routine task.

The cognitive index is based on three variables from the EWCS which specify whether the job involves:

- use of computers at work;
- use of the internet;
- complex tasks.

Such variables are a reasonable measure of information-processing tasks, but they have the obvious problem of being too oriented towards computerised information-processing. For this reason, ESS data are used to calculate a secondary index of the skill requirements of jobs, based on the number of years of formal education necessary to perform the job adequately.

The final proxy cognitive index is an average of these two measures at the job level. As shown in Box 4, this index is quite consistent with the one used by Goos et al (2010), drawn from O*NET data.

For the social interaction index, two EWCS variables are used, measuring whether:

- the job requires interacting with customers, the public or other non-colleagues;
- the pace of work is determined by direct demands from customers.

For the trade intensity index, indicators from the World Input-Output Database are used, measured at the two-digit sector level.[15] The main trade intensity indicator is based on two sub-indices. One is the 1995–2007 average of the domestic value-added of exports (that is, eliminating the value of intermediate imports) relative to total value-added for each country and sector. The second is the 1995–2007 average of the gross value of imports relative to gross output for each country and sector. The centile indices of both variables are then averaged into a single proxy measure of trade intensity at the two-digit sector level.

For the union representation index, ESS data are used to calculate the share of workers who are union members in each occupation–sector combination.

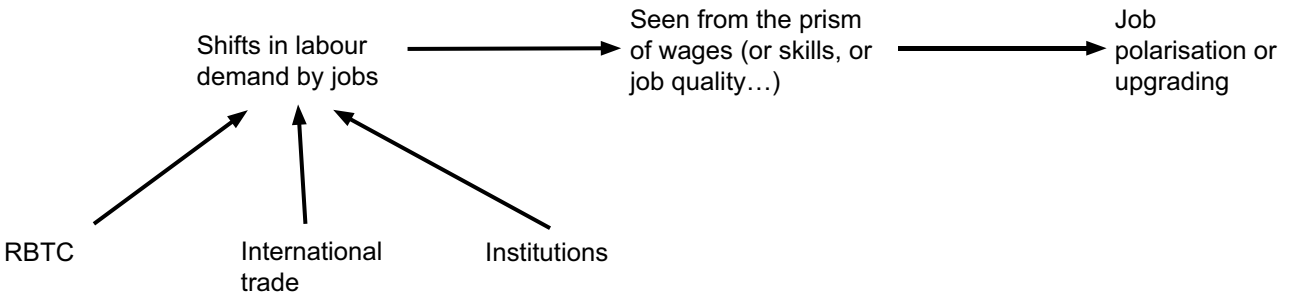
Finally, three indices calculated at the country level are correlated with some country-level outputs from the regressions:

- minimum wage as a share of the national median wage (from Eurostat);
- increase in the share of non-standard employment (defined as temporary or part-time, from Eurostat);
- the Organisation for Economic Co-operation and Development (OECD) index of employment protection legislation.

Analytic strategy

The research question that underlies many of the research papers reviewed here is also the basis to this report: what are the drivers behind the observed patterns of job polarisation and upgrading across developed economies? Figure 22 presents a broad overview of most of the proposed answers to this research question. The outcome that requires an explanation is job polarisation or upgrading patterns. This outcome represents the shifts in labour demand by jobs through the prism of wages, skills or job quality. This is the starting point of many of the research papers reviewed here, and it is also the starting point of this report. In order to evaluate the structural employment transformations over recent years, jobs are ranked according to wages, skills or job quality. This enables an assessment of the implications of recent employment shifts. It is proposed that most of the hypotheses reviewed here concern shifts in labour demand by jobs (shown in the left-hand side of Figure 22), which, when seen from the prism of wages, can be characterised as polarising or upgrading. This is important because, although this analysis aims to explain job polarisation or upgrading, the factors being analysed do not directly explain polarisation; rather, they explain shifts in labour demand that underlie this phenomenon.

Figure 22: *The structure of explanation of job polarisation and upgrading*



The main empirical test of the theoretical hypotheses, presented in Chapter 4, aims to follow the structure of explanation shown in Figure 22. First, a regression model is constructed for each country, to test the impact of RBTC, international trade and institutions on shifts in labour demand by jobs (shown at the left of Figure 22). The outcome variable is identified through the shifts in labour demand; specifically, relative change in employment over the period being studied. Jobs comprise the unit of analysis – combinations of occupations and sectors – and the variables constructed in the previous

[15] This is an EU-funded database which provides time-series of world input-output tables for 40 countries worldwide and a model for the rest of the world, covering the period from 1995 to 2011 (Timmer, 2012). For more details, see http://www.wiod.org.

section are added as explanatory factors. These regressions are used to generate a theory-driven counterfactual of shifts in labour demand in individual countries during the period. In other words, a new variable is constructed, holding the structural change in employment that would be expected if the model and the operationalisation used here is correct.

Second, to test the right-hand side of Figure 22, jobs by their wages will again be ranked by wages and divided into initial quintiles; that is, five groups with the same amount of employment in the beginning of the period in each country, from low to high wages. The theory-driven, counterfactual predictions regarding shifts in labour demand are then plotted through each prism, and compared with the real pattern of labour demand for jobs at the different wage levels. This enables an evaluation of whether the theory-based counterfactual structural change in employment fits the observed patterns of polarisation and upgrading, or whether it departs significantly from it and in what ways it does so. This should be a relatively straightforward way to test the reviewed hypotheses. For instance, if the RBTC argument is correct, a regression model with independent variables measuring the routine and cognitive content of jobs should be able to predict reasonably well the recent shifts in labour demand. In particular, the predicted values should be clearly polarised when analysed through the prism of wages. If such a model does not produce polarisation (if the polarised pattern is not visible in the predicted values, but is visible in the residuals), we can say that to the extent that our operationalisation is reasonable, the observed polarisation was not the result of RBTC.

Before carrying out an empirical test of the theoretical hypotheses, the next chapter explores in a purely descriptive manner the associations between the different elements shown in Figure 22. The aim here is to shed some light on the implications of the different hypotheses and their interrelations.

3 Descriptive analysis of the different explanatory frameworks

This chapter uses a simple, descriptive approach to shed some light on the arguments summarised in Figure 22. It first looks at the average scores on the indices constructed earlier for the two-digit ISCO occupational categories,[16] and then discusses the structure of correlations between the different indices. It finishes with a brief review of the degree of homogeneity in the wage and skill hierarchies of the same jobs across different European countries.

Ranking occupational profiles on the indices

A cursory inspection of how the two-digit occupational categories (for the EU as a whole) score on the indices constructed should provide some insight into the indices and provide a rough evaluation of their plausibility regarding the initial understanding of the requirements of different job types. This is shown in Table 5. All the variables have been normalised by transforming them into centiles, based on the full jobs structure sorted according to each of the indices. So if legislators and senior officials have a value of 87.9 on the wage index in Table 5, this means that their average percentile position in terms of their median hourly wage is 87.9. This normalisation should facilitate their comparison, and is also used in the statistical analysis in the next chapter.

The values seem quite plausible on initial inspection. The ranking of ISCO categories is clearly associated with the skill requirements of jobs and their hierarchical position within organisations, which means that, with few exceptions, wages, skills and cognitive tasks are reflected in this classification. Managers of small enterprises occupy a lower position, in terms of wages, skills and cognitive demands, than their position in the ISCO hierarchy might suggest. The opposite happens for some skilled and semi-skilled manufacturing occupations. It is interesting that the higher-than-expected position of skilled and semi-skilled occupations is particularly notable in terms of wages, but less so in terms of skills or cognitive demands; this is the case, for example, for extraction and building trades workers, stationary plant and related operators, machine operators and assemblers and drivers and mobile plant operators. By contrast, clerical occupations have relatively higher skills and cognitive requirements than wage levels.

Table 5: *Average scores of occupational categories on indices*

	Ranking of occupations (normalised as centiles)						
ISCO-88 codes (two-digit level)	**Wage**	**Skills**	**Cognitive**	**Routine**	**Social**	**Trade**	**Union**
Legislators and senior officials	87.9	86.3	92.0	7.4	55.0	30.3	51.1
Corporate managers	90.6	79.7	85.5	14.2	56.4	57.9	44.9
Managers of small enterprises	74.7	56.2	59.1	31.9	78.0	52.0	31.1
Physical, mathematical and engineering science professionals	90.0	92.9	94.0	19.8	41.1	64.8	51.3
Life science and health professionals	94.8	98.7	85.9	34.1	86.7	15.1	76.4
Teaching professionals	92.2	94.6	80.6	9.5	79.4	16.1	87.3
Other professionals	87.3	89.8	90.2	19.6	53.5	47.9	51.5
Physical and engineering science associate professionals	72.4	77.2	79.3	34.6	39.4	64.8	57.7
Life science and health associate professionals	71.2	81.4	66.2	35.6	84.7	16.1	68.3
Teaching associate professionals	67.9	83.8	60.2	11.4	78.7	12.0	78.3
Other associate professionals	70.3	72.5	74.6	24.5	59.2	47.6	46.8
Office clerks	44.6	59.0	64.4	52.9	42.3	51.1	54.9
Customer services clerks	44.3	53.9	54.5	72.1	85.9	48.9	51.0
Personal and protective services workers	31.5	42.4	31.5	50.8	73.2	29.9	44.0
Models, salespersons and demonstrators	17.0	38.7	25.0	61.8	94.7	44.7	23.4
Skilled agricultural and fishery workers	22.0	15.5	26.4	54.5	12.2	71.0	12.7
Extraction and building trades workers	43.2	28.2	37.1	72.9	35.9	39.3	49.3
Metal, machinery and related trades workers	47.2	44.0	48.4	56.5	27.3	68.0	65.0

[16] ISCO-88 categories are used in this section because the EU-LFS data used for the analysis included this version of the classification until 2010, the period covered here.

ISCO-88 codes (two-digit level)	Ranking of occupations (normalised as centiles)						
	Wage	Skills	Cognitive	Routine	Social	Trade	Union
Precision, handicraft, craft printing and related trades workers	45.0	44.7	40.4	68.7	33.8	74.8	52.5
Other craft and related trades workers	9.9	24.3	25.2	83.9	28.8	76.9	25.3
Stationary plant and related operators	49.0	24.0	30.6	72.9	13.1	79.1	81.0
Machine operators and assemblers	27.7	15.1	24.1	89.4	9.1	85.1	58.7
Drivers and mobile plant operators	45.5	16.2	17.4	64.6	51.2	60.8	64.8
Sales and services elementary occupations	11.5	5.8	6.2	77.5	29.8	36.1	41.3
Agricultural, fishery and related labourers	3.3	1.4	3.9	83.6	4.1	74.1	17.6
Labourers in mining, construction, manufacturing and transport	20.8	6.8	9.8	84.0	16.9	60.6	45.6

The routine index, on the other hand, goes generally in the opposite direction: the degree of routine involved in the job increases moving downwards in the occupational hierarchy. All occupations above that of clerk – all the managerial, professional and associate professional occupations – have generally low scores, while all those below clerk have relatively high scores. A few cases do not fit this general pattern. Health professionals and associate professionals show levels of routine that are slightly higher than other similar occupations. By contrast, the routine levels for personal and protective service workers, skilled agricultural workers, and skilled manufacturing workers are slightly lower.

The social interaction index is less associated with the occupational hierarchy than the indices discussed so far. High levels of social interaction are spread across the hierarchy. The highest levels for this index are found among models, salespersons and demonstrators, customer services clerks, health professionals, teaching professionals, teaching associate professionals, and managers of small enterprises. The lowest values are generally found for agricultural, construction and industrial occupations, and to some extent for hard science professionals, associate professionals and office clerks.

The distribution for the trade index is more or less opposite to that of the social interaction index, with some exceptions: managerial and hard science occupations have relatively high values in both cases, as do clerical occupations, salespersons and drivers and mobile plant operators. By contrast, building trades workers and sales and services elementary occupations have low scores both in terms of social interaction and trade intensity.

Finally, the union representation index is probably least clearly linked to the occupational hierarchy, with high and low values across the classification. The values, again, look reasonably plausible, with higher unionisation rates for teaching and health professionals and associate professionals, as well as skilled and semi-skilled industrial occupations; lower values exist for unskilled service workers, managerial occupations, agricultural workers and personal and protective service workers.

Broad correlation patterns between indices

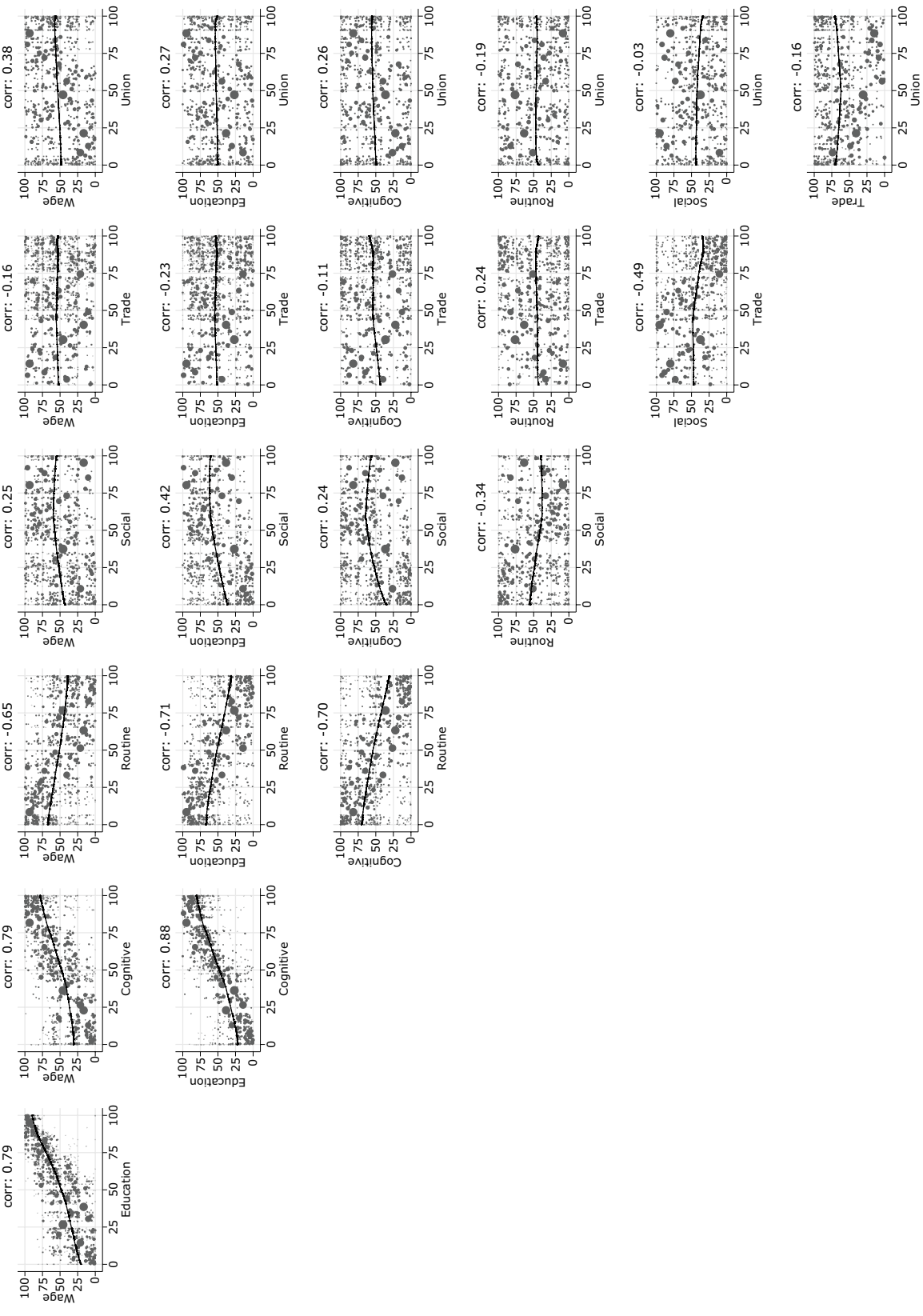
A relatively unsophisticated analysis of the simple correlations between the indices can provide an indication of the plausibility of some of the explanations for patterns of polarisation and upgrading. Figure 23 shows these correlations, displaying for each pair of variables a scatterplot in which each dot represents a job, based on the two-digit sector–occupation combination, for the EU as a whole. These dots are sized according to their employment weight in the initial year of the period studied here, with a superimposed, locally weighted smoothed regression line to summarise the type of association between them. The Pearson correlation coefficient is displayed on top of each chart; this is the square root of the coefficient of determination, or r^2.

Some such correlations are predicted by the theories reviewed; the following subsections discuss whether or not they reflect the empirical results.

Correlation between wages, skills and job quality

As explained above, the main argument around polarisation or upgrading rests on the analysis of structural changes in employment through the lens of wages, skills or job quality. These three concepts are assumed to be, for practical purposes, almost interchangeable, which means that the ranking of jobs by any one of them should lead to very similar results. The first chart in the upper left corner of Figure 23 shows that, according to these data, this assumption is only partly correct. The lowess line shows

Figure 23: *Correlations between indices, with jobs weighted by employment in the initial year*



that the correlation between the centile indices of jobs in terms of wages and education is linear, as expected, and relatively high. But it is not perfect, which means that they are not interchangeable and that they can lead to significantly different results when they are used to evaluate the implications of structural shifts in employment. A correlation coefficient of 0.79 corresponds to a coefficient of determination of 0.62, which means that nearly 40% of the distribution of each of the two indices cannot be linearly predicted by the other. As already shown in Figure 20, this 40% does produce significant differences: for the EU as a whole, the use of wages, skills or a multidimensional job quality index produces different patterns – polarisation in the first case and structural upgrading in the latter two. Table 5, which shows the index scores for the different occupational categories, provides some hints as to why this is the case. There are some significant jobs that occupy a higher position in terms of wages than in terms of skills or job quality. This mostly relates to semi-skilled and unskilled occupations in manufacturing and construction. Since these jobs have experienced a secular decline throughout the whole period studied here, they contribute to polarisation in terms of wages by depressing the middle of the wage structure, but to upgrading in terms of skills and job quality, by depressing the bottom of the skills and job quality structures. (For a more detailed discussion, see Eurofound, 2013.)

Correlation between cognitive and routine indices

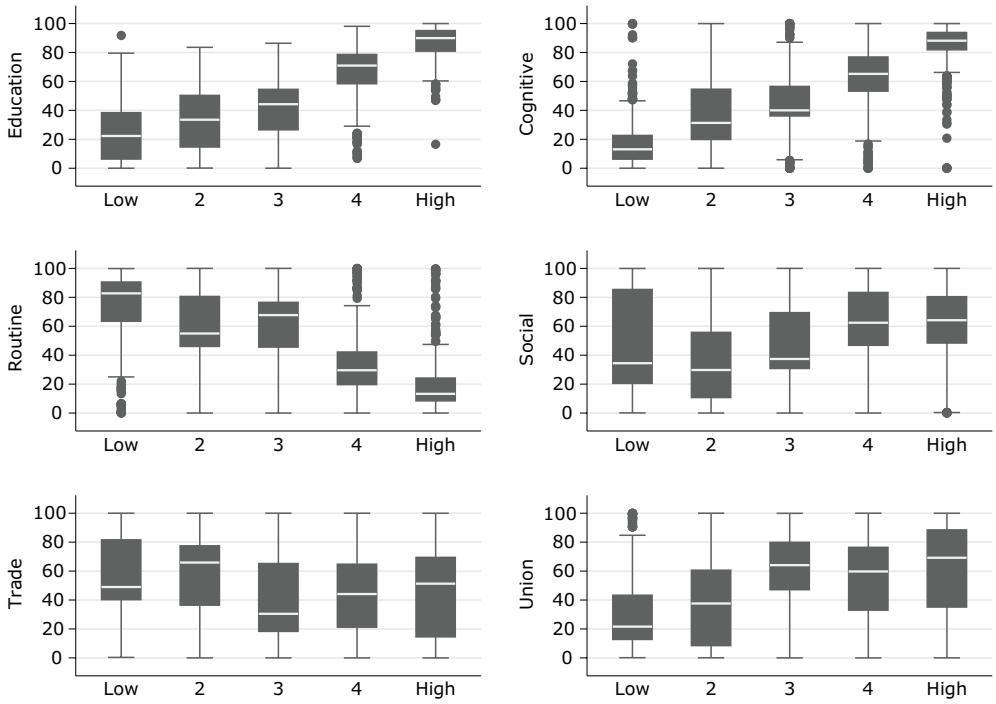
According to the RBTC argument, the cognitive and routine dimensions of jobs should be associated in a particular, non-linear way: routine tasks should be more frequent in jobs with mid-level cognitive task demands and less frequent at the two extremes of the cognitive axis. However, this does not seem to be the case. Figure 23 shows that although the linear correlation between them is not extremely high (-0.7, corresponding to an r^2 of 0.49), it shows a very significant overlap between the two variables, as expected from a purely theoretical standpoint. In other words, routine tasks are not more frequent in jobs with mid-level cognitive requirements, but in jobs where the cognitive demands are relatively low. This significant, negative linear association between the cognitive and routine attributes of jobs supports the idea defended earlier that, even conceptually, the cognitive and routine requirements of a job can be seen, to some extent, as two opposing ends of one continuum. So it is not simply that they are empirically correlated, but that they can be seen as two sides of the same coin: routine tasks generally require less cognitive effort.

Correlation between routine tasks index and other indices

According to the RBTC approach, jobs requiring routine tasks should also be more frequent in the middle of the job quality continuum and less frequent at the higher and lower levels. By contrast, the cognitive dimensions of a job should be highly positively correlated with job quality, which Figure 23 shows is indeed the case. In particular, the skills index and the cognitive demands index have an extremely high correlation (0.88, corresponding to an r^2 of 0.78), with a roughly logistic lowess line. But Figure 23 also shows that the routine tasks index does not behave as expected: rather than being more frequent in the middle, routine tasks show a more or less linear, negative association with both the wage and the skills indices. Figure 24 illustrates the same point, using the quintile approach that will be used again when evaluating the overall patterns of structural change in employment. In this chart, the jobs have been rearranged in quintiles according to their values in the wage index, so that each of the categories on the horizontal axis represents one-fifth of employment, from lower to higher wages. On this horizontal axis, a series of boxplots summarise the distribution of the routine tasks index for each wage quintile.

The relationship between the two variables does not appear entirely linear; for instance, the median of the routine tasks index is slightly higher for the middle than for the second lowest quintile. However, it is clear that the degree of routine tends to decrease from the low to the high wage quintile, rather than being higher in the middle than in the extremes. The association between the routine index and the cognitive index is even more clearly linear and monotonically negative. This point is quite important because, as argued in Chapter 1, a key assumption of the RBTC argument is that jobs in the middle of the wage–skills–job-quality structure tend to have a higher routine content. Yet, according to our data, and at least for the EU, that is not really the case. This finding alone makes the RBTC argument not very plausible as an explanation for job polarisation: if routine tasks are more often found in low-skilled and low-paid jobs, the process of RBTC would tend to depress the bottom and expand the top (a form of occupational upgrading). This would not be so different from the classical effect of SBTC. The polarising effect could still be possible, although it is not very plausible, if the high-routine jobs that have shrunk in recent years are concentrated in the middle of the job-wage structure.

Figure 24: *Boxplots with distribution of scores for different centile indices by wage quintiles*



Correlation between social interaction index and other indices

In some, though not all, of the RBTC papers reviewed here, service and care tasks are assumed to be more frequently found in the bottom of the job quality continuum. The social interaction index constructed here is not identical to the concept of service tasks in the reviewed literature, because it is exclusively based on the degree of social interaction with non-colleagues required by the job, but it is certainly related to the concept. But as Figure 23 shows, the association between this index and the others does not conform to the idea of service tasks being downwards-biased with respect to wages and skills. The correlations are very low (0.25 for wage, 0.42 for skills), but go in the opposite direction: social interaction tasks are more frequent in the upper levels of skills and wages, rather than less so. The quintile representation in Figure 24 shows that this relationship is slightly more complicated, but still does not conform to the argument from the research literature. Although the quantity of social interaction tasks in a job increases with the position in the wage structure, a significant proportion of jobs with a relatively high degree of social interaction are found at the very bottom, so the overall picture is slightly polarised. In addition, the association is not entirely linear at the top levels, with no significant difference found between the fourth and fifth quintiles. In any case, the bias is more upwards than downwards, with a certain degree of polarisation.

According to arguments regarding the tradability of occupations by Blinder (2009) and the care economy by Dwyer (2013), social interaction tasks should be more frequent both at the bottom and top levels of the job quality continuum. As already noted, this fits reasonably well the empirical results for the EU, as shown in Figures 23 and 24. Social interaction tasks, as measured here, are more likely to be found in the top and, to some extent, the bottom levels. Lower levels are likely in the second-lowest and middle wage quintiles. For this reason alone, it seems plausible that, to the extent that employment shifts have been biased towards jobs with higher levels of social interaction, this variable can explain job polarisation, at least to some degree.

Correlation between trade intensity index and other indices

The trade intensity variable has low correlations with most of the other indices except the social interaction index. This confirms Blinder's contention that the offshorability of jobs is dependent in part on their not comprising tasks that require face-to-face interaction with end users. But the association between the trade intensity index developed here and the job quality continuum is not as expected. This is perhaps because the trade intensity index is less precise a measure; it is

the only indicator that does not have occupation–sector-specific scores, but scores just for sectors. As Figures 23 and 24 show, although there is not a very clear pattern, linear or not, of association between trade intensity and the wage index, the higher levels of trade intensity seem to be in the bottom or mid–low levels, rather than the middle of the job quality continuum. Interestingly, the trade intensity of some high-paying jobs seems to increase slightly with respect to the middle and mid–high wage quintiles. In any case, the patterns here are less clear, so it is more difficult to evaluate their potential implications in terms of job polarisation or upgrading.

Correlation between unionisation and other indices

From an institutional perspective, it has often been argued that the most highly unionised jobs tend to be located in the middle of the job quality continuum. This variable has a low level of linear correlation with all the rest, but as Figures 23 and 24 show, if anything, the degree of unionisation seems to be upwards biased with respect to wages, though not linearly. The jobs in the two bottom quintiles clearly have lower levels of unionisation than the jobs in the three top quintiles, which are roughly similar. That being said, the most consistently high level of unionisation is found in the middle quintile, whereas the top quintile shows a much more spread distribution, where jobs have much more varying levels of unionisation. So there is a curvilinear, positive association between union density and wages at the job level that may be associated, to some extent, with polarisation, if highly unionised jobs have decreased in relative terms in recent years.

Homogeneity or diversity in the wage and skill job structures across Europe

As previously mentioned, the findings of job polarisation or upgrading have generally been predicated on an analysis of structural change in employment through the lens of wage, skill levels or job quality. Wages, skills and job quality are not interchangeable for the purposes of this report, because they can lead to considerably different conclusions when used to evaluate the implications of recent changes in the employment structure. A related but different question is whether the wage and skill hierarchies of jobs are significantly different across countries, or similar enough to justify using the same wage and skills indices to classify employment. Partly because of limited data availability in Europe, the analysis of job polarisation and upgrading patterns has often been carried out using a common index for wages, skills or other variables to classify jobs. Such an index is then applied to country-specific data on shifts in employment by occupation and sector (for instance, in Goos et al, 2009). The assumption is that even if structural employment change can vary across countries, the relative position of jobs against each other remains basically the same throughout developed economies and can therefore be classified in the same way.

Table 6 below displays the pairwise correlations between the wage and skill centile indices of jobs across the 23 European countries for which data are available. There is a significant amount of variation in these correlation indices. For instance, the correlation between the wage centiles of Greece and Austria is 0.51, corresponding to a common variance of only 26%, whereas between Italy and Germany the correlation is 0.9, amounting to a common variance of 81%. In general, the correlations are higher for the skills indices than for wages: a principal components factor analysis of the wage and education country centiles produces a first factor that explains 75% of the overall variance in the country-specific wage indices and 86% in the country-specific skills indices. The uniqueness scores (the percentage of variance of a particular wage or skill centile that is not explained by the common factor) allow us to evaluate the degree of variation between a country's wage and skills structures with respect to the common EU patterns. In terms of wages, many countries have relatively high uniqueness scores (often above 30%): in particular, Greece, the Baltic states, Sweden, Denmark and Austria. In terms of education, the scores are lower (less than 20%), with particularly high values for Germany, Denmark, the Baltic states, Portugal, Spain and the UK.

Table 6: *Correlations between wage and skills scores by country*

Correlations between the wage centile values at the job level

	AT	BE	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HU	IE	IT	LT	LU	LV	NL	PT	SE	SI	SK	UK
AT		0.77	0.71	0.81	0.83	0.63	0.70	0.51	0.84	0.82	0.71	0.79	0.72	0.82	0.56	0.82	0.56	0.77	0.81	0.78	0.85	0.79	0.66
BE	0.77		0.63	0.86	0.85	0.71	0.52	0.60	0.85	0.87	0.71	0.76	0.81	0.85	0.66	0.87	0.49	0.75	0.80	0.82	0.76	0.85	0.71
CY	0.71	0.63		0.75	0.68	0.69	0.74	0.52	0.73	0.65	0.73	0.66	0.66	0.61	0.56	0.68	0.56	0.77	0.63	0.65	0.72	0.72	0.69
CZ	0.81	0.86	0.75		0.86	0.74	0.69	0.65	0.89	0.86	0.81	0.84	0.81	0.84	0.71	0.85	0.65	0.81	0.82	0.79	0.81	0.89	0.79
DE	0.83	0.85	0.68	0.86		0.77	0.69	0.64	0.88	0.86	0.84	0.83	0.84	0.90	0.74	0.86	0.61	0.82	0.87	0.82	0.79	0.84	0.84
DK	0.63	0.71	0.69	0.74	0.77		0.68	0.57	0.72	0.72	0.82	0.69	0.79	0.69	0.67	0.65	0.55	0.78	0.69	0.75	0.57	0.75	0.83
EE	0.70	0.52	0.74	0.69	0.69	0.68		0.52	0.64	0.58	0.79	0.73	0.63	0.61	0.70	0.59	0.73	0.73	0.67	0.57	0.64	0.70	0.75
EL	0.51	0.60	0.52	0.65	0.64	0.57	0.52		0.67	0.63	0.64	0.60	0.69	0.65	0.52	0.61	0.55	0.59	0.67	0.51	0.46	0.67	0.63
ES	0.84	0.85	0.73	0.89	0.88	0.72	0.64	0.67		0.85	0.82	0.81	0.80	0.87	0.66	0.83	0.55	0.78	0.85	0.81	0.80	0.86	0.73
FI	0.82	0.87	0.65	0.86	0.86	0.72	0.58	0.63	0.85		0.76	0.71	0.81	0.86	0.62	0.83	0.51	0.79	0.79	0.88	0.73	0.86	0.76
FR	0.71	0.71	0.73	0.81	0.84	0.82	0.79	0.64	0.82	0.76		0.77	0.82	0.79	0.70	0.71	0.62	0.82	0.80	0.71	0.65	0.81	0.88
HU	0.79	0.76	0.66	0.84	0.83	0.69	0.73	0.60	0.81	0.71	0.77		0.71	0.80	0.70	0.78	0.69	0.75	0.84	0.68	0.82	0.76	0.74
IE	0.72	0.81	0.66	0.81	0.84	0.79	0.63	0.69	0.80	0.81	0.82	0.71		0.84	0.73	0.78	0.63	0.81	0.78	0.77	0.65	0.81	0.86
IT	0.82	0.85	0.61	0.84	0.90	0.69	0.61	0.65	0.87	0.86	0.79	0.80	0.84		0.69	0.85	0.56	0.78	0.86	0.79	0.79	0.82	0.76
LT	0.56	0.66	0.56	0.71	0.74	0.67	0.70	0.52	0.66	0.62	0.70	0.70	0.73	0.69		0.67	0.76	0.65	0.71	0.62	0.62	0.68	0.73
LU	0.82	0.87	0.68	0.85	0.86	0.65	0.59	0.61	0.83	0.83	0.71	0.78	0.78	0.85	0.67		0.61	0.74	0.82	0.74	0.81	0.80	0.71
LV	0.56	0.49	0.56	0.65	0.61	0.55	0.73	0.55	0.55	0.51	0.62	0.69	0.63	0.56	0.76	0.61		0.57	0.68	0.44	0.55	0.59	0.67
NL	0.77	0.75	0.77	0.81	0.82	0.78	0.73	0.59	0.78	0.79	0.82	0.75	0.81	0.78	0.65	0.74	0.57		0.72	0.78	0.71	0.82	0.81
PT	0.81	0.80	0.63	0.82	0.87	0.69	0.67	0.67	0.85	0.79	0.80	0.84	0.78	0.86	0.71	0.82	0.68	0.72		0.69	0.77	0.83	0.75
SE	0.78	0.82	0.65	0.79	0.82	0.75	0.57	0.51	0.81	0.88	0.71	0.68	0.77	0.79	0.62	0.74	0.44	0.78	0.69		0.70	0.76	0.70
SI	0.85	0.76	0.72	0.81	0.79	0.57	0.64	0.46	0.80	0.73	0.65	0.82	0.65	0.79	0.62	0.81	0.55	0.71	0.77	0.70		0.73	0.61
SK	0.79	0.85	0.72	0.89	0.84	0.75	0.70	0.67	0.86	0.86	0.81	0.76	0.81	0.82	0.68	0.80	0.59	0.82	0.83	0.76	0.73		0.79
UK	0.66	0.71	0.69	0.79	0.84	0.83	0.75	0.63	0.73	0.76	0.88	0.74	0.86	0.76	0.73	0.71	0.67	0.81	0.75	0.70	0.61	0.79	

PCF analysis of wage centiles, 452 cases (jobs), .75 variance explained by 1st factor. Uniqueness value for each country:

	AT	BE	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HU	IE	IT	LT	LU	LV	NL	PT	SE	SI	SK	UK
Uniq.	0.25	0.20	0.39	0.11	0.10	0.31	0.39	0.51	0.15	0.19	0.17	0.22	0.20	0.16	0.39	0.19	0.49	0.21	0.19	0.29	0.30	0.15	0.20

Correlations between the skills centile values at the job level

	AT	BE	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HU	IE	IT	LT	LU	LV	NL	PT	SE	SI	SK	UK
AT		0.85	0.81	0.92	0.91	0.88	0.78	0.80	0.80	0.85	0.88	0.90	0.85	0.82	0.80	0.89	0.78	0.89	0.77	0.83	0.88	0.88	0.90
BE	0.85		0.86	0.85	0.83	0.84	0.86	0.88	0.87	0.91	0.92	0.87	0.91	0.92	0.84	0.86	0.82	0.92	0.87	0.87	0.86	0.84	0.84
CY	0.81	0.86		0.83	0.76	0.78	0.85	0.90	0.85	0.83	0.82	0.85	0.88	0.89	0.84	0.80	0.83	0.86	0.87	0.84	0.86	0.84	0.77
CZ	0.92	0.85	0.83		0.90	0.87	0.81	0.82	0.79	0.85	0.87	0.95	0.87	0.82	0.84	0.86	0.83	0.89	0.77	0.83	0.91	0.95	0.89
DE	0.91	0.83	0.76	0.90		0.90	0.75	0.74	0.72	0.84	0.87	0.86	0.81	0.76	0.75	0.88	0.73	0.88	0.71	0.82	0.84	0.85	0.90
DK	0.88	0.84	0.78	0.87	0.90		0.76	0.78	0.77	0.86	0.87	0.84	0.84	0.79	0.75	0.84	0.74	0.88	0.74	0.85	0.83	0.81	0.90
EE	0.78	0.86	0.85	0.81	0.75	0.76		0.84	0.82	0.84	0.84	0.84	0.86	0.87	0.82	0.81	0.84	0.86	0.84	0.82	0.84	0.82	0.77
EL	0.80	0.88	0.90	0.82	0.74	0.78	0.84		0.92	0.84	0.84	0.85	0.90	0.92	0.85	0.80	0.85	0.85	0.91	0.84	0.88	0.85	0.77
ES	0.80	0.87	0.85	0.79	0.72	0.77	0.82	0.92		0.85	0.83	0.82	0.89	0.93	0.82	0.79	0.82	0.85	0.90	0.84	0.84	0.81	0.80
FI	0.85	0.91	0.83	0.85	0.84	0.86	0.84	0.84	0.85		0.90	0.87	0.89	0.88	0.82	0.87	0.81	0.92	0.82	0.87	0.86	0.84	0.86
FR	0.88	0.92	0.82	0.87	0.87	0.87	0.84	0.84	0.83	0.90		0.88	0.89	0.88	0.81	0.89	0.80	0.91	0.83	0.86	0.87	0.85	0.87
HU	0.90	0.87	0.85	0.95	0.86	0.84	0.84	0.85	0.82	0.87	0.88		0.88	0.85	0.86	0.86	0.85	0.88	0.81	0.83	0.94	0.95	0.85
IE	0.85	0.91	0.88	0.87	0.81	0.84	0.86	0.90	0.89	0.89	0.89	0.88		0.91	0.86	0.83	0.84	0.91	0.88	0.88	0.88	0.87	0.87
IT	0.82	0.92	0.89	0.82	0.76	0.79	0.87	0.92	0.93	0.88	0.88	0.85	0.91		0.85	0.83	0.86	0.90	0.92	0.88	0.87	0.84	0.81
LT	0.80	0.84	0.84	0.84	0.75	0.75	0.82	0.85	0.82	0.82	0.81	0.86	0.86	0.85		0.78	0.86	0.83	0.83	0.81	0.86	0.86	0.76
LU	0.89	0.86	0.80	0.86	0.88	0.84	0.81	0.80	0.79	0.87	0.89	0.86	0.83	0.83	0.78		0.78	0.90	0.77	0.83	0.86	0.84	0.86
LV	0.78	0.82	0.83	0.83	0.73	0.74	0.84	0.85	0.82	0.81	0.80	0.85	0.84	0.86	0.86	0.78		0.82	0.84	0.78	0.85	0.86	0.74
NL	0.89	0.92	0.86	0.89	0.88	0.88	0.86	0.85	0.85	0.92	0.91	0.88	0.91	0.90	0.83	0.90	0.82		0.83	0.90	0.89	0.87	0.90
PT	0.77	0.87	0.87	0.77	0.71	0.74	0.84	0.91	0.90	0.82	0.83	0.81	0.88	0.92	0.83	0.77	0.84	0.83		0.82	0.84	0.80	0.74
SE	0.83	0.87	0.84	0.83	0.82	0.85	0.82	0.84	0.84	0.87	0.86	0.83	0.88	0.88	0.81	0.83	0.78	0.90	0.82		0.85	0.82	0.87
SI	0.88	0.86	0.86	0.91	0.84	0.83	0.84	0.88	0.84	0.86	0.87	0.94	0.88	0.87	0.86	0.86	0.85	0.89	0.84	0.85		0.92	0.84
SK	0.88	0.84	0.84	0.95	0.85	0.81	0.82	0.85	0.81	0.84	0.85	0.95	0.87	0.84	0.86	0.84	0.86	0.87	0.80	0.82	0.92		0.84
UK	0.90	0.84	0.77	0.89	0.90	0.90	0.77	0.77	0.80	0.86	0.87	0.85	0.87	0.81	0.76	0.86	0.74	0.90	0.74	0.87	0.84	0.84	

PCF analysis of skill centiles, 523 cases (jobs), .86 variance explained by 1st factor. Uniqueness value for each country:

	AT	BE	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HU	IE	IT	LT	LU	LV	NL	PT	SE	SI	SK	UK
Uniq.	0.13	0.09	0.16	0.12	0.20	0.18	0.17	0.14	0.16	0.11	0.11	0.10	0.08	0.11	0.17	0.16	0.19	0.07	0.17	0.14	0.10	0.13	0.16

Note: Jobs are weighted by employment.

The wage and skills structures across Europe are relatively similar; a linear combination of the country-specific wage and skills rankings can account for 75% and 86% of their total variance, respectively. However, the important point here is that they are different enough to require the utilisation of country-specific indices in order to correctly evaluate the implications of structural change in employment in each country. This is particularly the case if employment shifts are being measured by wages. In some countries, such as Greece, the Baltic states, Denmark, Sweden and Austria, the use of a general wage hierarchy rather than a country-based one can lead to a rather misleading evaluation of employment shifts, because of the relatively idiosyncratic nature of wage levels across jobs in those countries.

If the wage and skill structures differ significantly across countries, requiring the use of country-specific scores, would the same point not apply to other indices previously considered, such as types of tasks, or the degree of social interaction? Unfortunately, the samples of the data sources used here are not big enough at the country level to allow the computation of job-specific scores needed. Due to these data limitations, a shared index for all EU countries must be used for each of those concepts. But if there are significant differences across countries, this could lead to misleading results.

Theoretically, it seems reasonable to expect that the variables of task content and social interaction, in particular, would have a smaller variation across countries than wage or skills level.[17] This is because they are more directly linked to the technical nature of jobs, which should be more universal at least in similarly developed economies. This idea can be tested roughly by evaluating the cross-national variation in the task and social content of a few large jobs that employ many people and are more likely to have a big enough sample to produce reliable scores for countries separately. This is shown in Figures 25 to 28. These figures contain country-specific scores for each of the key variables for the following four large occupation–sector combinations: trades workers in construction; drivers in land transport; salespersons in retail; and teaching professionals in education. The figures are quite rich in information, which facilitates the comparison. The two top charts in each figure show the proportion of employment in the initial year and the relative change over the period studied. The two charts below them show scores for the wage and skill centile indices, which are always country-specific. Below them, two charts show the scores of the cognitive and routine centile indices related to the RBTC hypothesis. The bottom two charts show the scores of the social interaction and union density indices. The scores represented by the bottom four charts in each figure are different to those used in the analysis of the rest of this report. While the rest of the report uses figures for the EU as a whole, these charts present an ad-hoc country-specific estimation which is only possible for these very large jobs.

What do these charts show? They show that the variability across countries in the task and social content indices is much lower than in the wage and skills centile scores for jobs. This is confirmed by the differences in the standard deviations of the indices; all the indices use the same scale and the standard deviations are directly comparable. The highest variation, in nearly all cases, is observed in the wage scores of jobs: as repeatedly argued here, the wage structures vary significantly across countries.

The skills index, constructed from a measure of the average educational level of workers in each job, shows a variation similar to that of wages, although this depends on the specific nature of each occupation. The centile scores of teachers have a remarkably low variation across countries, for example, whereas for salespersons in retail trade, they are even more dispersed than wages. The dispersion of the cognitive and routine task indices is significantly lower, in most cases around half the dispersion of the wage centile index; in two of the occupations – salespersons in retail and drivers in land transport – there is more dispersion in the routine than in the cognitive tasks index, perhaps related to the varying degree of technology penetration in the retail and transport sectors in different countries. The social interaction scores are also significantly less diverse across countries and similar to the two task indices. Finally, the union density scores of jobs seem to be more diverse across countries than the task content and social indices, although it is difficult to evaluate because the data are not available for all countries.

[17] Bear in mind that skill level is represented by the average educational level of job holders, not the skill requirements of jobs.

Based on this rough approximation, it seems unlikely that the use of a single EU-wide score for the task and social interaction variables would lead to any significantly wrong results. The results seem roughly coherent with the idea that, because these indices are more directly linked to the technical nature of the activities involved in the different jobs, they should be sufficiently similar across countries to justify using common scores. This contrasts with the wage indices and, to some extent, the skill indices as they are measured indirectly through educational attainment levels, which are also quite different across countries.

This is not the case with the union density indices, which do vary across countries. Importantly, this is not the result of differences in overall union density at the country level, since the index used is normalised and relative, but of differences in the distribution of union densities across occupations within each country. This means that the union density index, which is based on the EU average values, may be misleading and may therefore be unsuitable for evaluating the related institutional argument.

Figure 25: *Index scores for teaching professionals in education*

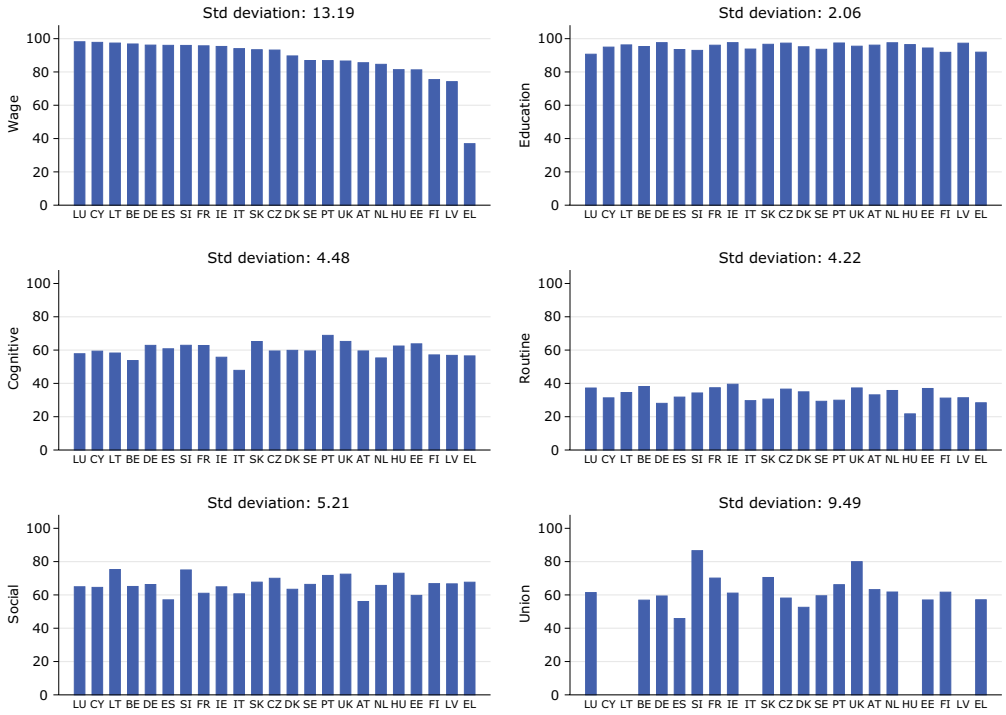


Figure 26: *Index scores for drivers in land transport*

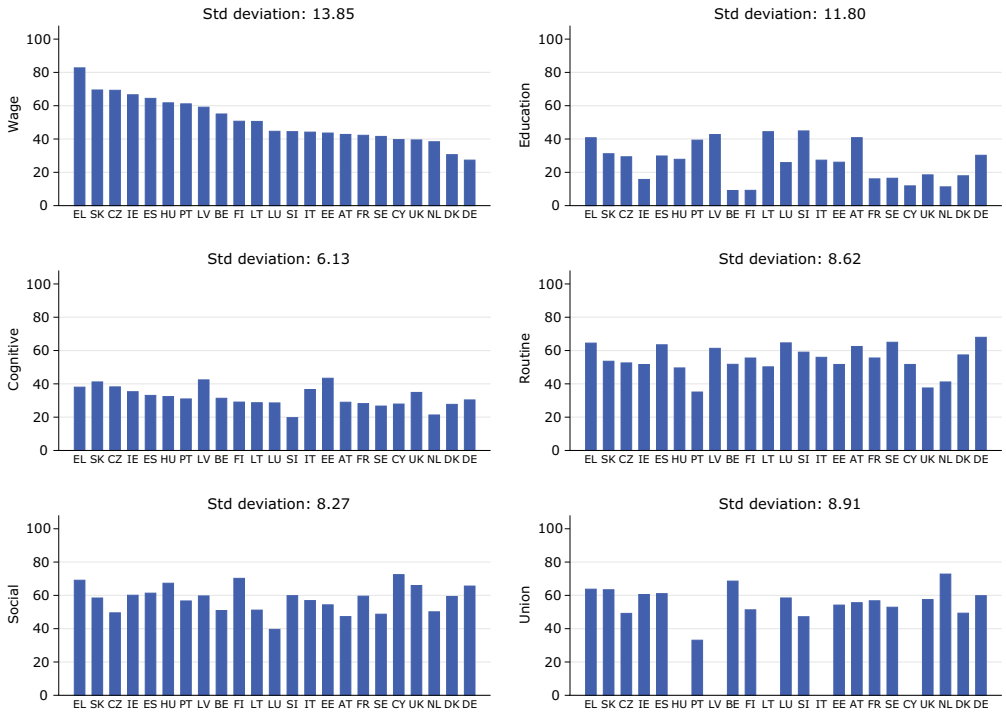


Figure 27: *Index scores for salespersons in retail*

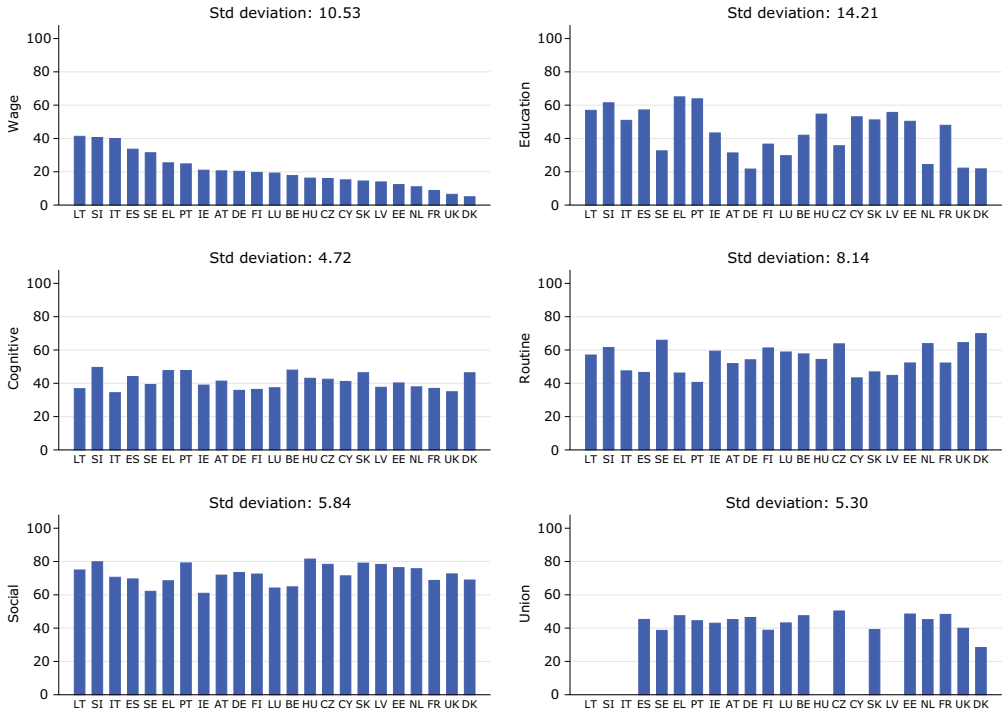
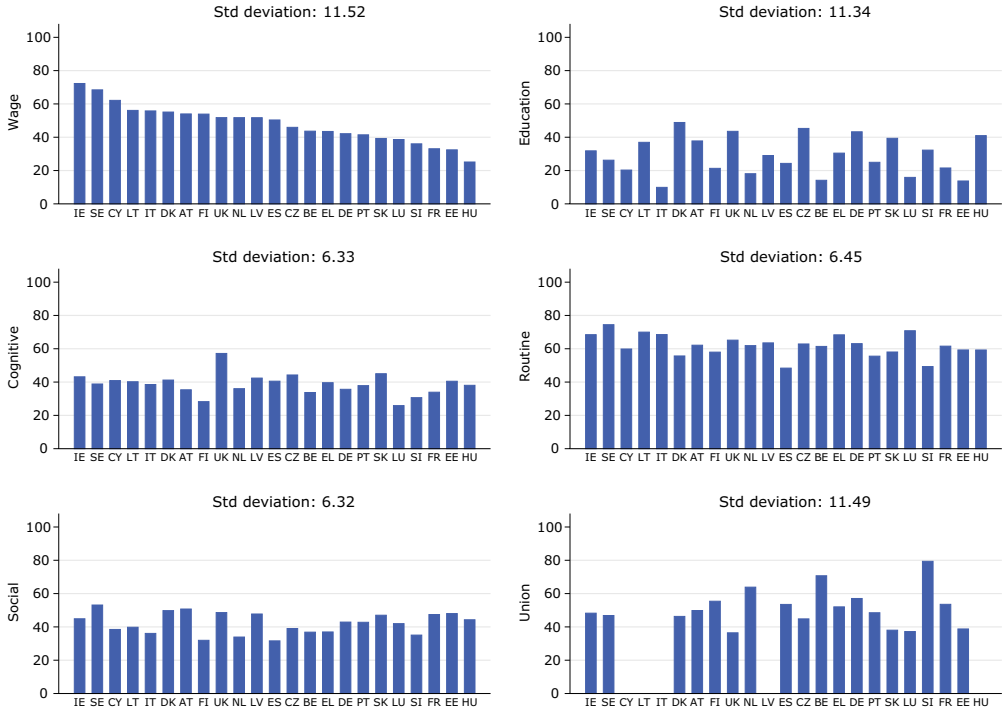


Figure 28: *Index scores for trade workers in construction*



4 Testing the different explanatory frameworks

The analytic strategy in this chapter consists of estimating a set of counterfactual values for the change in employment levels of different jobs (occupations within sectors). This is based on the empirical correlations between the observed levels of employment shifts across jobs and the values of the theory-derived variables constructed earlier. Such counterfactuals are simply the fitted values of a series of country-specific regression models constructed in steps following the theories discussed. The fitted values and the residuals (the simple difference with the observed values of change in employment across jobs) will be plotted against the initial wage quintiles in each country. Then the fit between the different theory-driven counterfactuals and the observed patterns of polarisation and upgrading will be evaluated visually.

The key goal of this analysis, therefore, is to evaluate the fit between our model-based predicted values of structural employment change and the real observed values, since we are predicting something that has already happened; that is, the shifts in employment by jobs between 1995 and 2007 in European countries. This means that although the basis of this analysis will be a series of regressions, the focus will not be the regression outputs, such as the coefficients and their statistical significance, nor even the fit between the predicted and observed shifts of employment by jobs on their own, as would be, for instance, measured by the coefficient of determination or r^2. Rather, the focus will be the fit between the predicted quintile picture and the observed one.

The latter point is important in order to evaluate properly the results of this analysis. This is because the outcome variable used in these regressions (relative change in employment across the different jobs in the different countries) has a large amount of unexplained variation, which has nothing to do with the observed patterns of polarisation and upgrading. To illustrate this point, Table 7 shows a simple country-level regression with only two independent variables, the normalised wage centile index and the same index squared to capture both upgrading and polarisation. It shows that the fit of the regression models is very low: in all cases, the capacity to predict the relative change in employment knowing the wage centile position of a particular job is below 5%.[18] But the wage centile index is the basis for the construction of the quintile charts or similar representations, such as locally weighted regression lines. These have been, to a large extent, the starting point of the whole job polarisation debate both in Europe and the US. The aggregate level patterns have not only been found to be meaningful and related to other socioeconomic developments, they have also been quite consistent over time and with respect to other variables.

Despite the large amount of 'noise' in the shifts in employment at the job level, which is probably related both to the variation in the EU-LFS small samples at the job level and to imprecise coding of occupations and sectors based on survey responses, the higher-level aggregated patterns are meaningful and significant in substantive terms. This is why fuzzy or non-parametric approaches such as quantile analysis work better in this case.

[18] A transformation of the outcome variable can slightly improve the predictive capacity of the model, for example by using change in log employment rather than simple relative change in employment (in which case, for instance, the r^2 of the wage centile nearly doubles in most countries). But since the main goal of this report is to evaluate the fit between the counterfactuals and the observed patterns, a simple measure of relative change in employment at the job level is more adequate in this case. It produces essentially the same results, but in a more clear and understandable way.

Table 7: *Wages as predictors of relative change in employment across jobs*

	AT	BE	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HU
Wage	-0.000158	0.00658	-0.0202	0.0104**	-0.00768	-0.0045	-0.000393	0.0152	0.00996	-0.000827	-0.0127*	0.00714
Wage2	0.00000964	-0.0000343	0.000221*	-0.0000688*	0.0000963*	0.0000876*	-0.00000771	-0.000103	-0.0000629	0.0000559	0.000155**	-0.0000477
Constant	0.106	-0.0658	0.565	-0.276***	0.13	-0.0203	0.0615	-0.242	0.334*	0.000379	0.287*	-0.112
N	878	907	409	1020	1245	635	521	872	978	623	1066	936
R-sq	**0.001**	**0.025**	**0.044**	**0.043**	**0.036**	**0.059**	**0.001**	**0.055**	**0.018**	**0.041**	**0.048**	**0.011**

	IE	IT	LT	LU	LV	NL	PL	SE	SI	SK	UK
Wage	0.0208*	0.0126*	0.0256***	-0.00917	0.0196	-0.0165**	0.0294***	0.00592	-0.00389	0.00109	-0.00462
Wage2	-0.00012	-0.0000747	-0.000215***	0.000201**	-0.000128	0.000150**	-0.000265***	-0.00000527	0.0000807	-0.0000122	0.0000704**
Constant	0.0427	-0.205*	-0.593***	0.0116	-0.480**	0.543***	-0.417***	-0.142	0.0374	0.043	0.0943
N	927	963	549	500	602	925	785	683	761	833	1103
R-sq	**0.01**	**0.051**	**0.061**	**0.094**	**0.035**	**0.038**	**0.08**	**0.051**	**0.024**	**0.01**	**0.039**

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

This is the reason why the current analysis will be concerned not so much about the standard measures of fit and significance in its models and predictions, but about the fit between predictions and the observed patterns of change once they are plotted at the quintile level. This enables the use of the ordinary least squares regression model to decompose variance in job growth into an explained or, more precisely, an empirically correlated part, and an unexplained, or uncorrelated, part. At the same time, a highly aggregated non-parametric approach can be used for the final evaluation of the fit between the predicted and observed patterns of structural change in employment.

In this analysis, the units of analysis are jobs, defined by the cross-classification of occupation (ISCO) and sector (NACE) at the two-digit level. Depending on the size of the EU-LFS sample in the different countries, the number of jobs available in each country ranges from 350 to 1,150. The outcome variable is the relative change in employment in each job between 1995 and 2007, although in some countries, the period is shorter (see Eurofound, 2013, for more details). The regression models are fitted by weighted ordinary least squares, using initial employment during the period for weighting the importance of different jobs in each country. The regressions are run separately in each country, although with an identical specification.

Table 8 shows the coefficients and fit statistics of each nested model. It begins with the model that uses only the variable measuring the cognitive requirement of jobs as a predictor, and ends with the model using all job-level and sector-level predictors. This table shows that the coefficients and fit of the models are of a similar magnitude to those of the wage index, as presented in Table 7, although they become higher as more variables are included. While the focus is on visually exploring how the predictions match the quintile patterns, the coefficients in Table 8 also provide an idea of relations between the variables. The variable measuring cognitive tasks is generally negative and the squared term positive. This convex effect may suggest polarisation; in fact, in the polarising countries, the coefficients are more significant. The variable measuring routine tasks has very little effect, with few significant coefficients, and is more often negative than positive in its squared term; this is a concave function. The coefficients for the social interaction variable are generally significant and also suggest a concave function, as do the union density coefficients.

Table 8: *Country-level regressions*

	Cognitive				
	N	Cognitive	Cognitive²	Const	R-sq
AT	703	-0.0101*	0.000113*	0.262*	0.012
BE	732	-0.0162***	0.000202***	0.286**	0.101
CY	373	-0.0106	0.000142	0.346	0.033
CZ	789	0.00215	0.0000127	-0.131	0.033
DE	846	-0.00800*	0.000103**	0.126	0.046
DK	578	-0.00378	0.0000708	0.00105	0.037
EE	474	-0.00817	0.0000795	0.166	0.004
EL	700	-0.0155*	0.000209**	0.256	0.11
ES	765	-0.0245*	0.000295*	0.866***	0.093
FI	564	-0.00448	0.0000870*	0.0815	0.038
FR	794	-0.0143**	0.000165***	0.329**	0.05
HU	734	-0.00155	0.0000411	0.0324	0.012
IE	703	-0.00293	0.0000705	0.597**	0.002
IT	716	-0.00709	0.000120*	0.13	0.057
LT	489	-0.00675	0.000096	-0.00798	0.019
LU	449	-0.0167*	0.000268***	0.168	0.097
LV	513	-0.00308	0.0000807	-0.0374	0.018
NL	742	-0.0143**	0.000153**	0.425***	0.037
PT	661	-0.00336	0.0000477	0.181	0.005
SE	617	-0.0122*	0.000148**	0.256*	0.038
SI	650	-0.0141	0.000167*	0.266	0.028
SK	694	-0.00305	0.0000366	0.0908	0.002
UK	806	-0.000482	0.0000394	-0.0078	0.057

	Cognitive and routine					
	Cognitive	Cognitive²	Routine	Routine²	Const	R-sq
AT	-0.0110*	0.000141**	0.00872	-0.0000606	-0.0162	0.02
BE	-0.0186***	0.000216***	0.000385	-0.0000186	0.408**	0.106
CY	-0.0156	0.00018	0.00722	-0.0000896	0.411	0.041
CZ	0.00432	-0.00000317	-0.00505	0.0000588	-0.129	0.041
DE	-0.00897*	0.000104**	-0.00258	0.0000136	0.257*	0.051
DK	-0.00786	0.0000845*	-0.00564	0.0000158	0.391**	0.061
EE	-0.00243	0.0000614	0.00138	0.000044	-0.271	0.021
EL	-0.0107	0.000175**	-0.00501	0.0000732	0.138	0.123
ES	-0.0257*	0.000322**	0.00634	-0.0000435	0.668	0.098
FI	-0.00461	0.0000866*	-0.00195	0.000017	0.133	0.04
FR	-0.0152**	0.000157**	-0.00453	0.000017	0.569**	0.062
HU	-0.00178	0.0000543	0.00278	-0.000012	-0.096	0.015
IE	-0.0073	0.000106	0.00807	-0.0000946	0.608	0.003
IT	-0.00822	0.000118*	-0.00265	0.00000742	0.303	0.062
LT	-0.00513	0.000129	0.00902	-0.0000213	-0.576*	0.051
LU	-0.0134	0.000229**	-0.0128	0.000123	0.365	0.102
LV	0.000531	0.0000721	-0.00277	0.0000708	-0.286	0.027
NL	-0.0194**	0.000197**	0.00817	-0.0000891	0.422*	0.048
PT	-0.00951	0.0000979	0.0119*	-0.000138**	0.187	0.025
SE	-0.0174**	0.000189**	0.00851	-0.0001	0.29	0.051
SI	-0.0164	0.000175*	-0.00175	-0.00000335	0.455	0.032
SK	-0.000613	0.0000327	-0.00179	0.000049	-0.0884	0.015
UK	-0.00691*	0.0000787**	0.00515*	-0.0000869***	0.216*	0.104

	Cognitive, routine and social							
	Cognitive	Cognitive²	Routine	Routine²	Social	Social²	Const	R-sq
AT	-0.0116*	0.000142**	0.00786	-0.0000439	0.00195	0.0000262	-0.187	0.043
BE	-0.0206***	0.000229***	-0.000933	0.00000228	0.0116***	-0.0000915**	0.186	0.127
CY	-0.0156	0.000176	0.00706	-0.0000883	0.00507	-0.0000542	0.355	0.043
CZ	0.00432	-0.00000559	-0.00637	0.0000764*	0.00419	-0.0000265	-0.234*	0.047
DE	-0.0103**	0.000117**	-0.00361	0.0000374	0.00581	-0.0000193	0.0273	0.098
DK	-0.00982*	0.0000986**	-0.00778*	0.0000549	0.0159***	-0.000120***	0.0241	0.108
EE	-0.00463	0.0000674	-0.000508	0.0000807	0.0261*	-0.000201*	-0.841*	0.069
EL	-0.0109	0.000154**	-0.00117	0.0000405	0.0174***	-0.000106*	-0.382	0.202
ES	-0.0253**	0.000296**	0.00133	0.0000286	0.0292**	-0.000225**	0.0335	0.165
FI	-0.00599	0.0000926*	-0.00262	0.0000339	0.0117**	-0.0000879*	-0.136	0.058
FR	-0.0162**	0.000159**	-0.00613	0.0000449	0.0139***	-0.000111**	0.273	0.09
HU	-0.00141	0.0000395	-0.000448	0.0000254	0.0136**	-0.000105*	-0.358*	0.037
IE	-0.0167	0.000149	0.00775	-0.0000832	0.0471***	-0.000413***	-0.0656	0.016
IT	-0.00918*	0.000118*	-0.00493	0.0000427	0.0138**	-0.000106*	0.00961	0.084
LT	-0.00634	0.000116*	0.0083	-0.0000133	0.0148**	-0.0000826	-0.926***	0.103
LU	-0.0160*	0.000238**	-0.0149	0.000146	0.0153*	-0.000119*	0.123	0.113
LV	-0.00209	0.0000633	-0.00529	0.0000977	0.0278**	-0.000212*	-0.773*	0.065
NL	-0.0204**	0.000203***	0.00556	-0.0000478	0.0157***	-0.000108*	0.0243	0.107
PT	-0.00958	0.0000865	0.0107	-0.000124*	0.0133*	-0.000114	-0.0422	0.04
SE	-0.0183**	0.000199***	0.00731	-0.0000746	0.00827	-0.0000554	0.0477	0.064
SI	-0.016	0.000169	-0.00301	0.0000159	0.000402	0.0000228	0.359	0.04
SK	-0.00254	0.0000401	-0.00586	0.000101*	0.0125**	-0.0000723	-0.371*	0.058
UK	-0.00807**	0.0000872**	0.00207	-0.0000384	0.0170***	-0.000136***	-0.159	0.184

	Cognitive, routine, social and trade								
	Cognitive	Cognitive²	Routine	Routine²	Social	Social²	Trade	Const	R-sq
AT	-0.0119*	0.000145**	0.00794	-0.0000459	0.00239	0.0000247	0.000676	-0.227	0.043
BE	-0.0199***	0.000219***	-0.00119	0.00000738	0.0110***	-0.0000926**	-0.00189	0.3	0.134
CY	-0.0118	0.000147	0.00592	-0.0000812	-0.00305	0.00000848	-0.00536	0.761	0.072
CZ	0.00428	-0.00000611	-0.00622	0.0000723*	0.00495	-0.0000302	0.000975	-0.298*	0.049
DE	-0.00999*	0.000115**	-0.00383	0.0000417	0.00473	-0.0000136	-0.0011	0.103	0.101
DK	-0.00931*	0.000102**	-0.00840*	0.0000672	0.0126***	-0.000103**	-0.00302**	0.236	0.122
EE	-0.00458	0.00007	-0.000523	0.0000898	0.0244*	-0.000206*	-0.00401	-0.579	0.078
EL	-0.00831	0.000128**	-0.00169	0.0000489	0.0129**	-0.0000880*	-0.00481**	-0.0215	0.23
ES	-0.0205*	0.000261**	0.0000388	0.0000476	0.0210**	-0.000174*	-0.00582*	0.426	0.186
FI	-0.00602	0.0000914*	-0.00239	0.0000304	0.0123**	-0.0000895*	0.000745	-0.19	0.058
FR	-0.0154**	0.000160**	-0.00625	0.0000501	0.0112**	-0.0000967*	-0.00217	0.416	0.097
HU	-0.00121	0.0000393	-0.000447	0.000027	0.0133**	-0.000103*	-0.00023	-0.353*	0.038
IE	-0.013	0.000122	0.00297	-0.0000173	0.0440***	-0.000396***	-0.00796*	0.352	0.023
IT	-0.0104*	0.000129*	-0.00433	0.0000356	0.0162**	-0.000122*	0.00183	-0.134	0.088
LT	-0.00523	0.000105	0.00738	-0.000000334	0.0137**	-0.0000821	-0.00246	-0.769**	0.109
LU	-0.0182*	0.000295**	-0.0144	0.000152	0.00698	-0.0000486	-0.00615**	0.507	0.135
LV	0.00213	0.0000249	-0.00622	0.000115	0.0257**	-0.000216*	-0.00528	-0.487	0.078
NL	-0.0199**	0.000203***	0.00538	-0.0000421	0.0128**	-0.0000974*	-0.00314**	0.252	0.121
PT	-0.00775	0.0000768	0.00993	-0.000106	0.00855	-0.0000838	-0.00370*	0.197	0.053
SE	-0.0183**	0.000200***	0.00721	-0.0000725	0.00783	-0.0000532	-0.000464	0.08	0.064
SI	-0.0148	0.000162	-0.00403	0.0000347	-0.00147	0.0000193	-0.00385	0.609	0.048
SK	-0.00275	0.0000429	-0.00538	0.0000913	0.0136**	-0.0000753	0.00249	-0.532***	0.068
UK	-0.00827**	0.0000934***	0.00107	-0.0000264	0.0145***	-0.000120***	-0.00232**	0.0243	0.203

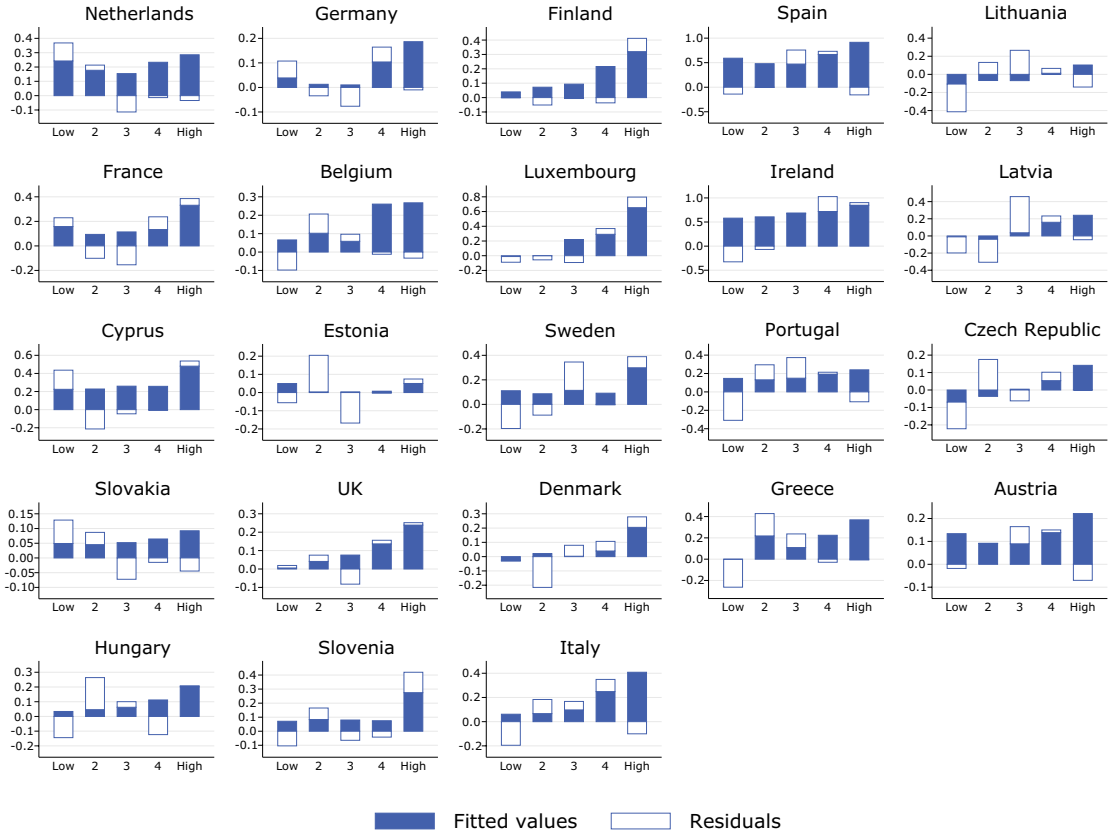
	Cognitive, routine, social, trade and union density										
	Cognitive	Cognitive²	Routine	Routine²	Social	Social²	Trade	Union	Union²	Const	R-sq
AT	-0.0114*	0.000150**	0.00451	-0.0000128	-0.00151	0.0000598	0.00054	0.00988*	-0.000125**	-0.198	0.063
BE	-0.0183***	0.000210***	-0.00538	0.0000442	0.00863**	-0.0000750*	-0.00251*	0.00567	-0.0000845*	0.430*	0.164
CY	-0.0107	0.000147	0.00292	-0.0000572	-0.00512	0.0000233	-0.0057	0.0048	-0.0000753	0.863	0.084
CZ	0.00329	0.00000206	-0.00922**	0.0000944**	0.00147	0.0000077	0.00207*	0.0170***	-0.000165***	-0.505***	0.099
DE	-0.00909*	0.000110**	-0.00535	0.0000551	0.00369	-0.00000584	-0.00119	0.00145	-0.0000287	0.161	0.114
DK	-0.00711	0.0000867*	-0.0125**	0.000105**	0.0116***	-0.0000936**	-0.00291**	0.00508	-0.0000763**	0.273	0.147
EE	-0.00494	0.0000739	-0.00479	0.000123	0.0184*	-0.000151	-0.00317	0.0224**	-0.000239**	-0.716*	0.109
EL	-0.00886	0.000137**	-0.00328	0.0000614	0.0125*	-0.0000887	-0.00480**	0.00768	-0.0000818	-0.0748	0.243
ES	-0.0205*	0.000271**	-0.00534	0.0000912	0.0185**	-0.000157*	-0.00573**	0.0200**	-0.000227**	0.335	0.229
FI	-0.00576	0.0000922*	-0.0052	0.0000532	0.00843*	-0.0000553	0.000881	0.0110**	-0.000126***	-0.191	0.08
FR	-0.0135*	0.000148**	-0.00772	0.0000656	0.0104**	-0.0000909*	-0.00221	0.00111	-0.0000328	0.46	0.117
HU	0.000115	0.0000291	-0.00404	0.0000568	0.0113*	-0.0000847	-0.000151	0.0108*	-0.000124**	-0.393*	0.058
IE	-0.00892	0.0000901	-0.000794	0.0000138	0.0405***	-0.000369***	-0.00782*	0.0230**	-0.000242**	0.0746	0.028
IT	-0.00888*	0.000124*	-0.00703	0.0000611	0.0150**	-0.000113*	0.00141	0.00461	-0.0000696	-0.0883	0.106
LT	-0.00298	0.0000903	0.00207	0.0000402	0.00905	-0.0000471	-0.00237	0.0195***	-0.000215***	-0.841**	0.15
LU	-0.0198*	0.000308**	-0.0163	0.000166	0.00368	-0.0000158	-0.00582**	0.0117	-0.000109	0.414	0.14
LV	0.00249	0.0000289	-0.00938	0.000143	0.0271**	-0.000232*	-0.00597	0.00624	-0.000104	-0.406	0.094
NL	-0.0181**	0.000189**	0.00452	-0.0000347	0.0118**	-0.0000946*	-0.00385***	-0.00306	0.00000749	0.438	0.133
PT	-0.00746	0.000079	0.00856	-0.0000949	0.00788	-0.0000804	-0.00386*	0.0026	-0.0000373	0.235	0.054
SE	-0.0176**	0.000197***	0.00454	-0.00005	0.00554	-0.000032	-0.000459	0.00434	-0.0000604	0.147	0.073
SI	-0.0164	0.000181*	-0.00494	0.0000376	-0.00361	0.0000371	-0.0034	0.00953*	-0.000109**	0.58	0.06
SK	-0.00353	0.0000554	-0.0101*	0.000132**	0.0102*	-0.0000441	0.00307*	0.0137**	-0.000156***	-0.557***	0.103
UK	-0.00819**	0.0000925***	-0.000126	-0.0000171	0.0139***	-0.000113***	-0.00217**	0.00336	-0.0000362	0.00671	0.213

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Initial model: cognitive index only

The strategy of this report is to compare the predicted and actual values of employment change in each of the nested models shown in Table 8. Figure 29 shows fitted values and residuals plotted against the wage quintiles for the initial model including the cognitive index only (and squared). It shows that this single variable can approximate, quite closely, the original observed patterns of structural change in employment for many countries.[19]

Figure 29: *Counterfactual quintile figures for models with the cognitive index only, by country*



In particular, it seems quite clear that the cognitive index is quite strongly associated with the upgrading pattern, which characterised structural change in employment for a majority of countries in Europe between 1995 and 2007. In other words, the observed upwards bias in terms of wages in labour demand is strongly correlated with the degree of information-processing tasks required by the different jobs. This is not very surprising since it is basically a restatement of the SBTC argument. In most cases, the patterns of job growth predicted by this simple model are linearly upgrading, but there are some interesting exceptions. In the Netherlands and France, the association between the cognitive requirements of jobs and relative change in employment seems linked to a mild polarisation, with fitted values of employment change being lower for the mid-level quintiles.[20] But, in general, even for most countries where the observed values show a more or less clear polarisation, the prediction based on the empirical correlation between the cognitive index and employment shifts by job is one of upgrading. In particular, the relative or absolute decrease of employment in the middle quintile of the polarising countries is found in the residuals rather than in the predicted values; this is the case for France, Germany, the UK and even the Netherlands. At the same time, the expansion of the bottom level in many of these countries is rela-

[19] The fitted and residual values shown in Figures 29 to 32 are expressed as average relative change in employment by job in each of the five quintiles (with jobs weighted by initial employment). Together, they add to the observed relative change (final minus initial employment divided by initial), calculated at the job level and averaged at the quintile level in the charts.

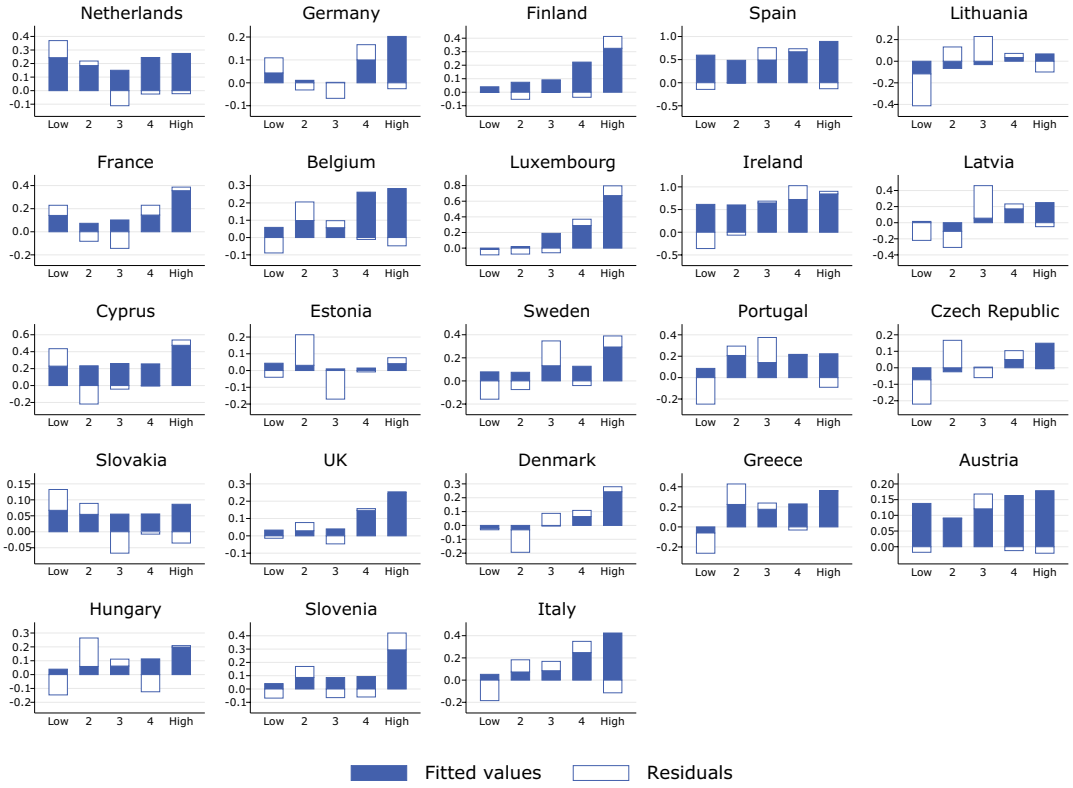
[20] The model can indeed produce polarisation in its fitted values, since a square term for the cognitive index is also included.

tively muted in the counterfactual patterns. Another interesting pattern is that for Spain and Ireland, where the predicted values are nearly as flat as the observed values. This simply suggests that the massive employment expansion of these countries was of a different nature to that of the rest of Europe, and seems not to fit the same story of SBTC.

Effect of routine tasks index

The full argument of RBTC links polarisation specifically to the routine content of jobs. Figure 30 shows the fitted values and residuals for the model including also the routine tasks index and its squared term. The addition of the routine tasks index seems to have little impact on the fit of the models in the polarising countries. Nor does it produce significantly more polarised counterfactuals anywhere.[21] Rather, it seems that the effect of the routine index is so similar to the effect of the cognitive index that in most cases it only marginally intensifies it. This was predicted in the previous chapter, on the basis of correlations between indices. In fact, a simpler model with just the routine index as predictor gives a very similar pattern to that presented in Figure 29 for the cognitive index only. So the extent of routine in different jobs, according to this analysis, is not the key driver behind polarisation – if anything, it is more related to upgrading, in a similar way as the cognitive index.

Figure 30: *Counterfactual quintile figures for models with the cognitive and routine tasks indices, by country*

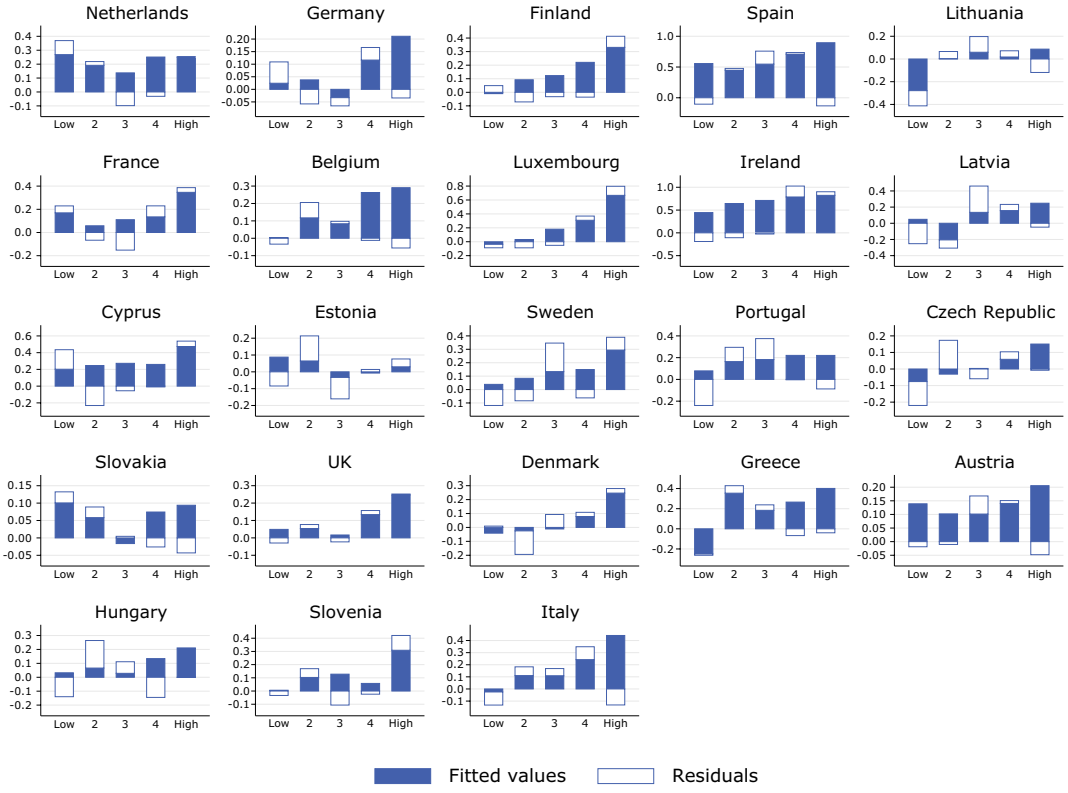


[21] It could be argued that the polarising effect of routine should have already appeared in the counterfactuals, with only the cognitive index in the model, because of the particular association between routine and cognitive task content. Jobs in the middle of the cognitive index would have a higher routine content, so the polarising effect should be there even before the routine index is introduced. But, as already noted, the cognitive index is more associated with upgrading than with polarisation, being associated to only a very mild polarisation in a very limited number of cases. If this argument is correct, the introduction of the routine index should make the polarisation pattern much clearer, even if it had already appeared in the model involving only the cognitive index. This is because the extent of routine should be linearly and negatively linked to relative change in employment.

Effect of social interaction index

The addition of the social interaction index to the model in Figure 31, without having a radical impact, seems to produce significantly more polarised results in some key countries – France, the Netherlands, Slovakia and the UK – by accounting for an additional expansion of the lower quintile. It also leads to some net job destruction in the middle quintile in Germany. While the inclusion of the social interaction index produces a significantly more moderate pattern of polarisation than that actually observed in the polarising countries, the broad picture produced is more similar to the observed variety of patterns across Europe. Most of the polarising countries show a polarising pattern now in the counterfactuals as well, although in many cases, the relative or absolute decrease in employment in the middle remains partly in the residuals.

Figure 31: *Counterfactual quintile figures for models with the cognitive, routine and social interaction indices, by country*



Effect of trade intensity and unionisation indices

The inclusion of the trade intensity variable (Figure 32) has a rather small impact, with no discernible effect in terms of polarisation. A similar point can be made about the unionisation index (Figure 33).

Figure 32: *Counterfactual quintile figures for models with the cognitive, routine, social interaction and trade intensity indices, by country*

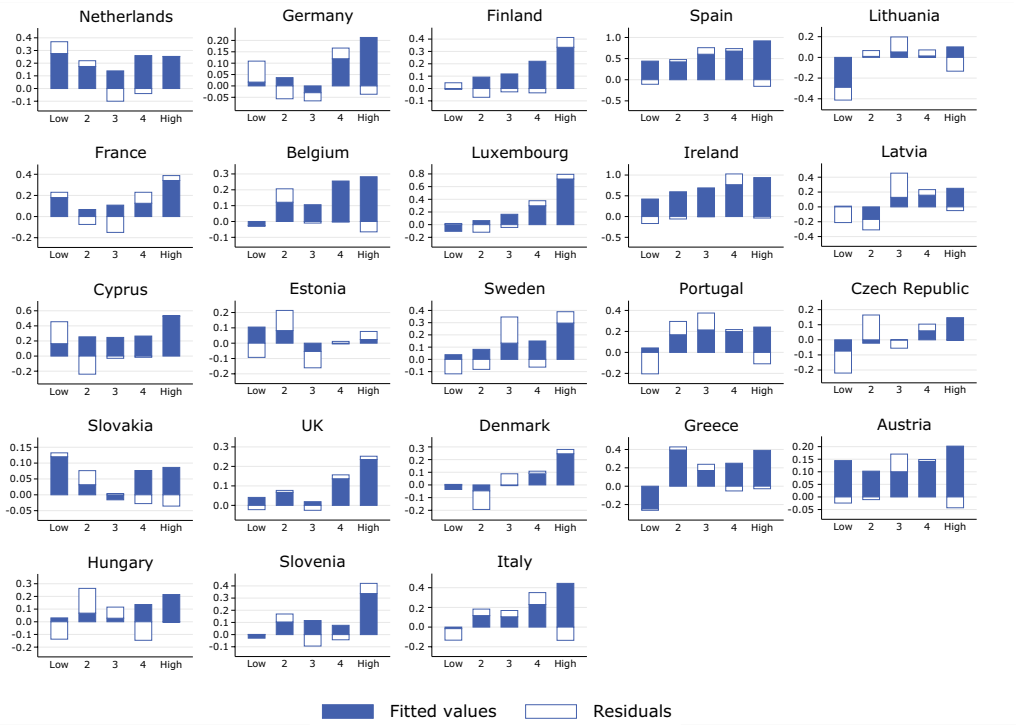
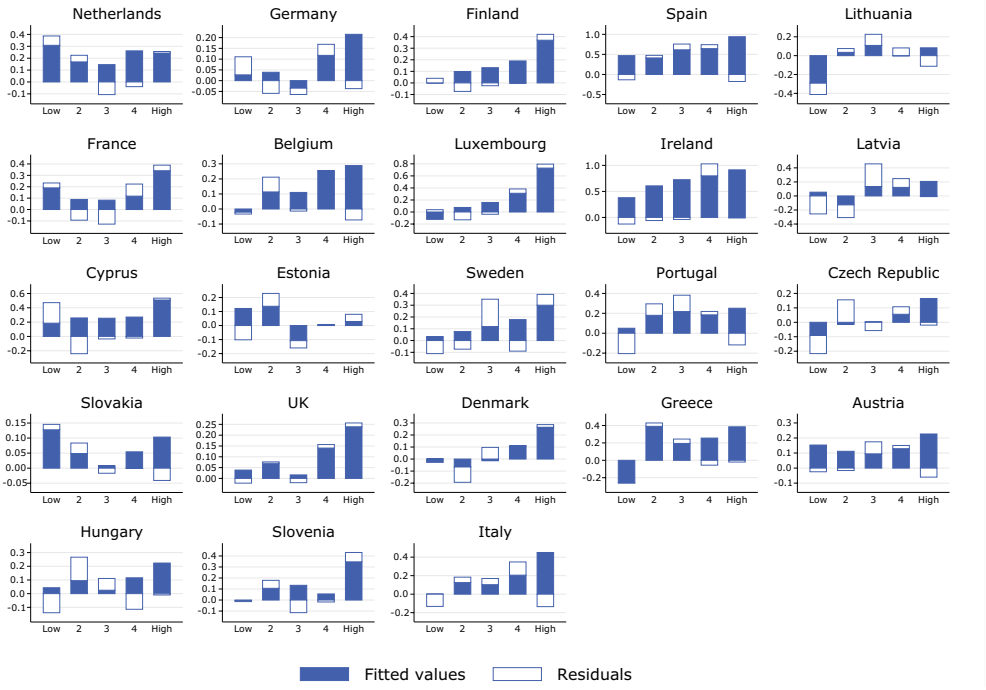


Figure 33: *Counterfactual quintile figures for models with the cognitive, routine, social interaction, trade and union density indices, by country*



Conclusions on the counterfactual analysis

This simple counterfactual analysis suggests that the RBTC model, in which the cognitive and routine aspects of jobs are supposed to explain a more or less pervasive polarisation, does not account very well for the observed patterns of structural change in employment in Europe between 1995 and 2007.[22] The cognitive and routine content of a job seem to be more associated with the generalised pattern of upwards wage-biased structural change, accounting for only a marginal amount of polarisation and only in very few cases. It is with the introduction of the social interaction index, which measures a job's degree of face-to-face interaction with customers, that the polarisation pattern seems to fit better, although only to a limited extent. Most of the models predict upgrading, even in the polarising countries. Importantly, however, none predicts polarisation in the upgrading countries, although this would have been theoretically possible. If this had been predicted, it would suggest a common underlying polarising pattern that was for some reason muted in some countries, due to unobserved factors, which would be reflected in de-polarising residuals.[23]

It seems that the traditional SBTC hypothesis is the best fit for Europe, predicting a more or less general upgrading, with polarisation being linked to the social interaction index; it therefore fits with Blinder's offshorability argument or Dwyer's hypothesis of the care economy.

Institutional factors

What about institutions? Can they explain some of the remaining residual? Can they explain the fact that the social interaction index, and to a lesser extent the cognitive index, seems to be associated with some degree of polarisation in some cases but not in others? As already discussed in the theoretical section, the methodology used in this report is not best suited to testing the institutional hypothesis. The relationship between institutions and the observed patterns of structural change is at a different level (often the country level). It should operate in the form of complex interactions with the other factors and is dominated by idiosyncrasies and specificities that are extremely difficult, if not impossible, to transform into parameters that can be introduced into an econometric model. In other words, testing the institutional explanations requires a qualitative rather than a quantitative approach, using a smaller selection of countries and with a historically framed analysis – close, for instance, to the approach typical of the literature on the varieties of capitalism.

For purely exploratory purposes, however, these last few pages will try to incorporate institutional factors into the analysis, linking some of the country-level results of the regression models discussed earlier with country-level institutional variables. In principle, there are two main ways in which institutions can be entered into the equation and which underlie our analytical model. On the one hand, institutional factors can interact with the other explanatory variables. This is often highlighted in the research literature. Examples of this effect include a high minimum wage or employment protection legislation (EPL) neutralising the polarising impact of technology by muting the expansion of low-paid employment, or a destandardisation of employment contracts facilitating or intensifying the same polarising trends. On the other hand, institutional factors can also have a direct effect on their own in terms of shifts in employment across jobs. This would take place, for instance, if a process of contract destandardisation had increased low-wage employment, independently of the task or social interaction content of the relevant jobs.

In the context of the current operationalisation, interaction effects can be tested by looking at the correlation between the coefficients in the models and the country-level institutional variables in question. To test the possible effect of institutional variables

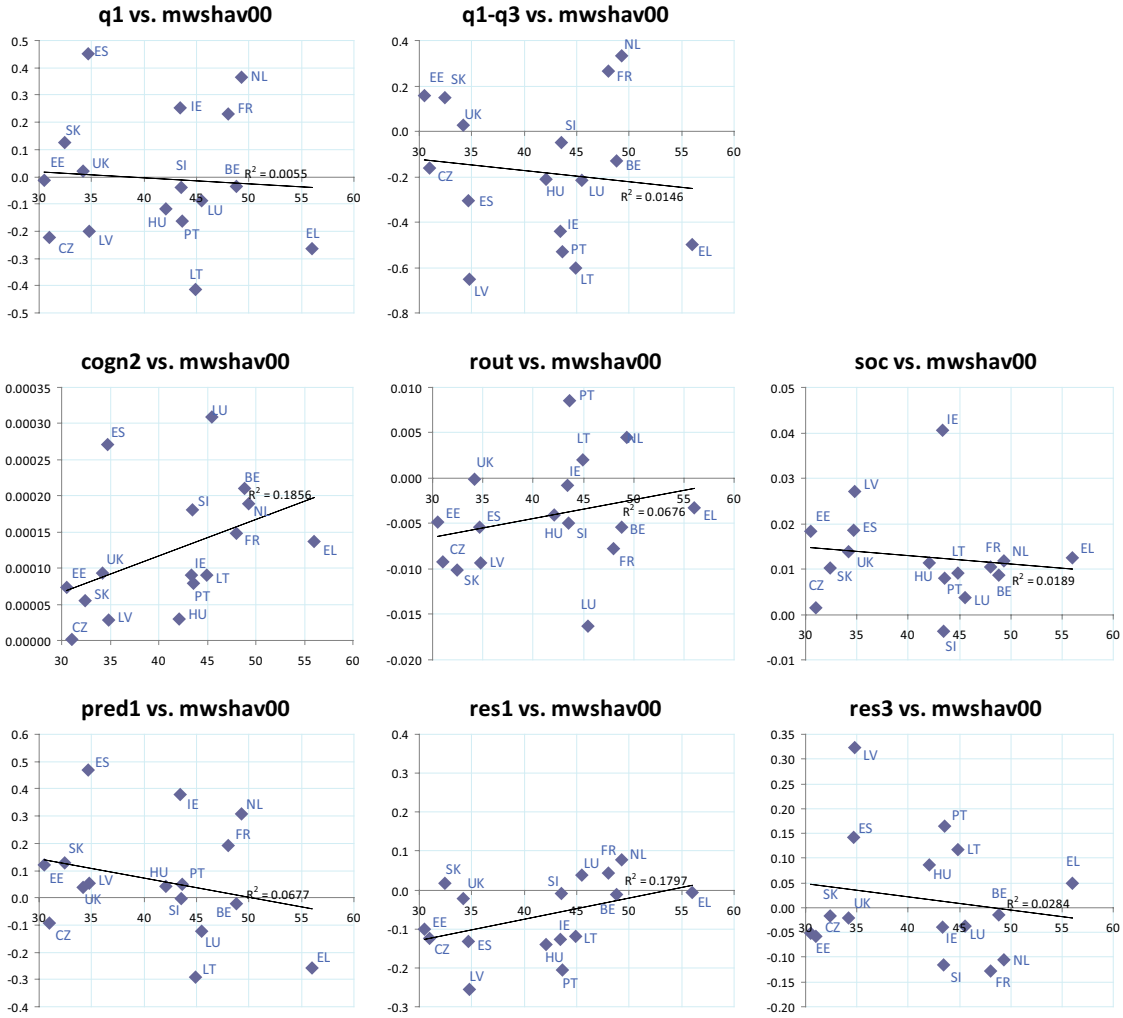
[22] Decomposition of the data involves a potential problem. Because some of the independent variables in the models are significantly correlated, particularly the cognitive and routine task indices, the effect of one variable could be wrongly attributed to another one. The order of the introduction of variables may affect the results. To evaluate this potential source of bias, the order in which variables were introduced was changed, and the results remained consistent. An entirely different approach would be to estimate the full model directly and then use the coefficients to generate partial predictions for each variable. But the collinearity problem would be even worse in this case, since it might be impossible to differentiate the effect of individual variables while controlling for others. Notwithstanding this limitation, this approach was also tried; again, the results remained consistent.

[23] As with most research on this area, wages were used to classify jobs into quintiles for this counterfactual exercise. Using skills or a multidimensional index of job quality produces similar results, although with a more consistent upgrading in nearly all countries, with the models fitting even better the observed outcomes.

on their own, the residuals of the models can be checked to see if they correlate with them. Since the residuals are uncorrelated with the variables included in the model, their correlation with institutional variables would suggest that they have an effect on their own. In both cases, this test must be taken with caution and only as an approximation: as mentioned earlier, the institutional explanation does not adapt very well to the kind of quantitative analysis that is employed in this report.

Figure 34 shows a set of scatterplots between different variables from our models and a country-level variable measuring minimum wage as a share of average wage in the year 2000, which can be taken as an approximation of minimum wage rates across EU countries.[24] The institutional argument is that a higher minimum wage can reduce the growth of low-paid employment. As previously mentioned, this can operate in interaction with the other variables in the model, muting the polarising effect of routinisation, for instance, or on its own, by reducing the expansion of low-paid employment irrespective of its task, social or trade content.

Figure 34: *Association between country-level results and minimum wage as a share of average wage in 2000*



Notes: q1 = relative growth of the lowest-paid quintile; mwshav00 = minimum wage as a share of average wage in the year 2000; q1–q3 = difference between the relative change of the lowest and middle wage quintiles; cogn2 = coefficient in the model for cognitive squared; rout = coefficient in the model for routine; soc = coefficient in the model for social; pred1 = relative change predicted by the model for the lowest wage quintile; res1 = difference between predicted and actual value of relative change of the lowest wage quintile; res3 = difference between predicted and actual value of relative change of the middle wage quintile.

[24] The source of the variable is Eurostat: minimum wage as a share of average monthly earnings. There are no data for Scandinavian countries, Austria, Germany or Italy; these countries do not have statutory minimum wages so it is impossible to calculate a comparable figure, although they do have collectively agreed minimum wages that vary across sectors; see Eurofound (2014).

The top, leftmost chart in Figure 34 shows the observed expansion of the first (or bottom) quintile versus the generosity of minimum wages. It does not suggest much of a relationship between the two variables at country level; the bottom quintile of employment expanded irrespective of the generosity of minimum wages. But the argument is more concerned with lower-end polarisation than the expansion of low pay. The second chart shows the differential in employment growth between the bottom and the middle quintile; the higher the value here, the higher lower-tail polarisation. Again, it does not suggest any significant association with minimum wage generosity. But could the generosity of minimum wages be somehow related to the impact of the different variables in these models? The second row of charts in Figure 34 display the association between the coefficient for the squared term of the cognitive variable, which captures the non-linear effect of cognitive task content and is therefore linked to polarisation, the coefficient for routine tasks, and the coefficient for social interaction. The results do not hint at any significant effect of the generosity of minimum wages on the effect of these variables, because the interactions are very low and do not even go in the expected direction. For instance, a higher minimum wage would be very slightly associated with a higher, non-linear effect of the cognitive index, but should reduce this effect if it makes the creation of low-paid employment more costly.

The final row, also comprising three charts, shows the correlation between the generosity of minimum wages, the predicted values for the bottom quintile, and the residuals for the bottom and middle quintiles. Again, the associations are extremely small and do not go in the expected direction. A more generous minimum wage is related to a larger residual for the bottom level and a smaller for the middle level; all else being equal, the minimum wage would expand the creation of low-paid employment compared to middle-paid employment. So in this very rough approximation, it does not seem that the level of minimum wages played a significant role in the polarisation story. This seems consistent with most recent literature on the employment effects of minimum wage, which finds a negligible effect even for the most generous levels (Schmitt, 2013; Eurofound, 2014). Even if overall employment effects were negligible, there could still be significant distributional effects in terms of the jobs structure; but again, this is not found.

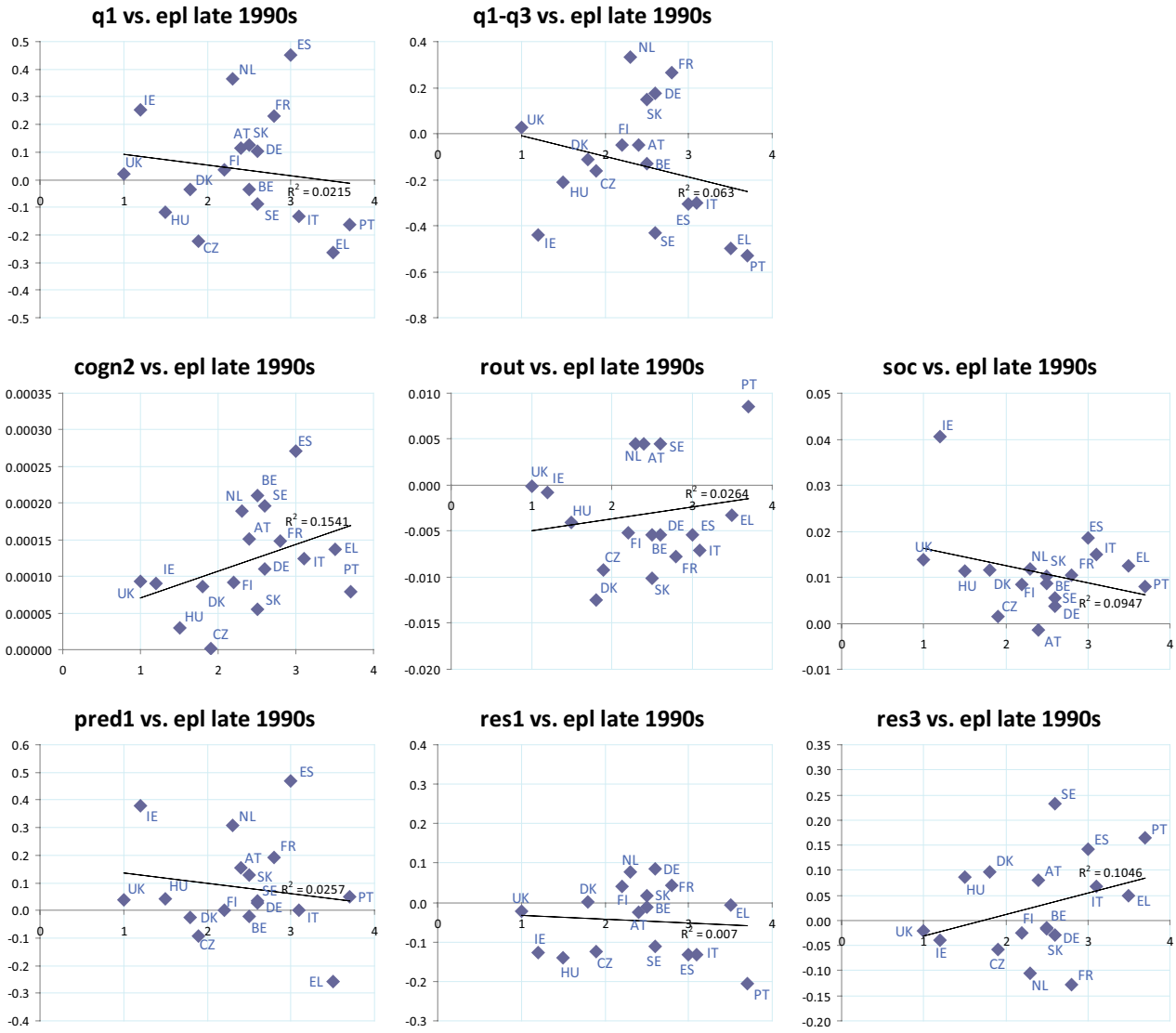
Something similar can be said about the index of employment protection legislation (EPL), which was developed by the OECD as a way of trying to summarise, in one number, the extent of protection of employment across countries.[25] EPL could be expected to affect the employment structure, although the way in which it might do so can depend considerably on the types of workers most affected, which is not measured by the overall EPL variable used here. A lower EPL could be expected to facilitate the expansion of low-paid employment if it is mostly targeted at that segment of workers (in a similar way as minimum wages). But it can also strongly affect workers in the middle quintiles, leading to different effects. In Figure 35, we can see that, during the 1990s, in countries with a stricter EPL, the bottom quintile grew slightly less than the other quintiles. It also shows that the differential growth of the bottom was slightly higher than that of the middle quintile, which could support the idea that a high EPL can inhibit an underlying polarisation trend, and vice versa. Still, the association is too low to interpret it as evidence of anything.

The scatterplots for the coefficients in these models suggest that a higher EPL intensifies the non-linear effect of cognitive task content and reduces the effect of social interaction. In both cases, this is perhaps contrary to what could be expected. But again, the associations are too small and too obviously plagued by exceptions to suggest anything meaningful. Neither are the residuals at the country level significantly associated with EPL. These results do not necessarily mean that EPL has nothing to do with the observed variation across countries in terms of patterns of structural employment change. It means that the existing indices cannot capture such an effect, and for this reason the effects should be approached in a different way.[26]

[25] The EPL index used here is the overall EPL (version 2) of the late 1990s, published by the OECD (2004).

[26] It could be argued that what matters is not the strictness of EPL itself at the beginning of the period being studied, which is the one used here, but its change over the period. Taking the change in EPL between 1998 and 2007, the associations are even less clear. According to OECD data, Italy, Greece and Portugal had the biggest reductions in EPL over the period. All of these countries are characterised by the opposite of polarisation. Yet some of the most clearly polarising countries, like France and the UK, actually increased their EPL during this period, according to the OECD figures. EPL in the Netherlands stayed the same over the same period, while Germany only reduced its EPL slightly, despite the controversy surrounding the Hartz and similar reforms in the early 2000s.

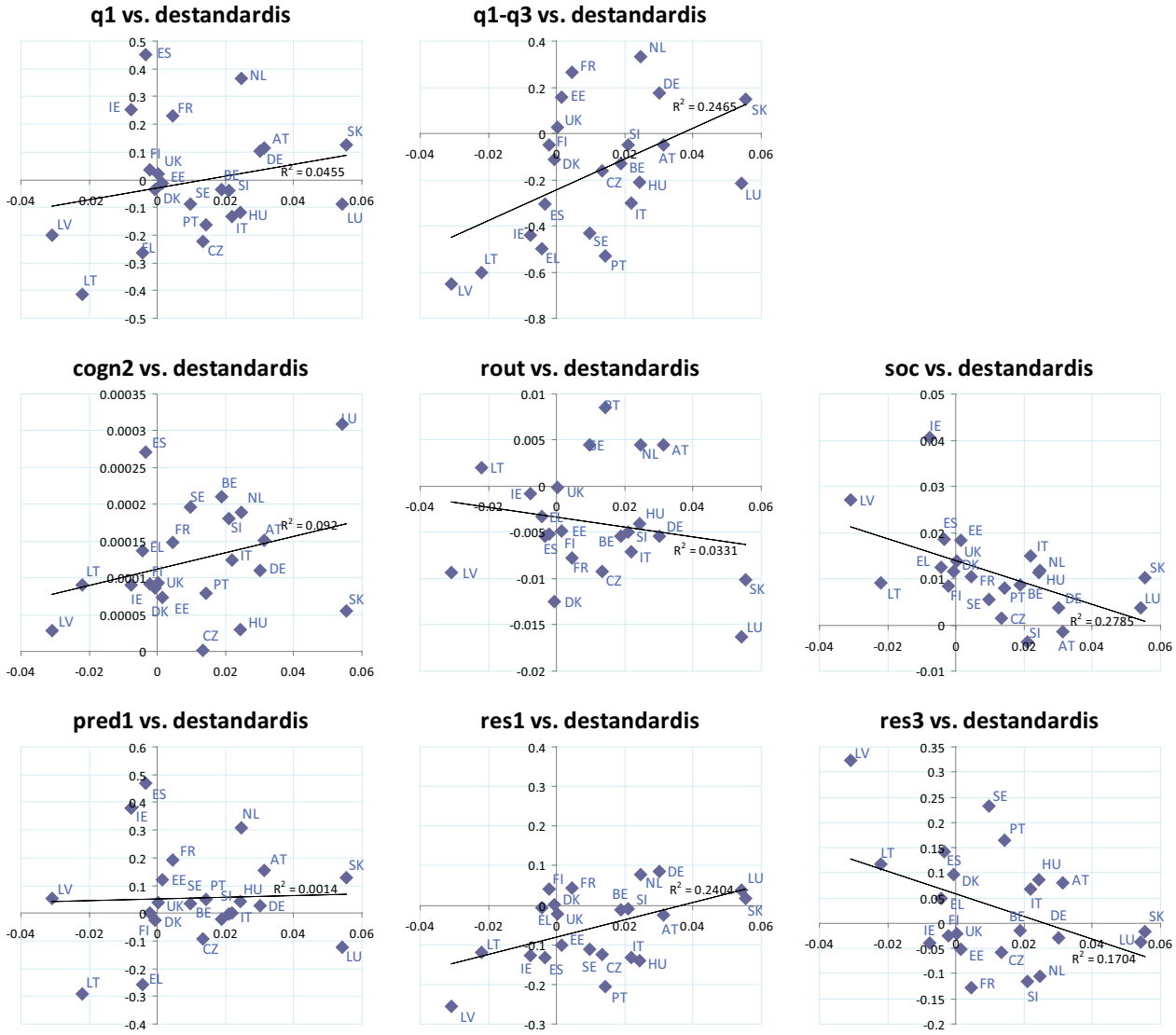
Figure 35: *Association between country-level results and the EPL index, late 1990s*



Notes: q1 = relative growth of the lowest-paid quintile; epl late 90s: OECD's Employment Protection Legislation Index for the late 1990s; q1–q3 = difference between the relative change of the lowest and middle wage quintiles; cogn2 = coefficient in the model for cognitive squared; rout = coefficient in the model for routine; soc = coefficient in the model for social; pred1 = relative change predicted by the model for the lowest wage quintile; res1 = difference between predicted and actual value of relative change of the lowest wage quintile; res3 = difference between predicted and actual value of relative change of the middle wage quintile.

Figure 36 presents the same type of charts for a final institutional variable: the degree of destandardisation of employment, measured as the overall increase in the share of non-standard employment (everything except full-time permanent employment) in each country between 1995 and 2007.[27] Although this variable should in some ways be similar to the EPL index (or rather, its change), it measures more directly the actual effects of changes in EPL in one particularly important respect.

Figure 36: *Association between country-level results and destandardisation of employment*



Notes: q1 = relative growth of the lowest-paid quintile; destandardis = overall increase in the share of non-standard employment between 1995 and 2007; q1–q3 = difference between the relative change of the lowest and middle wage quintiles; cogn2 = coefficient in the model for cognitive squared; rout = coefficient in the model for routine; soc = coefficient in the model for social; pred1 = relative change predicted by the model for the lowest wage quintile; res1 = difference between predicted and actual value of relative change of the lowest wage quintile; res3 = difference between predicted and actual value of relative change of the middle wage quintile.

27 This variable comes directly from the database for this report.

The first chart in Figure 36 shows that this measure of destandardisation is not associated with the increase in low-paid employment, but the second chart shows a promising association with the differential between the bottom and the middle quintiles – a measure of lower-tail polarisation. In general, the countries that destandardised their labour markets more are those that experienced more lower-tail polarisation. At the level of coefficients, the association is perhaps less clear: destandardisation is associated in the expected way with the squared term of cognitive tasks, although the association is too small. The same can be said for the effect of routine, which in fact goes in the opposite direction. The association between destandardisation and the coefficient for social interaction is a bit stronger and more interesting, although difficult to explain: as the degree of destandardisation increases, the correlation between social interaction and employment growth diminishes.

The most significant results are the residual plots in the third row of Figure 36. Whereas the prediction for lower-paid jobs is almost totally uncorrelated with the index of destandardisation at country level, the residuals for the lowest-paid quintile clearly increase with the degree of destandardisation: the r^2 is 11%, but the result is very strongly affected by a single outlier, Cyprus, which, if eliminated as in Figure 36, boosts the r^2 to 24%. At the same time, the residuals for the third quintile clearly decrease. In other words, the positive residual for the lowest quintile of the model, and the negative residual for the middle quintile, which are by construction uncorrelated with the variables in the model, suggest that a significant amount of the observed polarisation is associated with the actual increase in non-standard employment in some countries. Notwithstanding the necessary caution required in trying to study institutional effects with multinational quantitative data, this does suggest that destandardisation could have been a significant factor in the observed polarisation, independently of the other factors included in the models.

Conclusions

In the last few years, the social sciences have seen a growing debate about the patterns that characterise structural change in labour markets: polarisation (employment growth in high-paid and low-paid jobs, with decline in mid-paid jobs), upgrading (employment growth in higher-paying jobs) or a diversity including examples of both. The debate also embraces the identification of the key factors behind such changes. Previous studies have shown that over the last two decades there has been diversity in patterns of structural employment change in Europe, which can be classified as variations of the two dominant patterns of polarisation and upgrading identified in the literature (Eurofound 2008a, 2011, 2013; Fernández-Macías et al, 2012). This diversity of patterns makes Europe a useful testing field for theories that aim to identify the main drivers behind job polarisation and upgrading. This report has aimed to construct a relatively simple test of such arguments, following a detailed discussion of their assumptions and an alternative operationalisation.

This report has argued that there are problems in some of the theoretical hypotheses around job polarisation and upgrading, which can lead to inconsistencies in the analysis and misleading results. It is often assumed that wages are an adequate proxy for skills, but this can lead to an incorrect interpretation of polarisation. This is because, at least in the European case, the polarisation phenomenon is mostly found when labour market shifts are analysed from the perspective of wages, but not when they are looked at from the perspective of skills. This is problem is particularly salient in the context of comparative research, since there are systematic variations in wage structures across countries as a result of historical and institutional differences. This report also argued that the differentiation between the cognitive and the routine requirements of jobs, which is crucial for the argument of routine-biased technical change (RBTC), is problematic even at a conceptual level. This is because cognitive and routine tasks had been previously considered to overlap rather than be orthogonal; in other words, jobs that require higher cognitive effort are likely to involve fewer routine tasks, and vice versa.

This report's review of the operationalisation of these concepts into job-level indices and classifications found some inconsistencies with respect to theory and between the different applications of the same hypotheses, which can be at least partly attributed to the lack of adequate data sources. This problem is particularly present in the operationalisation of cognitive and routine task content, which often incorporates a wide range of indicators not clearly linked to the underlying theoretical arguments. For instance, cognitive task indices often include measures of managerial responsibilities, while routine task indices are often constructed from indicators of finger dexterity and quality control tasks, which may be correlated empirically but are conceptually unrelated to the theoretical concepts.

Following this report's operationalisation of concepts using European data sources, an inspection of simple correlations between the different theory-derived indices showed that some of the key underlying assumptions of the explanatory frameworks do not hold. As already argued at a theoretical level, there is a strong overlap between the indices of cognitive and routine task content, which is not very coherent with the arguments of RBTC. There are also significant differences in the wage structures in the different countries, so any comparative analysis of job polarisation from a wage perspective should use country-specific wage data, as done in this report.

A simple correlation-based, counterfactual analysis broke down the observed patterns, partly correlated and partly uncorrelated to the theoretical arguments, using the predictions from country-level ordinary least squares multivariate models. This enabled the following arguments to be made.

- The task content of jobs (measured bi-dimensionally with the indices of cognitive and routine task requirements) is more associated with upgrading than with polarisation.
- The routine task content, as measured by the index developed for this analysis, adds little explanatory value to the model that includes only skills or cognitive task content.
- The degree of direct social interaction required by a job correlates more with polarisation than the routine task content.

- Although the quantitative approach taken here does not lend itself to institutional analysis, the expansion of non-standard employment in some countries seems to be associated with the residual polarisation from the theoretical models, suggesting that it could have had an effect on its own.

As a theory for explaining job polarisation, the RBTC argument does not fit well with the observed patterns for Europe in the period studied here. Of the two key variables for the task model, the cognitive task content seems more closely associated with the observed patterns of structural change in European labour markets. However, this association goes generally in the direction of upgrading rather than polarisation, with only a small non-linear effect in a couple of cases. This fits the traditional argument of skills-biased technical change (SBTC) much better, which would have predicted a more or less linear association between skills and labour demand as a result of computerisation. The core of the RBTC argument rests on routine task requirements disrupting the linear association between skills and labour demand and generating polarisation, but we could not find much evidence of such an effect in Europe. Indeed, the routine task content tended to correlate negatively with the cognitive task content, and thus its association with the shifts in labour demand did not produce any significantly different results.

It is important to note that these results do not show that recent technological change has not caused technology to replace routine tasks, but that such an effect, if it exists, would strongly overlap with the already established fact that technological change increases the demand for skills. In other words, there may be RBTC, but rather than producing polarisation, this change would be confounded with SBTC, or at least a part of it.

The offshorability argument, proxied here through an index of direct social interaction at the job level (following the work of Blinder, 2009), seemed to be a more plausible explanation for the polarising trend observed in some countries. Adding this variable to the model tended to make the counterfactual picture more polarised, by expanding low-paid and reducing mid-paid employment, since the job expansion at the bottom level tended to be associated with higher rates of social interaction, while the jobs in the middle tended to be associated with lower levels of social interaction. But, arguably, such developments could also be linked to more institutional and cultural developments, such as the incorporation of women into the labour force and the formalisation of care activities previously performed within households, as argued by Dwyer (2013). This operationalisation does not allow the differentiation of such explanations, which should be explored further in future research.

The capacity of this report to test institutional explanations is considerably poorer than it is for the other arguments, because it requires a different approach involving more detailed analysis of a smaller group of countries. A union density variable was included in the models, but this did not add much to the models that already included the task content and trade indices. This may be because it was not country-specific or it may be that union density has no correlation with the shifts in labour demand once task content and trade levels across jobs are controlled for.

An exploratory analysis comparing some of the results presented here with country-level institutional variables produced little by way of substantial results. The generosity of the minimum wage and a unidimensional index of employment protection legislation could not be linked meaningfully to job polarisation. However, the overall increase in non-standard employment contracts seemed to be associated with the residual polarisation unexplained by the regression models, suggesting that it could have played a significant role in this respect.

What policy-relevant conclusions can be derived from this exercise? The most important outcome, perhaps, is that it allows a better understanding of what is specific and what is universal about the patterns of structural change in European employment in recent years. As already argued in previous research, structural upgrading was a more or less universal feature of European labour markets in the period 1995–2008, whereas polarisation was specific to a few countries. This finding can be further refined by noting that such upgrading was strongly associated with the extent of the cognitive demands of jobs (and secondarily, of routine demands), which fits reasonably well with the argument that recent technological

change is, on the whole, linearly biased in terms of skills. It can also be added that the few European cases of job polarisation were not driven by RBTC, as has been claimed. To some extent, polarisation was linked to the degree of direct social interaction that a job involves and thus plausibly to international trade, since jobs that require no direct social interaction are more easily traded. However, polarisation remained largely unexplained by the theoretical hypotheses tested here. A plausible explanation for residual country-specific polarisation may be the still-important institutional variance across European countries, but with the methodology used here, it was possible only to provide a hint of such a relationship by noting a correlation between residual polarisation and destandardisation of employment contracts. To make any further progress in understanding cases of polarisation, a different and qualitative approach is most likely needed.

Overall, these findings reinforce the consistent policy conclusion of the European Jobs Monitor since its first publication in 2008: there certainly are some important commonalities in recent European occupational change, but there is also a significant degree of variation which cannot (at present) be explained by pervasive inescapable forces such as technology or international trade, as often argued. These inescapable forces are linked to a more or less universal process of structural upgrading that is probably the occupational correlate of economic growth – but polarisation, where observed, is not the result of the same factors. In other words, these findings support a healthy scepticism with respect to any deterministic or fatalistic understanding of the implications of technology and globalisation on European employment structures, and reinforces the idea that policy can lead to significantly different results even with respect to structural change in employment, for better or worse.

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Annex 1: Construction of the job rankings

This annex provides details about the process of constructing the job wage, job education and job quality rankings used in this report.

Problem of the change in classifications

The jobs-based approach that underlies the European Jobs Monitor (EJM) is based on studying change in employment across occupations and sectors from the perspective of some specific job quality ordinal index. The process is as follows:

1. overall employment is split into jobs (occupations within sectors at the two-digit level of ISCO and NACE);
2. those jobs are ranked and grouped according to some job quality indicator;
3. the change in employment numbers across jobs is plotted against their quality.

Eurofound's original Jobs project (Eurofound, 2008a; Fernández-Macías et al, 2012) used two fixed rankings to analyse structural change in employment in 23 EU countries between 1995 and 2007. One of those rankings was based on the average level of educational attainment of workers within each job, drawing from EU Labour Force Survey (EU-LFS) data. The other ranking was based on the average hourly pay of workers within each job, and was constructed from different statistical sources combined at the job level.[28] These two rankings provided a sound basis for analysing structural change in employment across the EU between 1995 and 2007.

From 2008 onwards, the classification of sectors in the EU-LFS moved to using Revision 2 of the NACE international standard and, from 2011 onwards, the classification of occupations in the EU-LFS moved to the 08 version of the ISCO international standard. In both cases, the revisions were so substantial that there is no compatibility between the old and the new classification systems at any level of disaggregation. Hence there is no way to avoid the discontinuity.

Construction of the educational ranking

This ranking is the simplest to construct, because the EU-LFS includes all the necessary information. The basis of this ranking is the variable International Standard Classification of Education (ISCED) included in the EU-LFS datasets. ISCED is an internationally comparable codification of national educational systems. It was originally designed by the United Nations Educational, Scientific and Cultural Organisation (UNESCO) in the 1970s and has been updated several times (UNESCO, 2006).

A highly aggregated version of ISCED is used, which distinguishes just three broad levels of education:

- low (basic schooling or less, below ISCED 2);
- medium (upper secondary and post-secondary pre-tertiary, ISCED 3–4);
- high (tertiary, ISCED 5 and above).

For each country, the average educational level of all workers within each job was calculated, assigning an arbitrary value of 0 to low, 0.5 to medium and 1 to high educational level. These values were used to generate the educational ranking.

Because the basis for the ranking is the average of just three values (0, 0.5 and 1), there are some jobs that have exactly the same value (for instance, professional jobs that only have workers with third-level education) and which cannot therefore be ordered unambiguously. To get round this problem, an EU-level average of the national averages was constructed,

[28] The underlying structure of this ranking was provided by the 2002 European Structure of Earnings Survey (ESES). To cover for jobs not included in the ESES sample, it was necessary to complement it with data from the European Household Panel Survey and the European Survey on Income and Living Conditions, as well as with data from national accounts to provide more detailed data on wages in the manufacturing sector (see Eurofound, 2008b for more details).

which was used as a secondary ranking variable. So if two jobs have the same value at the national level, they will be sorted according to their EU-level average, which is much less likely to be identical because it is based on a much larger sample.

For the period of 2011 Q2 to 2013 Q2, the average educational values are based on the 2011 EU-LFS dataset.

Construction of the wage ranking

As in previous analyses of EJM data, the construction of the wage ranking is more complicated (Eurofound, 2008b, 2011). The main reason is that the EU-LFS does not include a variable that measures wages as a continuous quantity, which can be then divided by the number of hours worked to obtain an indicator of hourly labour compensation.

Up to 2009, there was no mandatory collection of wage data at all, which forced previous EJM analyses to use external data for this purpose (Eurofound, 2008b) or to rely on voluntarily submitted wage data, which covered less than half of the Member States and was of variable quality. From 2009, the EU-LFS has included a variable that positions each worker on the distribution of wages of their country within a decile scale. This variable has two problems for the purposes of this analysis.

- It provides a very crude approximation to the actual distribution of wages in each country, with just 10 possible values instead of the full complexity of a continuous variable.
- It allows only the identification of the relative position of each worker within a 10-point scale, as it is impossible to know the monetary values corresponding to each position in such a scale. Due to the latter problem, it is impossible to calculate even an approximate value for hourly wage, which is necessary to avoid getting a biased average at the job level according to the share of part-timers in the job.

Unfortunately, there is no EU-wide data source that allows the calculation of a reliable estimate of average hourly wages at the job level (two-digit occupation by two-digit sector). The closest match is the European Structure of Earnings Survey (ESES), which was last carried out in 2010. This includes a continuous variable of wages and another on working hours, and allows the classification of workers by sector (NACE Rev. 2.0) and occupation (ISCO-08). However, this source does not cover the full economy, omitting the public sector and agriculture, as well as all companies with fewer than 10 employees.

A job-wage ranking was used in this analysis, based on a combination of the ESES data (2010) and the income decile data from the 2011 EU-LFS survey. With the ESES data, average hourly wages per job were calculated within each country. Through this, a nation-specific ranking was generated, with interpolation of a weighted EU average ranking in order to fill the gaps in national rankings. With the EU-LFS data, the average income decile position was calculated for full-time workers in jobs involving at least 50% of full-time workers, applying the same EU average interpolation.

The values of the two normalised rankings were averaged and the result was normalised again.

Two different sources are used because no single source is adequate for this purpose. A simple average at the job level of two different normalised job quality rankings (each of them incomplete on its own) should provide a more reliable indicator, which can be used to rank the jobs and study their evolution over time.

Construction of the non-pecuniary job quality ranking

The third job-ranking criterion is a multidimensional indicator covering four major dimensions of job quality identified in the job quality literature: intrinsic job quality; employment quality; workplace risks; and working time and work–life

balance. This indicator is non-pecuniary in that it does not include any component based on wage or work income. This omission is deliberate to avoid any overlap with the primary job-wage ranking. The indicator is based on combining data from over 40 questions from the 2010 European Working Conditions Survey (EWCS). Individual jobs are then ranked based on their average score across the included variables. For a full account of the construction of the job quality ranking, see Chapter 3, Eurofound (2013).

Annex 2: Number of jobs by employment shares

Table A1 shows how many jobs – a job defined as a given occupation (two-digit ISCO classification) in a given sector (two-digit NACE classification) – account for increasing shares of total employment at country level. For example, between one and three of the biggest-employing jobs account for 10% of employment in all countries. Between 3 and 13 jobs account for 25% of employment in all countries.

Table A1: *Number of jobs accounting for different shares of employment, EU28 Member States, 2011 Q2*

Country	10%	25%	50%	75%	90%	100%
EU28	2	10	65	275	721	3,123
AT	2	9	55	224	551	1,606
BE	2	10	64	246	581	1,345
BG	2	7	39	192	505	1,292
CY	2	7	30	112	306	735
CZ	3	10	62	226	538	1,596
DE	3	13	70	253	614	2,171
DK	2	7	38	186	462	1,272
EE	2	10	51	155	310	588
ES	2	7	36	170	476	1,888
FI	3	9	45	186	473	1,365
FR	3	12	51	202	538	1,919
GR	1	3	16	82	291	1,303
HU	2	10	53	217	538	1,571
IE	2	8	44	206	551	1,642
IT	2	9	43	186	508	1,940
LT	2	7	43	186	433	981
LU	2	10	39	128	260	481
LV	2	10	51	178	371	739
MT	2	12	50	176	359	624
NL	2	9	44	191	519	1,848
PL	2	5	34	176	495	1,729
PT	2	7	36	146	388	1,231
RO	1	2	15	103	337	1,320
SE	2	8	47	210	551	1,890
SI	2	8	55	207	456	1,060
SK	2	8	43	162	401	1,091
UK	3	11	65	262	650	2,067

Annex 3: Employment shares by education quintile

Table A2: *Distribution of employment (%) 2011 Q2 by job-education quintile, EU28*

		Job-education quintile					
		1	**2**	**3**	**4**	**5**	**Total**
Gender	Female	15	14	27	22	22	100
	Young (15–29 years)	20	20	27	18	15	100
	Core age (30–49 years)	19	17	21	21	22	100
Age	Older (50–64 years)	21	18	19	20	21	100
	Old (65+ years)	35	13	16	15	21	100
Employment status	Part-time	23	18	27	17	16	100
	Temporary	26	22	22	15	16	100
Nationality	EU	27	23	18	14	19	100
	Non-EU	27	26	19	11	17	100
Self-employed	With employees	15	11	30	22	22	100
	Without employees	36	12	18	14	20	100
Broad sector	Manufacturing	24	33	15	16	11	100
	Construction	59	6	15	16	4	100
	Private knowledge-intensive services	3	6	12	35	45	100
	Public knowledge-intensive services	7	12	16	25	41	100
	Less knowledge-intensive services	15	26	39	14	4	100

Annex 4: ISCO-88 codes

Below are the ISCO-88 codes at two-digit level.

11	Legislators and senior officials
12	Corporate managers
13	General managers
21	Physical, mathematical and engineering science professionals
22	Life science and health professionals
23	Teaching professionals
24	Other professionals
31	Physical and engineering science associate professionals
32	Life science and health associate professionals
33	Teaching associate professionals
34	Other associate professionals
41	Office clerks
42	Customer services clerks
51	Personal and protective services workers
52	Models, salespersons and demonstrators
61	Market-oriented skilled agricultural and fishery workers
62	Subsistence agricultural and fishery workers
71	Extraction and building trades workers
72	Metal, machinery and related trades workers
73	Precision, handicraft, printing and related trades workers
74	Other craft and related trades workers
81	Stationary-plant and related operators
82	Machine operators and assemblers
83	Drivers and mobile-plant operators
91	Sales and services elementary occupations
92	Agricultural, fishery and related labourers
93	Labourers in mining, construction, manufacturing and transport

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This report looks in detail at recent shifts in the employment structure at Member State and EU level, examining the main sectors and occupations that have contributed to job loss and job growth. It finds, for example, that in 2011–2013, the majority of net employment losses continued to occur in middle-paid and low-to-middle-paid jobs in construction and manufacturing. Employment growth remained resilient in high-paid, high-skilled jobs, and knowledge-intensive services have been the main source of this growth. The report also examines some of the likely drivers behind the changing employment structure: technological change, globalisation and labour market institutions.

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