I Z A Institute
of Labor Economics
Initiated by Deutsche Post Foundation

POLICY PAPER SERIES

IZA Policy Paper No. 144

Short-Term and Long-Term Determinants of Moderate Wage Growth in the EU

Áron Kiss
Kristine Van Herck

FEBRUARY 2019

I Z A Institute
of Labor Economics

Initiated by Deutsche Post Foundation

POLICY PAPER SERIES

IZA Policy Paper No. 144

Short-Term and Long-Term Determinants of Moderate Wage Growth in the EU

Áron Kiss
European Commission, DG EMPL

Kristine Van Herck
European Commission, DG EMPL

FEBRUARY 2019

IZA – Institute of Labor Economics

Schaumburg-Lippe-Straße 5–9
53113 Bonn, Germany

Phone: +49-228-3894-0
Email: publications@iza.org

www.iza.org

ABSTRACT

Short-Term and Long-Term Determinants of Moderate Wage Growth in the EU*

This paper analyses the factors explaining moderate wage growth in the EU in the post-crisis period. It investigates whether the historical relationship between wages and unemployment has weakened and whether composition effects moderated wage growth. The results suggest a negative answer to both questions. Wages in the EU have not stopped reacting to unemployment developments after the 2008 crisis. Wage growth was moderate because of low inflation, low trend productivity growth, and high unemployment. There are only a few Member States with a significant 'shortfall' in wage growth, including both low and high-unemployment countries. Migration, ageing and collective bargaining institutions appear to have mostly transitory effects on wage growth. During the last decade, changes in the composition of the workforce had a small but positive impact on wage growth in most of the EU, especially due to increasing average age and education level. In some Member States such as Germany, Italy, Luxembourg and Portugal, composition effects were a main driver of wage growth.

JEL Classification: E24
Keywords: wage growth, Wage Phillips curve, European Union

Corresponding author:
Áron Kiss
European Commission
Directorate-General for Employment, Social Affairs and Inclusion
B-1049 Brussels
Belgium
E-mail: Aron.KISS@ec.europa.eu

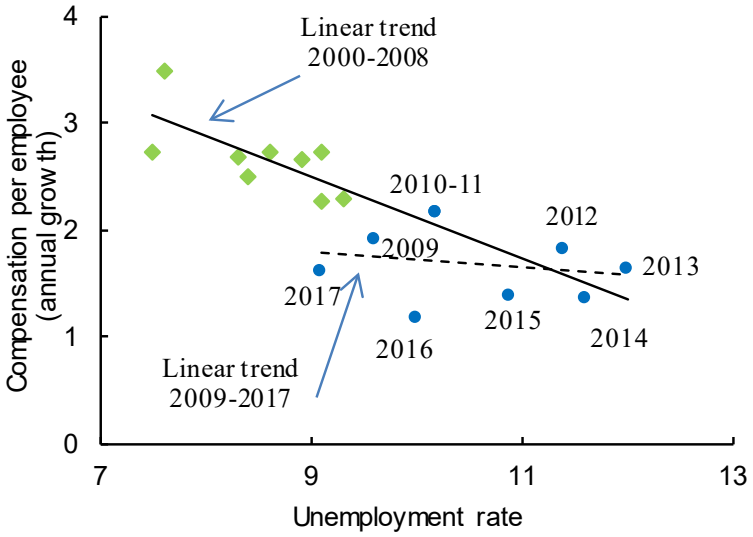
* The paper reflects the opinions of its authors and may not express the views of the European Commission. The authors would like to thank Alfonso Arpaia, Nathalie Darnaut, Barbara Kauffmann and other colleagues from DG Employment for useful comments and suggestions and Adam Kowalski for statistical assistance. Any remaining errors are ours. A previous version of this paper was published as Chapter II.1 of the Report "Labour market and wage developments in Europe, Annual Review 2018", published by the European Commission (2018a), Directorate-General for Employment, Social Affairs and Inclusion. URL: https://ec.europa.eu/social/main.jsp?catId=738&langId=en&pubId=8139&furtherPubs=yes.

1. Introduction

This paper analyses the determinants of moderate wage growth in the EU in the period 1995-2017. There is a growing consensus that low inflation, low trend productivity growth, as well as remaining reserves in the labour market explain much of the recent wage moderation in industrialised countries. At the same time, many questions remain. Has wage growth stopped responding to unemployment? What is the magnitude of the 'shortfall' in wage growth in the post-crisis period? What is the relative importance of the headline unemployment rate and versus additional, latent, labour market reserves? Is the composition of the workforce, or the jobs available in the economy, affecting aggregate wage growth? Finally, are the causes of low wage growth temporary or at least partly durable?

Wage growth remains moderate in the EU, especially in light of the steady decline of unemployment over recent years. In particular, it has been observed wage growth remains below what could be expected based on the pre-crisis relationship between nominal wage growth and the unemployment rate (Graph 1). It also appears that the wage Phillips curve, reflecting the relationship between unemployment and wage growth,[1] may have 'flattened': wages appear to react less to unemployment than before the crisis. But a visual inspection of such bi-variate 'Phillips curves' only provides partial insights. Unemployment is just one among the determinants of wage growth.

Graph 1: Wage Phillips curve for the euro area: The bivariate relationship between the unemployment rate and the annual growth rate of compensation per employee, 2000-2017



Source: European Commission (2018a, Graph I.1.11).

Many explanations have been put forward to explain moderate wage developments in advanced economies during the recovery. Moderate inflation and productivity growth have

[1] In this paper, the (wage) Phillips curve refers to the relationship between unemployment and nominal wage growth. Note that the term 'Phillips curve' is also used in the literature to refer a similar relationship between unemployment and price inflation.

been noted as important contributors. Many observers have also pointed out that apparent low unemployment rates may mask significant labour market reserves (or 'slack'), including discouraged job-seekers and underemployed part-time workers (see e.g. Bell and Blanchflower, 2018, for a discussion on the UK). Finally, long-term structural factors, including ageing, sectoral shifts, globalisation and changing industrial relations have also been suggested as contributors to wage moderation (see a more detailed discussion in Section 2).

This paper deepens the analysis of wage developments in the EU focusing first on the relationship between wage growth and relevant economic variables. To this end, the paper estimates variants of the 'wage Phillips curve': the statistical relationship linking wage growth to fundamentals including inflation, productivity growth and the unemployment rate. Based on these estimations, it calculates a benchmark for wage growth in all EU Member States for the period of 1995-2017. The estimations allow for an investigation of the short- and long-term determinants of wage growth and whether these have changed in the post-crisis period. The benchmarks, in turn, allow for an assessment of possible 'shortfalls' in wage growth in the EU both before and after the crisis.

Subsequently, the paper estimates the extent to which composition effects played a role in EU wage growth in the post-crisis period. How the composition of the workforce affects aggregate wage growth is especially relevant in an environment of low nominal wage growth. In such cases, small composition effects may significantly affect aggregate wage dynamics. A clear understanding of underlying wage developments is especially relevant in countries in which downward wage adjustment was necessary for the external adjustment in the aftermath of the euro-area crises.

The rest of the paper is organised as follows. Section 2 presents an estimation of determinants of EU nominal wage dynamics since the mid-1990s and wage benchmarks based on these. Section 3 focuses on the composition effects. Section 4 offers some conclusions.

2. Determinants of moderate wage growth in the EU: A quantitative assessment

2.1. Introduction

This section first estimates the statistical relationship between wage growth and the most relevant economic fundamentals. These fundamentals include inflation and productivity growth, besides unemployment. Only when controlling for all relevant factors is it possible to assess whether the effect of unemployment on wage growth has weakened or even disappeared since 2008.

In a second step, the estimated relationships are used to assess the extent of the possible 'shortfall' in wage growth in the EU. This is done by calculating rates of wage growth that could be expected (or predicted) given developments in fundamentals. The gap between actual and predicted wage growth is then interpreted as the 'surprise' component in wage growth, the part not explained by economic fundamentals. This can be interpreted as a

'shortfall' (or 'missing' wage growth) if this gap (surprise component) is negative. The extent of the shortfall is assessed both for the post-crisis period (2010-2017) and, as a comparison, for the pre-crisis period (2000-2007).

In a third step it is assessed how latent labour market developments, both short- and long-term, affect wage growth. Some of these issues have been in the focus of recent analyses, most notably the effects of alternative measures of labour market reserves (or 'slack') on wage developments. Other factors, including ageing, migration, job quality, and institutions of collective bargaining, have been less studied.

The approach used follows the existing literature on estimating 'wage Phillips curves'. It builds on methodologies that have been developed at the European Commission to benchmark wage developments in Member States (see, e.g., European Commission, 2011 and 2013; Arpaia and Kiss, 2015), and on recent analyses focusing on the determinants of wage growth in advanced economies (e.g. IMF, 2017; Hong et al., 2018; Bell and Blanchflower, 2018; European Commission, 2017a,b). All these studies build on Blanchard and Katz (1999) who argued for the inclusion of labour productivity (besides inflation and unemployment) in empirical models explaining wage growth. Models of this kind have also been justified by a link to the New-Keynesian model of the macro-economy, a model widely used in monetary policy analysis (Gali, 2011).

The present analysis contributes to the recent literature on estimating 'wage Phillips curves' in two ways. First, unlike other recent contributions, it extends the analysis to all EU Member States. Second, it presents some results for each Member State separately, in particular a comparison of actual and predicted wage growth. The focus on the EU, and each Member State separately, allows for a more nuanced understanding of issues specific to this group of countries, as differentiated from issues facing other advanced economies.

2.2. Data and methodology

Determinants of wage growth in 28 EU Member States are estimated for the period 1995-2017. The analysis is conducted on data taken from the AMECO Annual Macro-Economic Database of the European Commission.

In the baseline model, nominal wage growth is explained by inflation, trend labour productivity growth, as well as the level and change of the unemployment rate. Along a 'balanced growth path' (i.e. when all variables growth at a constant rate) as described by the theory of economic growth, nominal wage growth fully reflects inflation and real productivity growth. If real wage growth fully reflects productivity growth, the wage share (the share of national income that is paid in wages, also known as the labour income share) remains constant.[2]

[2] Long-term developments in the wage share, and the recent literature on factors explaining these developments are surveyed by OECD (2018, Chapter 2) and European Commission (2018a, Box II.1.3).

The unemployment rate is included to explain the effect of economic fluctuations on wage growth in the short run. Wage growth is expected to be slower when unemployment is high, and *vice versa*, as is suggested by the Phillips curves. This also means that the wage share may not be constant over the business cycle. The inclusion of both the level and the change of the unemployment rate is justified by recent analyses as a way to control for expected future developments in unemployment (IMF, 2017). Further variables are included in later subsections to check whether demographic or institutional developments affect wage growth in a systematic way in the EU. In some specifications, country and year effects are included to control for country specificities and unexplained common trends across countries.

In particular, determinants of nominal wage growth are estimated by versions (and extensions) of the following baseline specification:

$$WAGEGR_{i,t} = \alpha_i + \beta_1 U_{i,t} + \beta_2 \Delta U_{i,t} + \theta INFL_{i,t} + \gamma PRODTR_{i,t} + \mu_t + \varepsilon_{i,t}.$$

Here, $WAGEGR_{i,t}$ denotes the growth rate of gross wages and salaries in country i and year t; $U_{i,t}$ denotes the unemployment rate and $\Delta U_{i,t}$ its change; $INFL_{i,t}$ denotes inflation; $PRODTR$ denotes trend productivity growth, calculated as the five year trailing average of the growth rate of real GDP per person employed; α_i are country fixed effects and μ_t are year fixed effects; while $\varepsilon_{i,t}$ is the error term.

The specification follows the one chosen by the IMF (2017) in including both the level and change of the unemployment rate and trend (instead of simple) productivity growth. In contrast, it follows past work by the European Commission (2011, 2013) by including contemporaneous inflation as opposed to lagged inflation as is done by IMF (2017). While this raises simultaneity concerns, it is done for two main reasons. First, simultaneity issues are not solved by lagging the inflation term (see, e.g., Reed 2015). Second, contemporaneous inflation is better suited to construct a 'benchmark' (or conditional prediction) for wage developments as it is more closely correlated with it. Even if the estimated relationship cannot be interpreted as causal because of simultaneity, the estimated OLS regression remains the 'best linear predictor' of wage growth, conditional on the covariates.

The inclusion of country or year effects comes with advantages and disadvantages, therefore results are shown both with and without them. Estimations without country or year effects answer the question how various determinants affect wage growth in an average EU Member State in an average year. Therefore, predictions based on them provide a simple and transparent benchmark for wage growth.

Country effects take account of the fact that wage growth can be faster in some countries than in others, even with the same fundamentals. The advantage of including country effects is that it accommodates the possibility that the 'equilibrium' unemployment rate may be different across countries. In such a case, a certain level of unemployment may call for wage restraint in one country but not the other. The disadvantage is that, specifications with country effects erroneously register periods of surprisingly fast (or slow) wage growth as reflections of country specificity, even if those surprising wage developments involved accumulating imbalances and were unsustainable. Thus in some cases, wage benchmarks

based on specifications with country effects may lend false justification to the continuation of unsustainable wage developments. For this reason, specifications without country effects are preferred for the purpose of 'benchmarking' wage developments, while all specifications are analysed to assess the relationship between wage growth and its determinants.

Finally, year effects allow for the possibility that, in some years, wage growth is faster (or slower) than expected in all countries than it would be in an average year. While including year effects improves the fit of a statistical model, it comes with significant disadvantages. Most importantly, it is not clear why wage growth should be different, with the same fundamentals, in some years than others. Indeed, one of the aims of the present analysis is to find out whether there is 'missing wage growth' in the post-crisis years. Year effects would pick up any missing wage growth without providing a substantive explanation. In any case, results are also shown with year effects, as they have been included by some past studies.

The resulting regressions appear to be well-specified and robust. In particular, lagged wage growth is not statistically significant when included in regressions. Results are also robust to the inclusion of the estimated gap between labour productivity and wages (in levels), as done by European Commission (2011, 2013) and Arpaia and Kiss (2015).

2.3. Main determinants of EU wage dynamics since the mid-1990s

Table 1 presents estimations of the relationship between wage growth and economic fundamentals for the 28 Member States over the period 1995-2017. Columns (1) to (3) show results for the whole sample period, columns (4) to (6) for the pre-crisis period 1995-2007, and columns (7) to (9) for the post-crisis period 2010-2017. Results from three specifications are shown: without country or year effects, with country effects, and with both. The specifications without country effects are based on a pooling of country-year observations. These identify relationship on the basis of cross-country comparisons. For instance: was wage growth faster in countries and years in which inflation was faster (other factors being equal)? When country effects are included, results are based on a comparison of various years within the same country: was wage growth faster in years in which inflation was faster in the same country (other factors being equal)? Finally, year effects pick up common movements across countries over time, e.g., if wage growth was surprisingly low in a given year in all countries.

Over the whole period, wage growth closely reflects inflation and trend productivity growth. The point estimates suggest that about 93% of price changes and about 104% of trend productivity growth was translated into wage growth between 1995 and 2017 (column 1 in Table 1). When country and year effects are included, these relationships become somewhat looser (between 80% and 90%), but the hypothesis that the relationship is one-to-one cannot be rejected at conventional levels of statistical significance (columns 2 and 3).

Table 1: Determinants of wage growth in the EU28, various time periods

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Sample period:	1995-2017	1995-2017	1995-2017	1995-2007	1995-2007	1995-2007	2010-2017	2010-2017	2010-2017
Dependent variable: Growth rate of gross wages and salaries per employee									
Unemployment rate	-0.169***	-0.350***	-0.371***	-0.182***	-0.475***	-0.563***	-0.224***	-0.376***	-0.391**
	(0.04)	(0.06)	(0.08)	(0.07)	(0.17)	(0.14)	(0.04)	(0.13)	(0.16)
Change in the unemployment rate	-0.557**	-0.468**	-0.424**	-0.434***	-0.189	-0.163	-0.305*	-0.181	-0.305*
	(0.20)	(0.21)	(0.20)	(0.15)	(0.18)	(0.20)	(0.16)	(0.19)	(0.17)
Inflation rate	0.933***	0.826***	0.906***	1.137***	0.961***	0.949***	0.383***	0.223	0.278
	(0.15)	(0.14)	(0.14)	(0.18)	(0.15)	(0.18)	(0.13)	(0.14)	(0.32)
Trend productivity growth	1.036***	0.841***	0.836**	1.061***	0	1	1.151***	0.696**	0.960**
	(0.16)	(0.25)	(0.35)	(0.18)	(0.37)	(0.42)	(0.25)	(0.32)	(0.44)
Constant (presented if no country effects)	0.013***	.	.	0	.	.	0.028***	.	.
	(0.00)	(.)	(.)	(0.01)	(.)	(.)	(0.00)	(.)	(.)
Country fixed effects	no	yes	yes	no	yes	yes	no	yes	yes
Year fixed effects	no	no	yes	no	no	yes	no	no	yes
Observations	582	582	582	302	302	302	224	224	224
R-squared	0.62	0.66	0.69	0.69	0.77	0.79	0.44	0.62	0.64

Notes: (1) Ordinary least squares estimations with appropriate dummy variables. Annual data for a panel of 28 EU Member States. (2) Trend productivity growth is defined as the five-year trailing average of labour productivity growth rate. (3) Clustered standard errors in parentheses. Asterisks mark estimated coefficients which are statistically significant at the 10% (*), 5% (**) or the 1% level (***).
Source: Own calculations based on Eurostat data.

Wage growth was thus responsive to productivity developments in the EU over the last two decades. This nuances, but does not contradict, previous findings that real wages have somewhat lagged real productivity in cumulated terms over the last two decades. This apparent 'decoupling' of wages from productivity developments was analysed for instance by Schwellnus et al. (2017), who noted that, over the two decades after 1995, the labour share fell by an average of 0.6 to 2.5 percentage points (depending on the sectoral coverage) across 31 countries of the OECD, with large cross-country variation.[3]

Unemployment is an important determinant of wage growth over the whole period. Overall, a one percentage point increase in the unemployment rate is estimated to shave off about 0.7 to 0.8 percentage points from wage growth (sum of the estimated coefficients of unemployment level and change). Both the level and the change of unemployment affect wage growth, justifying the inclusion of both. There are differences across specifications as to the relative importance of both variables. The level of unemployment becomes more closely related to wage growth when country effects are included, reflecting the fact that the average unemployment rate differed across countries over the sample period. The negative effect of unemployment on nominal wages, together with the finding that inflation and trend productivity growth affect nominal wage growth almost one-to-one, imply that unemployment has a negative effect on the wage share.

Results for the pre- and post-crisis periods are broadly similar to those obtained for the whole period, but there are some differences. First, it appears that wage growth did not closely follow trend productivity growth within the same country in the pre-crisis period. In turn, the link between wage growth and inflation appears to have been weaker in the post-crisis

[3] See Table 1 in Schwellnus et al. (2017). Somewhat larger decreases, for a narrower country sample, are reported in OECD (2018, Figure 2.4) based on the same research.

period. Finally, the relation between wage growth and unemployment appears somewhat weaker in the post-crisis period, although the difference is not statistically significant.[4]

In the pre-crisis period, the relationship between wages and productivity growth was strong between countries, but weaker within the same country over time. The specification without country effects suggests that wage growth was indeed faster in countries with faster productivity growth, with a relationship close to one-to-one (column 4 in Table 1). At the same time, the specifications with country effects show that wage growth within the same country did not closely follow trend productivity growth (the coefficient is close to 50% and is not statistically significant; see columns 5 and 6).

The link between wage growth and inflation was weak in the post-crisis period. The point estimates suggest that just between 20% and 40% of inflation translated into wage growth in the period 2010-2017 (columns 7 to 9 in Table 1), and the effect is not statistically significantly different from zero when country effects are included. This is likely due to the fact that inflation was historically low in this period, and its fluctuations were partly driven by external factors like energy prices that are not easy to predict (see, e.g., ECB 2017). In contrast, the relationship between wages and trend productivity remained strong.

Unemployment remains an important determinant of EU wage developments after the 2008 crisis. Quantitatively, a one-percentage point increase in the unemployment rate is estimated to shave off about 0.4 to 0.7 percentage points from wage growth in most specifications both before and after the crisis (sum of the estimated coefficients of unemployment level and change). The estimated relationship between unemployment and wage growth is similar in the pre- and post-crisis periods. The estimated effects are slightly lower in the post-crisis period, but the difference is not statistically significant. Note that the effect of unemployment on wage growth is weaker when estimated for either of the sub-periods than for the whole sample period. This could be caused by the shortness of the sub-periods, which goes together with less variation in unemployment. Overall, this evidence means that the wage Phillips curve relationship continued to operate in the post-crisis period.

Results are qualitatively similar for sub-groups of EU Member States. Table A.1 in the Annex presents results for three country groups: the current 19 Member States of the euro area (EA19), the first 12 members of the euro area (EA12), and 11 Eastern and Central European Member States (EU11). Results for the EA19 are close to the EU28 results with two slight differences, which are not statistically significant. First, the effect of productivity growth on wage growth appears to be somewhat weaker in the euro area than in the whole EU, especially when country effects are included. Second, wage growth appears to be somewhat more sensitive to changes of the unemployment rate, and somewhat less sensitive to differences in levels. Results for the EA12 show a weaker link between inflation and wage growth than in the baseline results, especially when country effects are included. Also, wage growth is less sensitive to unemployment changes in the EA12 sample, the estimated effect

[4] Results for the sub-periods need to be interpreted with caution, because they are based on relatively short time periods. This matters especially in specifications with country effects. These may account for temporary phenomena such as country specificities. See also the discussion in Section 2.2.

not being statistically significant in any of the specifications. In contrast, wage growth appears to be more sensitive to both the level and the change of the unemployment rate in the EU11 than in the EU28. Both inflation and trend productivity growth is very closely linked to wage growth in these countries, suggesting that productivity convergence is likely to lead to wage convergence over the long run. (For a recent analysis of wage convergence in the EU, see European Commission, 2018a, Chapter II.2).

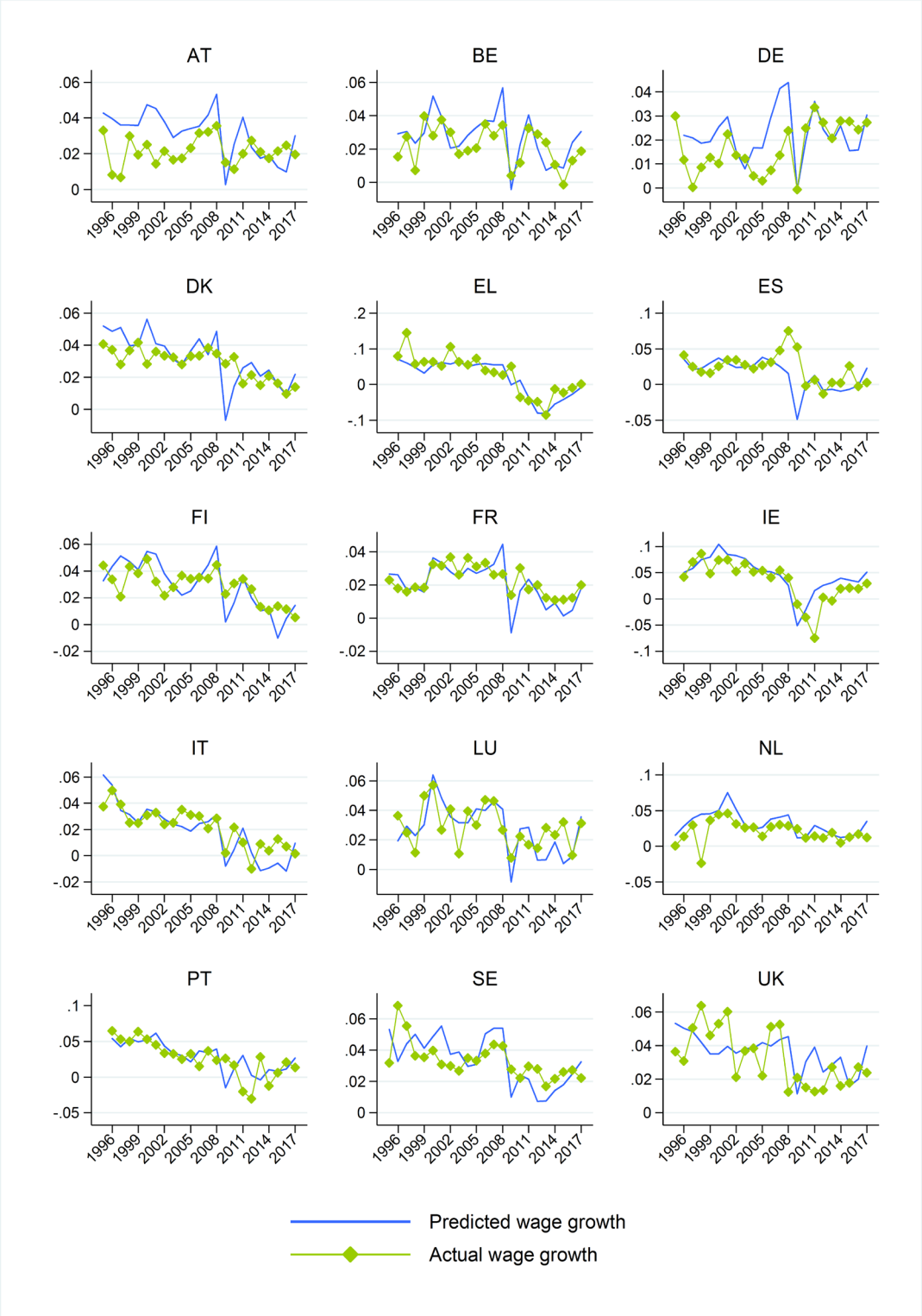
Results are also in line with previous analyses. In particular, they are close to IMF (2017, Annex Table 2.3.1) and Hong et al. (2018, Table 3), especially regarding the magnitude of the effect of the unemployment rate and the high coefficient of trend productivity growth. Both the estimated coefficient of inflation and that of the change of unemployment is larger than that found by the IMF, although the results get closer when the estimation is restricted to the EA12 sample. The effect of inflation is likely also larger because contemporaneous inflation is included in the regressions (as opposed to lagged inflation in the IMF work). Despite differences in methodology, the results are also similar to those found in previous work by the European Commission (2017a, p.17). The analysis of this paper includes labour productivity, rather than total factor productivity, as a measure of productivity, which explains the closer relationship with wage developments found here.

2.4. Identifying the possible shortfall in wage growth

Is there a shortfall in wage growth in the EU in the post-crisis period, and if so what is its magnitude? To answer this question, predicted wage growth is computed for each country and year based on the wage Phillips curves estimated above. This predicted wage growth serves as a 'benchmark' for wage developments. The gap between actual wage growth and this benchmark is a measure of the surprise component of wage growth. When this is negative, one can speak of a 'shortfall' in wage growth.

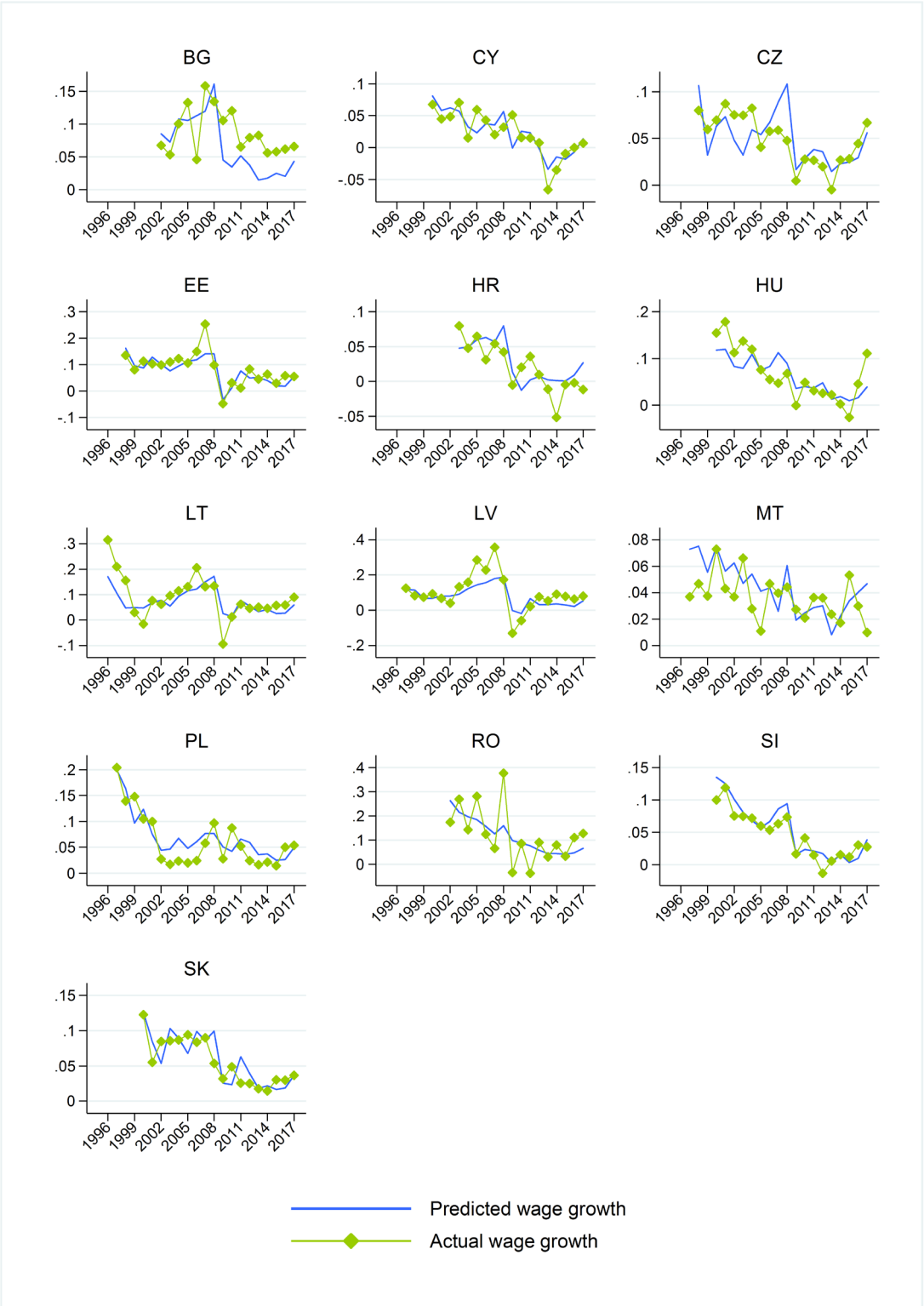
The wage 'benchmark' represents the wage growth that would be expected given developments in inflation, productivity and unemployment, in an average EU country in an average year. This benchmark is obtained by calculating predicted wage growth based on the estimated wage Phillips curve without country or year effects over the whole sample period (column 1 in Table 1). As discussed in Section 2.2, this specification is most suitable for benchmarking wage developments as it makes country comparisons simple and transparent. At the same time, the ‘benchmark’ is not normative: it does not represent the 'correct' or 'equilibrium' pace of wage growth. It simply reflects how wages moved together with economic fundamentals in 28 EU countries over the 23 years studied. Graphs 2 and 3 compare actual wage growth to the benchmark of wage growth predicted based on economic fundamentals, for each Member State over the period 1995-2017. Graph 2 includes the 15 countries which were EU members before 2004, while Graph 3 includes the 13 countries which became members in 2004 or later.

Graph 2: Actual and predicted wage growth, EU13, 1995-2017



Notes: Prediction based on specification without country effects over the period of 1995-2017, column (1) of Table 1 above.
Source: Own calculations.

Graph 3: Actual and predicted wage growth, EU13, 1995-2017, cont.

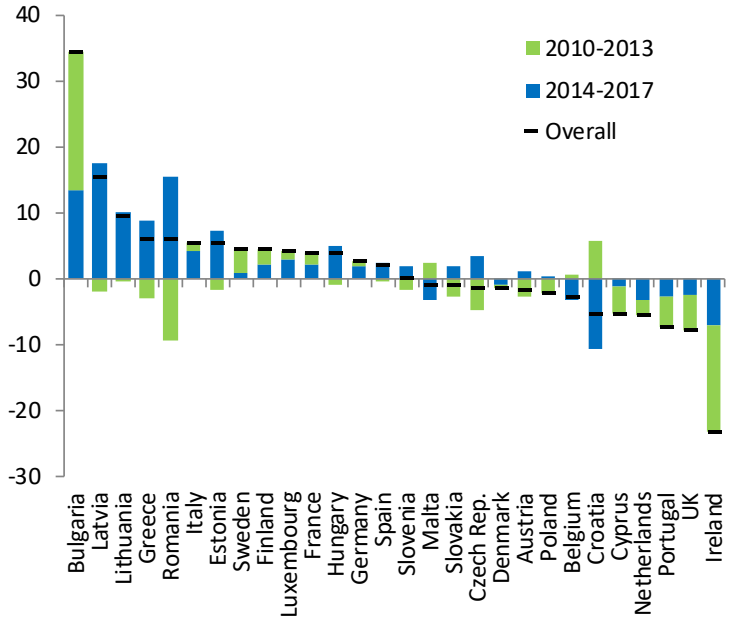


Note: Prediction based on specification without country effects over the period of 1995-2017, column (1) of Table 1 above.
Source: Own calculations.

For most countries and years, predicted wage growth is quite close to actual developments. There are a number of trends and events that are clearly visible in the graphs, of which two are highlighted here. First, the recession of 2009 becomes visible by a sudden fall in both actual and predicted wage growth, the latter particularly driven by falling labour productivity. Second, a trend of disinflation is observable in a number of countries over the whole period, especially in some Eastern-European Member States: actual and predicted nominal wage growth was close to a rate of 30% in Lithuania and Romania and close to 20% in Hungary and Poland, reflecting rapid inflation, at the beginning of the sample period. Comparatively fast wage growth is also observed in Greece, Ireland, Italy and Portugal in the late 1990s.

A shortfall in wage growth can be identified only for few Member States since 2010. Actual wage growth does not appear to be systematically below prediction in the post-crisis period. Graph 4 shows, for each country, the cumulated gap between actual and predicted wage growth in the post-crisis period. The graph divides this period into two equal parts: the first part (2010-2013) includes the second euro-area recession, while the second part (2014-2017) covers years of the recovery. There is a similar number of countries in which wage growth was faster than predicted based on economic fundamentals as those in which it was slower. Only six countries experienced a shortfall in wage growth that cumulated to more than 3 percentage points overall (or, roughly, more than 1/3 percentage points per year): these are, in descending order of the absolute gap, Ireland, the UK, Portugal, the Netherlands, Cyprus and Croatia. Most of the shortfall was accumulated in the crisis years of 2010 to 2013; only Croatia and Ireland experienced very a significant shortfall in wage growth between 2014 and 2017.

Graph 4: Cumulated gap between actual and predicted wage growth, EU28, 2010-2017, ppts



Notes: Prediction based on specification without country effects over the period of 1995-2017, column (1) of Table 1.
Source: Own calculations.

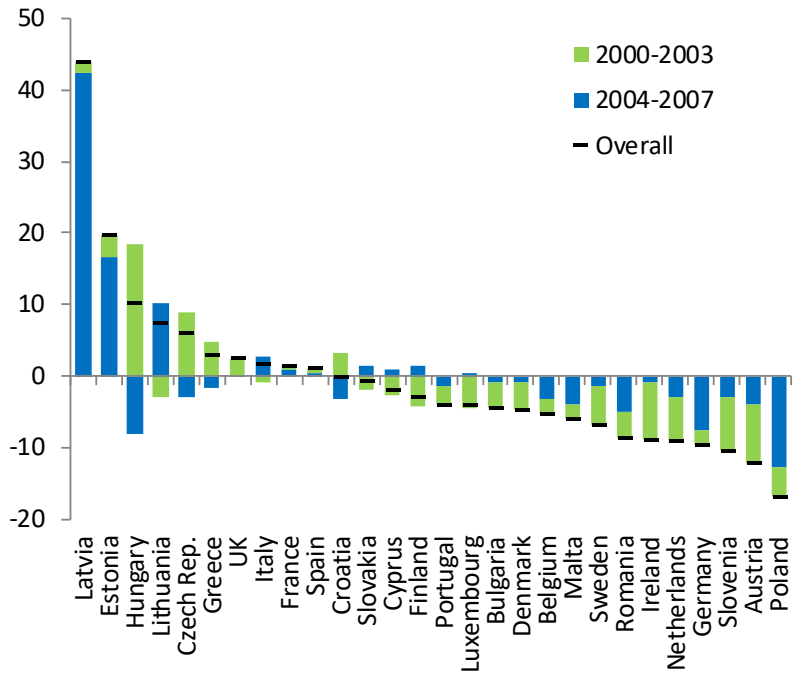
There is significant heterogeneity among the Member States that exhibit surprisingly low wage growth. Among the six countries identified above with the highest degree of shortfall in wage growth in the post-crisis period, the UK and the Netherlands appear closest to the US case that received much attention in the economic discussions. In 2017, the unemployment rate was below 5% (and below pre-crisis levels) in both countries. Here, like in the US, missing wage growth can be regarded as a genuine puzzle. In Ireland and Portugal, the unemployment rate is somewhat higher but came down steeply from very high levels.[5] In these countries there was also a need to undergo significant external adjustment to balance their current accounts and reduce the stock of foreign liabilities. Finally, in Croatia and Cyprus, the unemployment rate was still above 10% in 2017. Both countries have also experienced negative public sector wage growth as part of significant fiscal consolidation efforts since 2013 (see also European Commission [2018a, Graph I.2.22], as well as European Commission [2017a, Graph I.2.21]).

The group of countries with 'excess wage growth' in the post-crisis period is quite heterogeneous. The majority are catching-up economies of Central and Eastern European countries experiencing comparatively fast nominal wage growth (including Bulgaria, Estonia, Latvia, Lithuania, Romania). Yet, this group includes also countries with very low, or even negative, nominal wage growth (namely Greece and Italy) for which the benchmark wage growth is negative. In these countries, wage adjustment may be constrained by downward rigidities. As shown in the next section, in some of the countries with the most moderate wage developments (including Italy), composition effects may mask part of the underlying wage adjustment.

In some countries, there was a shortfall in wage growth in the pre-crisis period. Graph 5 shows, for each country, the cumulated gap between actual and predicted wage growth in the pre-crisis period 2000-2007. A shortfall in wage growth can be identified in more countries, and to a greater extent before the crisis than after. Countries with the greatest downward surprise in wage growth include euro area countries which developed large current account surpluses (e.g., Germany, the Netherlands and, to a lesser degree, Austria) but also some Member States outside the euro area which were pursuing significant disinflation policies (e.g., Poland, Romania and, joining the euro area in 2007, Slovenia; see also Graph 3 above).

[5] In Ireland, the shortfall in wage growth is not caused by the 2015 revision of GDP, which increases labour productivity. The effect was neutralised by replacing productivity growth in 2015 with the average of 2014 and 2016. At the same time, it is possible that statistical processes similar to those that led to the 2015 revision also affect other years. These effects are not neutralised by the methodology and may raise predicted wage growth as a statistical artefact.

Graph 5: Cumulated gap between actual and predicted wage growth, EU28, 2000-2007, ppts



Notes: (1) Prediction based on specification without country effects over the period of 1995-2017, column (1) of Table 1. (2) The sample period starts in 2002 for Bulgaria and Romania and 2003 for Croatia.
Source: Own calculations.

The observation that there is no widespread shortfall in wage growth in the post-crisis period is robust to alternative wage benchmarks. In particular, if the specification with country fixed effects is chosen as the basis for benchmarking, the countries with apparent shortfalls in wage growth in the post-crisis period remain a minority, while the countries with shortfalls in the pre-crisis period remain a majority.

2.5. Results with alternative measures of labour market slack

The relative importance of latent and overt labour market reserves differs across countries. Given the low headline unemployment rate in the UK and the Netherlands, it has been suggested that latent labour market reserves have played a role in the surprisingly low wage growth in these countries (European Commission, 2018b,c). In the case of the Netherlands, it has also been suggested that an expansion of temporary contracts may also have contributed to modest wage increases (European Commission, 2018b; confirmed by calculations in the next section). Heterogeneity in the significance of labour market reserves also finds support in the studies of IMF (2017) and Hong et al. (2018).

For a more systematic analysis of the role of latent labour market reserves, wage Phillips curve regressions have been re-estimated including indicators of these. Table A.2 in the Annex presents regression results with alternative measures of labour market reserves

('slack'). The focus is on two groups in particular: underemployed part-time workers (those who would like to work full time but do not find a full-time job) and individuals available for work but not seeking a job. In columns (1) to (4), the share of these workers in the labour force is introduced, as an additional variable, to baseline wage Phillips curve regressions without country effects. In columns (5) to (8), the regressions are repeated in a way that 'broad unemployment' (including these additional groups) is included instead of the standard unemployment rate. Odd-numbered columns refer to the whole sample period (whereby information about those available but not seeking a job starts only in 2005), while even-numbered columns refer to the post-crisis period.

Latent labour market reserves matter, but unemployment matters more. The regression results show that additional labour market reserves do not greatly affect wage growth when included in addition to the standard unemployment rate, but measures of broad unemployment have a similar effect on wages than standard unemployment alone. This is consistent with the finding by IMF (2017) and Hong et al. (2018) that involuntary part-time employment is a significant determinant of wage growth (even after controlling for headline unemployment) in countries where unemployment has fallen close to pre-crisis levels, or even below, but not in those where unemployment was still comparatively high in 2016. In many EU Member States, unemployment stayed high for longer than in other advanced economies analysed by the IMF study. This finding is also consistent with the analysis in European Commission (2017a, p. 17 and Table I.1.3).

2.6. The effect of demographic developments on wage growth

Have demographic developments affected wage growth in the EU? It has been suggested that ageing and migration may have had a negative effect on recent wage growth. To gain some insights into these issues, indicators of ageing and migration have been incorporated into the baseline wage Phillips curve estimations that were presented above. Table A.3 in the Annex presents the results. The additional variables included are:

- The "crude rate of net migration", i.e., the balance of immigration and out-migration flows, positive in case of net immigration (columns 1 and 2);
- In other specifications, the trend of the crude rate of net migration is included, calculated as a five-year trailing average (columns 3 and 4);
- The difference between the share of older (ages 55-64) and younger (aged 20-29) individuals in total active population (ages 15-64; columns 5 and 6);

To explore the robustness of results, the effect of each variable is explored both with country effects (in even-numbered columns), and without (in odd-numbered columns).

Expected effects are ambiguous, according to theory. In the simplest labour market models in which there is a single type of labour and the capital stock is fixed, immigration is a 'labour supply shock' restraining wage growth. However, in models with more complexity, a different result may emerge. For instance, Dustmann et al. (2013) show that, in a model with

many skill types, “whenever the immigrant skill composition differs from that of the native labour force, and if capital is elastic in supply, the effect on the average wages of native workers should be zero or even slightly positive”. This average effect masks heterogeneities along the wage distribution: wages might be moderated for workers who are in segments in which the density of immigrant workers is higher.[6] Dustmann et al. (2013) estimate that U.K. average wages have increased as a result of immigration between 1997 and 2005; they found negative effects on wages in the lowest quintile of the wage distribution, mirroring the location of immigrants in the wage distribution. Previous empirical studies are also not unequivocal on the effect of immigration on the wages of native workers, with results seeming to “cluster around zero” (Borjas, 2003).

The theoretical arguments are similarly ambiguous for the effect of the labour market participation of younger and older workers on general wages. In the simplistic framework of homogenous labour and a fixed capital stock, higher participation of older or younger workers is a ‘labour supply shock’ which may hold back overall wage growth. However, this may not be the case if the capital stock can expand as a response to a higher labour supply, and if there are complementarities between different groups of labour. The ageing of the workforce may also affect aggregate wage growth through a composition effect. Since older workers tend to earn a higher wage than younger workers, the ageing of the workforce may have a small positive effect on aggregate wages.

Wage growth is slightly higher in years when the trend of net migration is higher, other factors being equal. The rate of net migration in a single year does not appear to be correlated with wage growth (Table A.3, columns 1 and 2). At the same time, the trend of net migration is positively related to wage growth when country effects are included in the model (column 4), but not when country effects are excluded (column 3). This suggests that wage growth in a given country appears to be somewhat higher in times when trend net migration is relatively high (although the effect is only weakly statistically significant). According to the point estimate, an increase in net (im)migration by one person per 1000 inhabitants is statistically related to an increased wage growth of about one tenth of a percentage point.

The results are consistent with a small but positive effect of immigration on wages. At the same time, the methodology of aggregate cross-country regressions does not assure that these results can be interpreted as causal. The positive relation could also be caused by reverse causation (higher wage growth may spur immigration) or a common third factor, for instance if both increased immigration and higher wages may be related with a country experiencing "good times" economically.[7] In these cases, however, one would expect the contemporaneous effect to be strong and the lagged effect of migratory trends on wages to be weaker. The results show the opposite which hints at the possibility that the estimated effect could be causal.

[6] This is consistent in logic with an earlier analysis by Borjas (1999) who noted in a simpler framework that "natives in the host country benefit from immigration as long as immigrants and natives differ in their productive endowments; […] and that […] natives who have productive endowments that complement those of immigrants gain, while natives who have endowments that compete with those of immigrants lose."

[7] Work by the European Commission (2015) presented evidence that migration flows in the EU react to changes in unemployment to an increasing degree.

Wage growth appears to be slightly faster in countries in which the share of older workers is larger as compared to younger workers. A one percentage point increase in the difference between the shares of older and younger workers is statistically related to increased wage growth by about half of a tenth of a percentage point when country effects are not included (Table A.3, column 5). The effect is weaker and statistically not significant when country effects are included (column 6). The results are consistent with the notion that the ageing of the workforce affects aggregate wage growth through a composition effect. This hypothesis is supported by the fact that, when entered separately in the regression, the shares of older and younger workers have the opposite effect on aggregate wage growth, although the coefficient of the share of younger workers is not statistically significant (not shown in the table). Composition effects are investigated in detail in Section 4 below.

Overall, demographic developments do not appear to have significantly affected wage growth, when economic fundamentals are taken into account. Neither ageing nor migration appear to have held back EU wage growth over the period of study and, given the signs of the estimated effects, in the post-crisis period. This does not mean that these trends have not affected wage growth. Ageing, for instance, has been proposed as a possible factor contributing to low inflation. Such possible effects are outside the scope of this paper, but are briefly discussed in the Conclusions.

2.7. The effect of institutional settings on wage growth

How is wage growth affected by institutions related to collective bargaining? This subsection focuses on two aspects in particular: trade union density (the ratio of employees who are members of a trade union to all employees) and the coverage of collective bargaining (employees covered by the collective agreement as a share of all employees). Theoretically, union density and collective bargaining are expected to have a positive effect on wages, although models of wage bargaining vary in many respects, including what exactly unions and employer organisations are bargaining over and what effect this has on employment.[8]

Past studies are not unanimous on the relationships between collective bargaining institutions and macro-economic outcomes.[9] In one of the few studies with significant macro-level estimates, OECD (1997) found a positive effect of collective bargaining on real wage growth across 19 OECD countries and three years (1980, 1990 and 1994). The same study also found that, between 1980 and 1990, increases in collective bargaining coverage were associated with higher real wage growth, while increases in union density with lower real wage growth across 19 countries. In contrast, on a larger panel data set covering EU and OECD members over the period 1980-2007, the European Commission (2011, pp. 96-97) found that union density and bargaining coverage had no effect on wage levels or short-term wage dynamics

[8] For an overview of the theoretical literature, see Aidt and Tzannatos (2002) and Boeri and Van Ours (2013, Chapter 3).

[9] An empirical relationship that seems robust across different samples and time periods is that stronger collective bargaining is associated with a lower earnings inequality. For an overview of the empirical literature, see Aidt and Tzannatos (2002) and Boeri and Van Ours (2013, Chapter 3), as well as OECD (1997 and 2004).

when economic fundamentals were controlled for. Most recently, OECD (2018) found that collective bargaining coverage does not strongly affect economic outcomes in itself; its effects depend on the level of centralisation and coordination of the collective bargaining system.[10]

Table A.4 shows results from regressions including the change in union density and collective bargaining coverage. Regressions including the change in union density are shown in columns (1) to (4) while those including the change in collective bargaining coverage are shown in columns (5) to (8). To explore the robustness of the results, as well as possible changes of the effects over time, results are shown for the whole period (1995-2017) as well as the post-crisis period (2010-2017), and both with and without country effects.

Changes in collective bargaining coverage are estimated to have a small but immediate effect on wage growth. The point estimate over the whole period suggests that when bargaining coverage increases by one percentage point, wage growth tends to be higher by about one tenth of a percentage point (Table A.4, columns 1 and 2). To put this into context, collective bargaining coverage in the EU15 fell by about 4 percentage points (from 78% to 74%, unweighted average) between 2000 and 2013. This would imply a cumulative one-time reduction in wage growth of about 0.4%. The reduction was faster in Central Eastern European Member States: collective bargaining coverage in the EU10 (excluding Croatia for data availability) fell by about 9% (from 40% to 31%, unweighted average) from 2005 to 2012, which would imply a cumulative one-time reduction of almost a full percentage point. The estimated effects are robust to the inclusion of country effects and appear to be about 50% larger in the post-crisis period than in the whole period (columns 3 and 4).[11]

In the post-crisis period, wage growth appears to be lower in countries in which union density decreases more rapidly. Union density shows a downward trend in most Member States, with the falls especially significant in Eastern European Member States before 2000. Since 1995, union density has decreased annually by nearly a percentage point in an average Member State, while since 2010 the decrease has been about half a percentage point on average, annually. The estimations reported in Table A.4 suggest that changes in union density are not related to wage growth over the whole sample period (columns 5 and 6), but are positively related to wage growth in the post-crisis period. The effect is larger and statistically significant when wage growth is compared between countries (column 7), while smaller and not statistically significant when wage growth is compared within the same country over time (column 8). The point estimate in column 7 suggests that, after 2010, if a country saw union density drop by one percentage point more than its peers with similar fundamentals, it also tended to have slower wage growth, by about half a percentage point, than its peers. Since the post-crisis period is relatively short, and the result is not very robust (as opposed to the results on bargaining coverage), it is possible that it is only due to the experience of a few countries.

[10] The importance of coordination in collective bargaining is also emphasised by Eurofound (2015).
[11] Results are similar when 'excess coverage' (the difference between collective bargaining coverage and union density) is included in the regressions instead of bargaining coverage.

Short-term effects of institutional changes related to collective bargaining contrast with the lack of long-term effects of the levels of institutional indicators. Despite the immediate effect of the changes in especially bargaining coverage discussed above, the levels of bargaining coverage and union density do not appear to have an effect on wage growth over any of the time periods with or without country effects. (These results, small and not statistically significant, are not presented.) The coexistence of these results suggests that changes in these institutional variables have a short-term, transitory, effect on wage growth.

3. Has the composition of employment contributed to moderate wage growth in the EU?

3.1. Introduction

This section analyses the impact of changes in the composition of the workforce on wages. The composition of the workforce includes two types of aspects: composition in terms of individual characteristics (such as age in the example above) but also in terms of job characteristics (e.g. increasing share of the services sector or of temporary contracts). Because of data availability issues, the analysis of the post-crisis period is divided into two parts. The first part of the analysis focuses on wage growth between 2010 and 2014. Besides looking at developments of the average wage, this section also explores the impact of compositional changes on wages across the whole wage distribution and thus their possible implications for wage inequality. The second part of the analysis provides more recent estimates on the impact of composition effects on wage growth between 2014 and 2017.

Compositional effects in specific Member States have been studied, but few studies analyse them across Member States. A notable exception is the study by Christopoulou et al. (2010) who analysed changes in the wage structures in nine EU countries over 1995-2002. Unlike studies that focused on individual Member states, they find that composition effects derived from changes in age, gender or education of the labour force, largely exogenous to economic developments, had a minor contribution to the observed wage dynamics. In contrast they find that effects from job characteristics, likely driven by economic developments such as changes in the sector of employment, are more relevant. Recent analyses of how composition effects contributed to average wage growth in a single country include Abel et al. (2016) who estimate that composition effects had a slightly negative effect on wage growth in the UK in 2014 and, to a decreasing extent, in 2015.

There is also an expanding literature on the compositional effects on the wage structure. The majority of the studies have focused on the determinants of wage growth in the US or the United Kingdom (e.g. Bound and Johnson, 1992; Acemoglu, 2002; Belfield et al., 2017), but more recently an increasing number of studies focused on other Member States. Based on changes in the Portuguese wage distribution between 1986 and 1995, Machado and Mata (2005) find that an increase in educational attainment contributed decisively towards greater wage inequality. These findings are confirmed with more recent data (1988-2013) by Portugal et al. (2018). Using individual wage data for Germany, Beiwen et al. (2017) show that changes in the composition of the workforce explain more than half of the changes in wage

inequality between 1985 and 2010. They find a strong impact of changes in age, educational attainment (especially in the upper part of the distribution) and employment history (especially in the lower part of the distribution).

3.2. Data and methodology

This section analyses the impact of composition effects on wage growth in the EU between 2010 and 2017. For data availability reasons, the analysis is divided into two parts. In the first part, composition effects are identified by comparing the 2010 and 2014 waves of the Structure of Earnings Survey (SES) in a number of countries. The 2014 wave is the latest available one from this survey, so most recent developments need to be analysed by a different method. This is done in the second part, combining information from the 2014 SES with information from the Labour Force Survey from the years between 2014 and 2017. In this study, 22 Member States are included. These are: Belgium, Bulgaria, the Czech Republic, Cyprus, Estonia, Finland, France, Germany, Hungary, Italy, Latvia, Lithuania, Luxembourg, the Netherlands, Malta (only 2014-2017), Poland, Portugal, Romania, Slovenia (only 2014-2017), Slovakia, Spain and the United Kingdom.

Period 2010-2014. Average wage growth between 2010 and 2014 is decomposed based on individual-level data from the 2010 and 2014 Structure of Earnings Survey (SES). This survey contains information on hourly wages for employees working in firms with more than ten employees.[12] In addition, it includes detailed information on several individual (age, gender educational attainment) and job characteristics (occupation, sector, type of contract, working hours).

The average wage (W_T) in time period T is found to be dependent of a number individual and job characteristics (X_T) and can be estimated by a Mincer equation or wage equation: ($\ln W_T = X_T\beta_T + \varepsilon_T$). Wage growth ($\ln W_T - \ln W_{T-1}$) is then decomposed using an Oaxaca-Blinder decomposition into a composition, price and interaction effect:

$$\ln W_T - \ln W_{T-1} = \underbrace{(X_T - X_{T-1})\beta_{T-1}}_{Composition\ effect} + \underbrace{(\beta_T - \beta_{T-1})X_{T-1}}_{Price\ effect} + \underbrace{(X_T - X_{T-1})(\beta_T - \beta_{T-1})}_{Interaction\ effect}$$

In addition, the analysis estimates the impact of changes in the composition of the workforce on wage growth across the wage distribution. For this estimation the methodology proposed by Machado and Mata (2005) is used. This methodology is very similar to the Oaxaca-Blinder decomposition, but instead of estimating the effects at the overall mean it relies on estimates based on the mean characteristics of individuals in each of the deciles of the wage distribution. Wage growth by decile is then decomposed in an explained (composition effect) and unexplained (price and interaction effect combined) part.

Period 2014-2017. Since the latest wave of the SES is from 2014, a different method is needed to analyse latest developments. This method combines estimates based on the 2014

[12] The fact that the survey is excluding employees working in small companies may explain why aggregate wage growth based on the survey differs from aggregate wage growth based on national accounts.

SES with the 2014 and 2017 Labour Force Survey (LFS). The following methodology is used for this extension:

- In a first step, a linear regression based on the 2014 SES data is estimated with average hourly wages as the dependent variable and individual and job characteristics as independent variables. This regression is used to obtain the coefficients on the independent variables, which are the "returns" to the individual and job characteristics.

- In a second step, the coefficients obtained in the first step are multiplied by the changes in the individual and job characteristics from the LFS between 2014 and 2017. This allows obtaining the composition effects as it measures the wage changes due to changes in individual and job characteristics keeping the returns to these characteristics constant (based on 2014 levels).

There are drawbacks to this methodology as compared to the Oaxaca-Blinder decomposition explored in the first stage. First, the method is based on a linear approximation in the second step. Second, it only allows estimating the composition effect but not the price and interaction effects. Third, there are differences in between the population sampled in the SES and LFS: while the LFS covers the entire working-age population, the SES is in most Member States limited to employees working in firms with more than 10 employees.

Interpretation of the effects. Wage growth can be broken down into three components, namely the composition, price and interaction effects. The “composition effect” measures the changes in wages due to changes in individual and job characteristics, while keeping unchanged the wages earned by the same person in the same job. The “price effect” measures changes in wages due to changes in how much a given worker in a given job earns, while keeping the composition of the workforce constant. The price effect includes changes in the “constant term” of the wage equation (e.g. wage increases common to all employees, for instance compensating inflation) and changes in the so-called “returns” to observed characteristics of workers (e.g., the “return” to higher education in terms of higher wages earned by graduates).

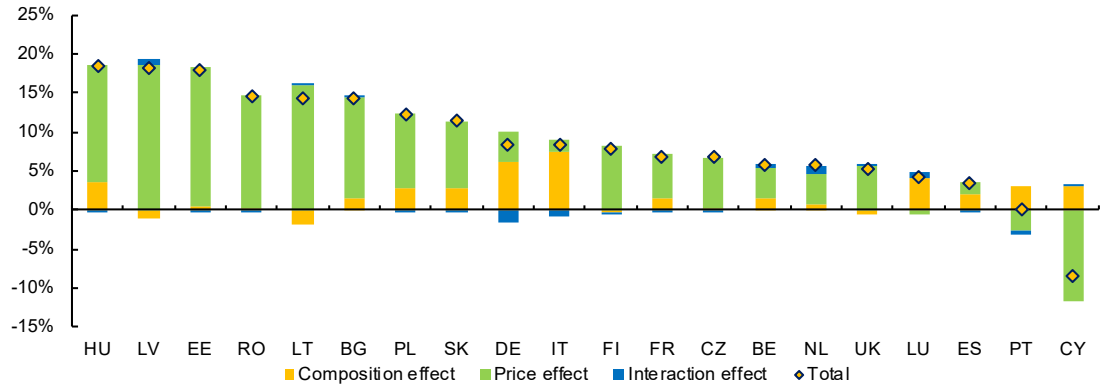
Finally, the “interaction effect” measures changes in wages due to the interaction between changes in characteristics and changes in returns. For instance, in a hypothetical economy in which wages of workers without a tertiary degree stay unchanged over a given period, an increasing return to higher education increases aggregate wage growth through a positive “price effect”; while an increasing rate of tertiary attainment increases aggregate wage growth by a positive “composition effect”. In this case, there will be a positive interaction effect: aggregate wage growth will be somewhat higher than the sum of the composition effect and the price effect. Generally, however, interaction effects are found to be small.

Section 3.3 first presents the breakdown into the composition, price and interaction effect. Then the composition effect is broken down into its components. This is done for average growth as well as wage growth across the wage distribution.

3.3. Results on the decomposition of wage growth between 2010 and 2014

In most Member States, composition effects had a small but positive contribution to aggregate wage growth. Graph 6 provides a breakdown of average wage growth (in percentage) between 2010 and 2014.[13] Average wage growth, in nominal terms, was positive in almost all Member States. It was strongest in Hungary, Latvia and Estonia (more than 15% in cumulative terms). In contrast, it was weak in Spain and Portugal and even negative in Cyprus. These findings are consistent with official wage statistics based on national account data. In most Member States, the main driver of wage growth was the "price effect", while the impact of the composition effect was much smaller. This is particularly the case in Member States with robust nominal wage growth, in some cases because of higher inflation over the period.[14] Finally, the interaction effect was negligible in almost all Member States.

Graph 6: Decomposition of aggregate wage growth, 2010-2014 (nominal hourly wages; in percentage)



Note: Based on an Oaxaca Blinder decomposition including age, gender, educational attainment, sector of employment, occupation, type of contract and hours worked. No data on sector of employment included for Germany and Italy.

Source: Own calculations based on individual level data from the Structure of Earnings Survey (2010-2014)

[13] In order to test for the robustness of the results, the same analysis was performed for wage growth between 2002 and 2006. The results of this analysis are in line with the results for wage growth between 2010 and 2014. In most Member States aggregate wage growth was driven by the price effect and only in few Member States, including Portugal, France and Belgium, composition effects played an important role. Note that it is not appropriate to analyse wage growth between 2006 and 2010 as the data on the sector of employment are not comparable as the result of a revision of the NACE codes.

[14] These will be included in the constant of the price effect, which captures changes in the relative prices that are common to all employees.

In a few Member States, changes in the composition of the workforce were the main driver of wage growth. This holds in particular for some of the Member States that experienced low or moderate wage growth, such as Italy, Germany, Luxembourg, Portugal, and Spain. In these countries, as well as in Cyprus and Hungary, composition effects (especially those related to education and occupation, see below) explained more than 3 pps of aggregate wage growth. In most cases, changes in the composition of the workforce have led to an increase of average hourly wages. In Portugal, the positive composition effect counterbalances the negative price effect, resulting in a largely unchanged level of aggregate nominal wages. However, there are some exceptions, such as Latvia, Lithuania and the United Kingdom, where changes in the composition of the workforce had a negative albeit small impact on wage growth.

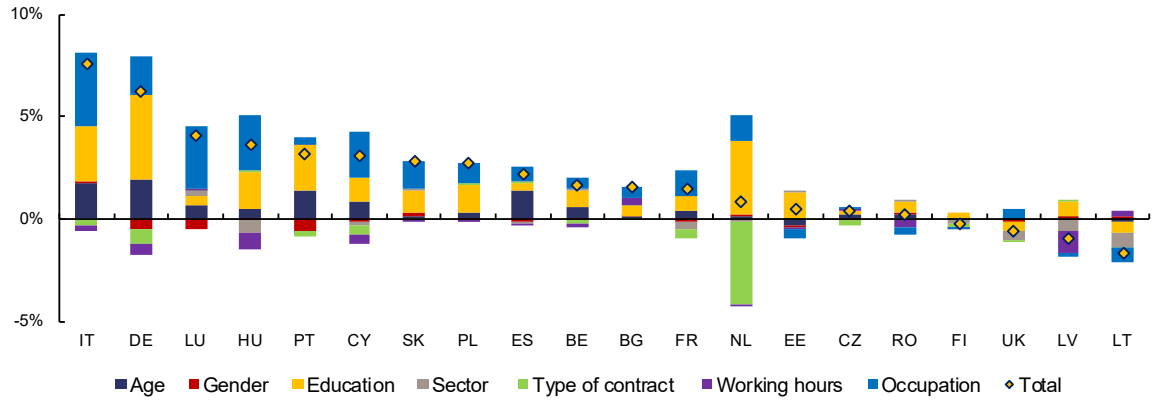
Upskilling of the workforce has been the main driver of composition effects. The composition effect can be broken down into its components. In the analysis the following individual and job characteristics are considered: age (6 categories), gender (male and female), education (3 categories), type of contract (permanent and fixed term), hours worked (part-time and full-time), occupation (9 categories) and sector (14 categories). Graph 7 presents the breakdown of the composition effect. Changes in educational attainment and occupation represent more than half of the composition effect in a majority of the Member States. This effect is particularly large in Germany, Italy, Hungary, the Netherlands and Portugal. An exception is Lithuania where changes in educational attainment and occupations appear to have had a negative (albeit small) impact on wage growth.

Population ageing also had a positive impact on the aggregate wage level. This effect is particularly important for Germany, Italy, Portugal, and Spain and, to a lesser extent Belgium and Cyprus. It reflects the increase in the share of older workers in the workforce, which is likely related to the impact of recent reforms aiming to increase the effective retirement age.

The increase in female employment had a small negative impact on aggregate wage growth. Women, on average, earn lower wages than men. For this reason, an increase in the proportion of women in the labour market may have a small negative effect on the aggregate wage level. While in most Member States the increase in female employment had only a marginal impact on wage growth, it was visible in others, including Germany, Luxembourg and Portugal.

The expansion of non-standard forms of work has a significant impact on aggregate wage growth in some countries. This is the case in the Netherlands where the rapid increase in the proportion of temporary contracts (2.9 pps increase between 2010 and 2014) had a large and significant negative impact on wage growth (4 pps). Similar, albeit smaller, effects are found for Germany, Cyprus, France, Italy and Portugal. In Germany, the rise in the proportion of part-time employees (in mini- and midi-jobs) led to a decline in aggregate wage growth (1 pp). Similar findings hold for Hungary, Cyprus and Latvia.

Graph 7: Composition effects of aggregate wage growth, 2010-2014 (nominal hourly wages; in percentage)



Note: Based on an Oaxaca Blinder decomposition including age, gender, educational attainment, sector of employment, occupation, type of contract and hours worked. No data on sector of employment included for Germany and Italy.
Source: Own calculations based on individual level data from the Structure of Earnings Survey (2010-2014)

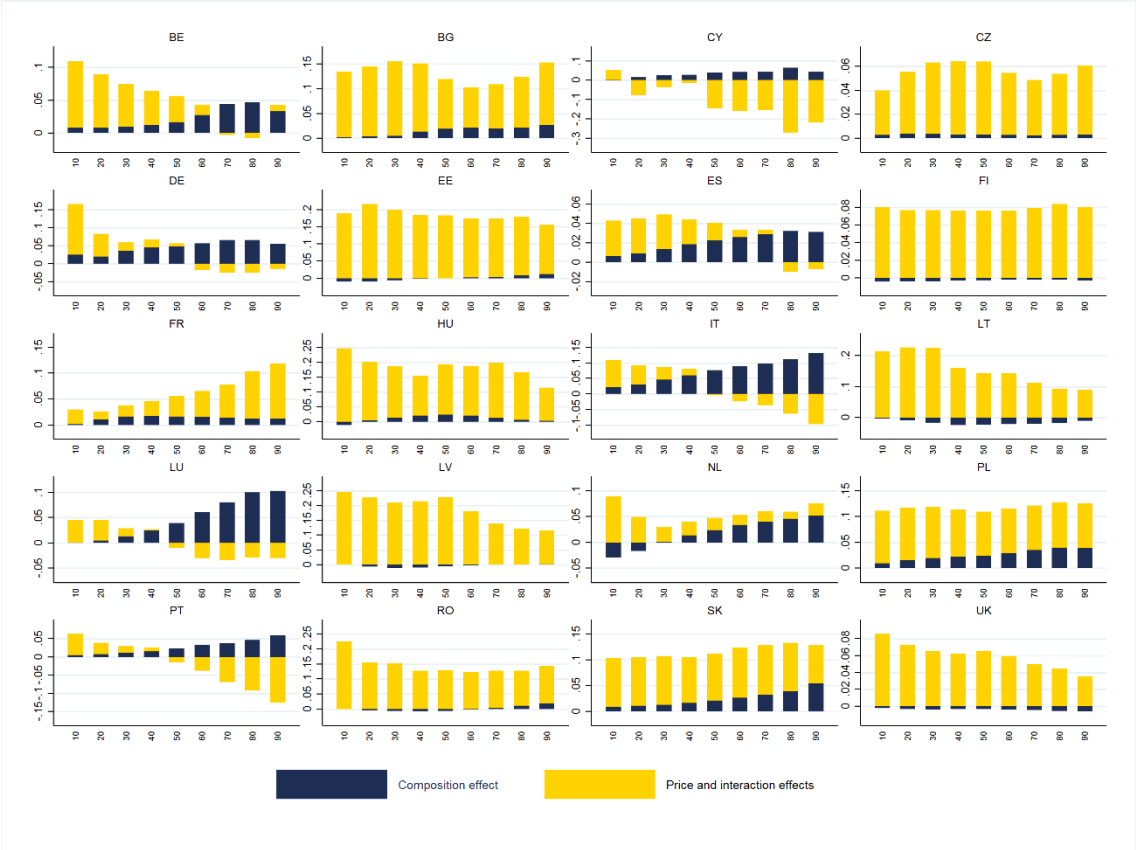
Wage growth in the Eastern European Member States is more uniform across the wage distribution than in the other Member States. In any country, aggregate wage growth is the outcome of developments in various parts of the wage distribution. Graph 8 presents the results on aggregate wage growth by decile for the period 2010 to 2014. In most Eastern Member States, wages increased at almost the same pace across the wage distribution. Notable exceptions are Lithuania and Latvia, where the strongest wage growth was observed in the lower deciles, indicating a decline in wage inequality.

In the Southern Member States, wage inequality declined substantially as a result of stronger wage increases in the lowest deciles. In fact in some Member States, such as Cyprus and Portugal, wages in the highest deciles even decreased in the period 2010-2014. In other Member States, such as Spain and Italy, wages in the highest deciles increased, mainly driven by composition effects. Even in these countries, the overall wage increases in the highest deciles were substantially smaller than those in the lowest deciles.

There is no uniform pattern in Western European Member States as concerns wage inequality. In Belgium and Germany, similarly to Southern Member States, wages increased more in the lowest than in the highest deciles, while the opposite is observed in France. In between these polar cases are Luxembourg and the Netherlands, where price effects were stronger at the bottom, and composition effects stronger at the top of the wage distribution, with wage growth being more moderate in the middle.

In general, composition effects are positive and more important for wage growth in the higher wage deciles. In a few Member States, such as Lithuania and the United Kingdom, changes in the composition of the workforce had a negative impact on aggregate wage growth in all wage deciles. In other Member States, such as Cyprus, Latvia and Romania, composition effects had a negative impact on wage growth in some deciles, but not in all.

Graph 8: Decomposition of aggregate wage growth by decile, 2010-2014 (nominal hourly wages; in percentage)



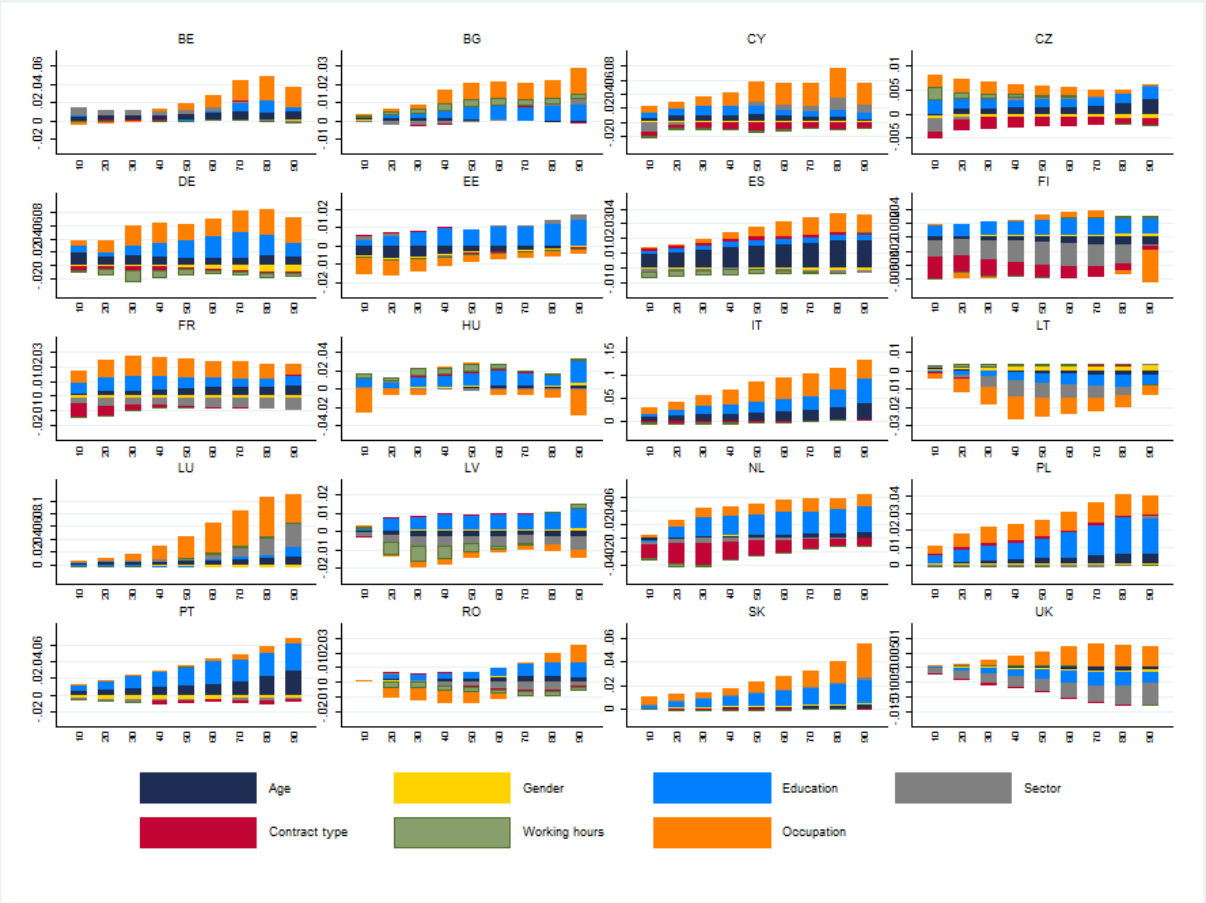
Note: Based on a decomposition methodology proposed by Machado and Mata including age, gender, educational attainment, sector of employment, occupation, type of contract and hours worked. No data on sector of employment included for Germany and Italy.
Source: Commission calculations based on the microdata from the SES (2010-2014)

Up-skilling mainly affected those at the top of the wage distribution, while the effect of ageing was more uniform. The effect of specific components differs across the wage distribution. Graph 9 provides a breakdown of the drivers of the compositional effect. Changes in educational attainment of the workforce had a positive impact on wage growth in all deciles of the wage distribution with the largest impact in the middle and upper segments. The impact of ageing on aggregate wage growth is different across Member States. In some Member States, such as Belgium, Germany and Finland, ageing of the workforce affected the wage growth in the lowest deciles to the same extent as it affected wage growth in the highest wage deciles. In other Member States, such as Italy or Portugal, the effect is strongly increasing with the wage level, suggesting that seniority pay affected mainly those at the top of the wage distribution.

Changes in the type of employment mainly affected wages in the lower part of the wage distribution. In the Netherlands, the increase in temporary employment had a negative impact on wages across the wage distribution, while in France the effect can be observed only in the lower wage deciles. In Finland, the decline in the importance of temporary employment had a larger positive impact on wages at the bottom of the distribution than at the top. Also

increases in part-time employment mainly affected wages at the bottom of the wage distribution. This is for example the case in Germany, where the increase in the share of part-time employment as a result of an increase in the share of mini- and midi-jobs, resulted in a substantial decline in the aggregate wage growth up to the fourth decile.

Graph 9: Composition effects of aggregate wage growth by quantile, 2010-2014 (nominal hourly wages; in percentage)

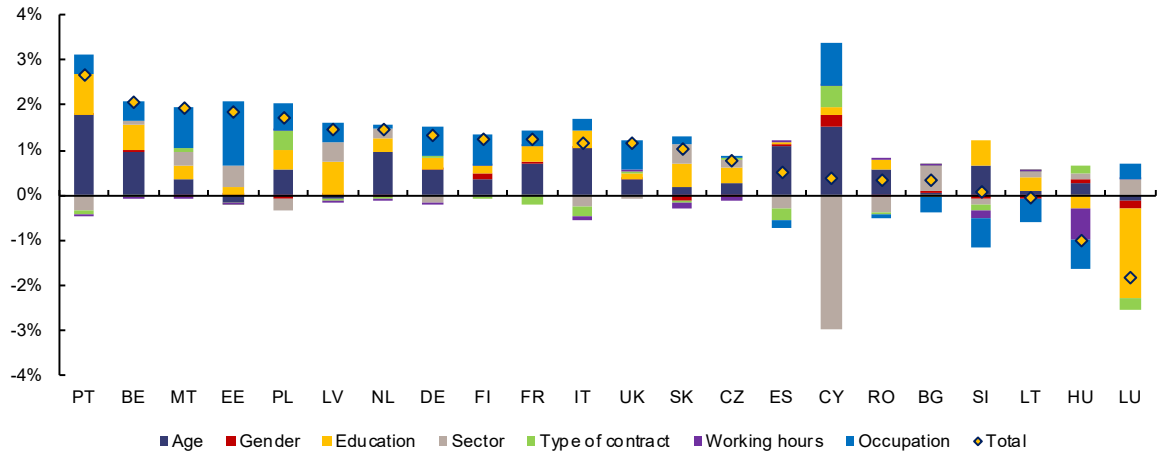


Note: Based on a decomposition methodology proposed by Machado and Mata including age, gender, educational attainment, sector of employment, occupation, type of contract and hours worked. No data on sector of employment included for Germany and Italy.
Source: Commission calculations based on the microdata of the SES (2010 and 2014)

3.4. Results on the decomposition of wage growth between 2014 and 2017

The composition effect on wage growth remained small between 2014 and 2017. Graph 10 presents a breakdown of the composition effect of aggregate wage growth between 2014 and 2017. The findings are broadly in line with those for the period 2010-2014. In all Member States, except Portugal, the composition effect on aggregate wage growth has been found to be lower than 2% or less than 0.67% per year.

Graph 10: Composition effects of aggregate wage growth, 2014-2017 (nominal hourly wages; in percentage)



Note: The effects are calculated based on linear approximation based on the changes in individual and job characteristics obtained from LFS (2014-2017) and the wage elasticities of the individual and job characteristics obtained from a linear regressions based on the 2014 SES.
Source: Commission calculations based on microdata from the 2014 and 2107 LFS and the 2014 SES.

Upskilling and ageing of the population remained the main drivers of composition effects after 2014. In the majority of Member States, changes in education and occupation explained more than half of the overall estimated composition effects. Only in Luxembourg and Hungary was there a negative impact of education on aggregate wage growth, reflecting an expansion of lower-skilled jobs during the recovery. In addition, the ageing of the population also had a positive effect on aggregate wage growth. This effect appears to be more important than in the period 2010-2014, both in terms of the number of Member States affected and the relative magnitude of the effect. The impact is particularly large for Southern Member States (Portugal, Cyprus, Italy and Spain).

The impact of gender composition was more diverse across countries after 2014 than before. As in the period between 2010 and 2014, the increasing share of women in the labour market had a small (negative) effect on aggregate wages in a few countries including Poland, Slovakia and Luxembourg. In other Member States, male employment rose faster during the recovery (after relatively larger losses in male employment during the crisis period), reducing the share of women in employment after 2014. This resulted in a positive composition effect in Cyprus, Hungary, Bulgaria and Finland.

In some Member States, an increase in the share of permanent employees had a positive impact on aggregate wage growth. This is in contrast to the period 2010-2014 when the type of contract had a negative on aggregate wage growth in all Member States. It suggests that part of the impact of an increase in temporary employment had on wage growth was transitionary and may be related to the business cycle. Nevertheless, in several Member States, including Portugal, Spain, Italy and Slovenia, the continued increases in temporary workers continue to have a negative impact on aggregate wage growth.

4. Conclusions

Unemployment has remained an important determinant of EU wage developments after the 2008 crisis. In estimated wage Phillips curve relationships, the link between unemployment and nominal wage growth is somewhat weaker after 2008 than before but the difference is not statistically significant when other economic fundamentals such as inflation and trend productivity growth are controlled for. This contrasts with the apparent "flattening" of the bivariate wage Phillips curve, as seen in Graph 1 also documented in European Commission (2018a), among others. Wage growth closely follows inflation and trend productivity growth since the mid-1990s. The link between wage growth and inflation has weakened in the low-inflation environment of the post-crisis period.

A shortfall in wage growth can be identified only in a few EU Member States since 2010. This appears to be in contrast with some other advanced economies, notably the US. EU Member States with a shortfall in wage growth include countries with low (the UK and the Netherlands), intermediate (Ireland, Portugal) as well as high unemployment (Croatia, Cyprus). Shortfalls had also accumulated in a number of countries in the pre-crisis period, especially in countries that developed high current account surpluses (e.g., Germany and the Netherlands) as well as some countries with significant disinflation episodes (Poland, Romania, and Slovenia). Overall, latent labour market reserves (such as involuntary part-time work) matter for wage growth in the EU, but headline unemployment matters more.

Migration, ageing and collective bargaining institutions appear to have mostly transitory effects on wage growth. Wage growth is slightly higher in years when trend net migration is higher, possibly also reflecting the fact that net migration is higher in 'good economic times'. The age of the workforce appears to slightly affect wage growth, possibly through a composition effect as older workers, remaining in the workforce for longer, tend to earn higher wages. Changes in collective bargaining coverage are estimated to have a small positive effect on wage growth. In the post-crisis period, wage growth appears to be lower in countries in which union density decreases more rapidly. These short-term effects contrast with the apparent lack of long-term effects of the levels of union density and bargaining coverage.

Some of the limitations of the analysis on wage Phillips curves are related to its scope and the time horizon studied. First, the paper focuses on domestic economic fundamentals shaping wage developments, but does not analyse issues related to external adjustment and international competitiveness, even though they played a role in wage developments in recent years. Second, while it analyses the relationship between wages and productivity, it does not have a focus on the wage share.[15] Third, to have a reasonably balanced panel data set of the 28 Member States, the analysis focuses on the period since 1995. For this reason it is outside

[15] OECD (2018) and European Commission (2018a, Box II.1.3), among others, provide an overview of the recent literature on trends in the wage share and its possible explanations.

its scope to assess whether there have been structural changes in the relationships determining wage growth before that date.

Changes in the composition of the workforce over the last decade had a small but positive impact on wage growth in most of the EU. In some Member States, composition effects were a main driver of wage growth. This was the case in particular in countries with relatively low or moderate wage growth, such as Germany, Italy, Luxembourg and Portugal. This also means that underlying wage growth was lower in these countries than headline wage growth suggests.

Education, age and non-standard employment appear to be the most important factors affecting wage growth through composition effects. In almost all Member States, upskilling had a positive contribution to wage growth, underlining the importance of higher education and life-long learning as highlighted in the European Pillar of Social Rights. In addition, in some Member States, such as Italy, Germany, Portugal and Spain, the ageing of the population also had a positive impact on wages, as working lives became longer. Finally, the recent increase in non-standard employment (part-time and temporary employment) as seen in the Netherlands, Germany or Cyprus, had a negative impact on wage growth, in particular for those earning lower wages. This shows that transitions towards open-ended contracts, as advocated in the Social Pillar, could have a positive impact on wages.

There are puzzles related to low inflation and low trend productivity growth. This paper shows that wage developments in the post-crisis period can broadly be explained by developments in inflation, productivity and unemployment. In turn, low inflation and productivity growth themselves have been puzzling to many observers. Low inflation developments have been explained by developments in energy prices and challenges inherent to the post-crisis economic environment, among other factors (ECB, 2017). In terms of longer-term, structural factors, it has been noted that inflation itself has become slower to react to measures of economic slack (Kuttner and Robinson, 2010), and that the common factor of inflation developments across countries has gained weight (Ciccarelli and Mojon, 2010).

Recessions in the wake of financial crises tend to be deeper, and recoveries slower, affecting trend productivity growth. Studies have attributed this effect to high levels of private and public debt characterising such episodes.[16] In addition, it has been noted that the current recovery has been comparatively "job-rich" which, by a mechanical effect, holds back labour productivity growth (see, e.g., in European Commission, 2015, 2016, ECB 2016). But recent analyses have also discussed possible reasons why productivity trends may not return to the fast pace observed in the middle of the 20th century and a brief period starting from the mid-1990s, including ageing, global competition, and increasing inequality (Gordon, 2010; 2012). A particular aspect of the challenges posed by ageing has come to be known as the 'secular stagnation hypothesis' (see an overview by Teulings and Baldwin, 2014).

[16] See, e.g., Abiad et al., 2009; Cerra and Saxena, 2008; Claessens et al., 2009; Reinhart and Rogoff, 2009; See also the related analysis in European Commission (2018a, Box I.1.1).

The analysis points to a number of policy conclusions. First, policies to support productivity growth in the long run, including strengthening innovation and investment, are also supportive of wage growth. Structural trends affecting investment and productivity are outside the scope of this paper, but policies extending working lives and mitigating inequality may help address some of the factors discussed in policy debates. So can policies aiming to address the legacy of the financial crisis, including mitigating the effects of debt overhang for households, financial and non-financial corporations and the public sector.

Strengthening collective bargaining can also support wage growth. The analysis suggests that some aspects of collective bargaining affect wage growth in the short run. Effective collective bargaining institutions may not only support wage growth in the short run but also improve coordination across sectors of the economy and improve the adjustment of the economy to economic shocks.

References

Abel, W., R. Burnham, and M. Corder (2016), "Wages, productivity and the changing composition of the UK workforce", *Quarterly Bulletin* 2016 Q1, pp. 12-22, Bank of England.

Abiad, A., R. Balakrishnan, P. Koeva Brooks, D. Leigh, and I. Tytell (2009), "What's the damage? Medium-term output dynamics after banking crises", IMF Working Paper 2009/245.

Acemoglu, D. (2002) "Technical Change, Inequality, and the Labour Market", *Journal of Economic Literature,* Vol. 40 (1), pp. 7-72

Aidt, T. and Z. Tzannatos (2002), "*Unions and collective bargaining: Economic effects in a global environment*", Washington, D.C.: The World Bank.

Arpaia, A. and A. Kiss (2015), "Benchmarks for the assessment of wage developments: Spring 2015", Directorate-General for Employment, Social Affairs and Inclusion.

Belfield, C., Blundell, R., Cribb, J., Hood, A. and R. Joyce (2017) "Two Decades of Income Inequality in Britain: The Role of Wages, Household Earnings and Redistribution", *Economica*, Vol. 84(334).

Bell and Blanchflower (2018), "The lack of wage growth and the falling NAIRU", NBER Working Paper No. 24502, April.

Blanchard, O. and L. F. Katz (1999), "Wage dynamics: Reconciling theory and evidence", *American Economic Review*, Papers and Proceedings, pp. 69-74.

Boeri, T. and J. van Ours (2013), "*The economics of imperfect labour markets*", Second edition, Princeton University Press.

Borjas, G. J. (1999), "The economic analysis of immigration." *Handbook of Labor Economics*, Vol. 3, Elsevier, 1697-1760.

Borjas, G. J. (2003), "The labour demand curve is downward sloping: Reexamining the impact of immigration on the labour market", *Quarterly Journal of Economics*, Vol. 118, Issue 4, 1335-1374.

Bound, J. and G. Johnson (1992). "Changes in the Structure of Wages in the 1980s: An Evaluation of Alternative Explanations", *American Economic Review*, 82(3): 371-392.

Cerra, V. and S. C. Saxena (2008), "Growth dynamics: The myth of economic recovery", *American Economic Review*, Vol 98, Issue 1, pp. 439-457.

Christopoulou, R., Jimeno, J.F. and A. Lamo (2010). "Changes in the Wage Structure in EU Countries", ECB Working Paper No. 1199, Germany.

Ciccarelli, M. and B. Mojon (2010), "Global inflation", *Review of Economics and Statistics*, Vol. 92, Issue 3, pp. 524-535.

Claessens, S., M.A. Kose and M.E. Terrones (2009), "What happens during recessions, crunches and busts?", *Economic Policy*, Vol. 24, No. 60, pp. 653-700.

Dustmann, C., T. Frattini and I.P. Preston (2013): "The effect of immigration along the distribution of wages", *Review of Economic Studies*, Vol 80, 145-173.

ECB (2016), "The employment-GDP relationship since the crisis", *ECB Economic Bulletin*, Issue 6 / 2016, European Central Bank.

ECB (2017), "Low inflation in the euro area: Causes and consequences", edited by M. Ciccarelli and C. Osbat, Occasional Paper No. 181, January, European Central Bank.

Eurofound (2015), "Pay in Europe in different wage-bargaining regimes", Publications Office of the European Union, Luxembourg.

European Commission (2011), "Labour Market Developments in Europe, 2011", Directorate-General for Economic and Financial Affairs. URL: http://ec.europa.eu/economy_finance/publications/european_economy/2011/ee2_en.htm.

European Commission (2013), "Benchmarks for the assessment of wage developments", European Economy, Occasional Papers, No. 146, European Commission.

European Commission (2015), "Labour Market and Wage Developments in Europe, 2015" Directorate-General for Employment, Social Affairs and Inclusion. URL: https://ec.europa.eu/social/main.jsp?pubId=7811&langId=en&catId=738&furtherPubs=yes&.

European Commission (2016), "Labour Market and Wage Developments in Europe, 2016" Directorate-General for Employment, Social Affairs and Inclusion. URL: https://ec.europa.eu/social/main.jsp?pubId=7935&langId=en&catId=738&furtherPubs=yes&.

European Commission (2017a): Labour market and wage developments in Europe: Annual Review 2017, Directorate-General for Employment, Social Affairs and Inclusion. URL: https://ec.europa.eu/social/main.jsp?pubId=8040&langId=en&catId=738&furtherPubs=yes&.

European Commission (2017b): European Economic Forecast, Autumn 2017, Directorate-General for Economic and Financial Affairs.

European Commission (2018a): “Labour market and wage developments in Europe, Annual Review 2018”, Directorate-General for Employment, Social Affairs and Inclusion. URL: https://ec.europa.eu/social/main.jsp?catId=738&langId=en&pubId=8139&furtherPubs=yes.

European Commission (2018b): "Country Report, The Netherlands 2018", Commission Staff Working Document, Brussels, March 7. URL: https://ec.europa.eu/info/publications/2018-european-semester-country-reports_en

European Commission (2018c): "Country Report, United Kingdom 2018", Commission Staff Working Document, Brussels, March 7. URL: https://ec.europa.eu/info/publications/2018-european-semester-country-reports_en

Gali, J. (2011), "The return of the wage Phillips curve", *Journal of the European Economic Association* 9(3), pp. 436–461.

Gordon, R.J. (2010), "Revisiting U.S. productivity growth over the past century with a view of the future", NBER Working Paper 15834.

Gordon, R.J. (2012), "Is U.S. economic growth over? Faltering innovation confronts the six headwinds", NBER Working Paper 18315.

Hong, G. H., Z. Koczan, W. Lian, and M. Nabar (2018), "More slack than meets the eye? Recent wage dynamics in advanced economies", IMF Working paper 2018/50.

IMF (2017): "Recent wage dynamics in advanced economies: Drivers and Implications", Chapter 2 of World Economic Outlook, October 2017, International Monetary Fund.

Kuttner, K. and T. Robinson (2010), "Understanding the flattening Phillips curve", *North American Journal of Economics and Finance*, Vol. 21, pp. 110-125.

Machado, J. and J. Mata (2005). "Counterfactual decomposition of changes in wage distributions using quantile regression", *Journal of Applied Econometrics*, Vol. 20, Issue 4.

OECD (1997), "Employment Outlook", Paris, Organisation for Economic Cooperation and Development.

OECD (2018), "Employment Outlook", Paris, Organisation for Economic Cooperation and Development.

Portugal, P., Raposo, P.S. and R. Heis (2018). "The distribution of wages and wage inequality", Working paper.

Reed, W. R. (2015), "On the practice of lagging variables to avoid simultaneity", *Oxford Bulletin of Economics and Statistics*, Vol. 77, Issue 6, 897-905.

Reinhart, C.M. and K.S. Rogoff (2009), "The aftermath of financial crises", *American Economic Review: Papers and Proceedings*, Vol 99, Issue 2, pp. 466-472.

Schwellnus, C., A. Kappeler, and P.-A. Pionnier (2017), "Decoupling of wages from productivity: Macro-level facts", OECD Economics Department Working Papers No. 1373.

Teulings, C. and R. Baldwin (2014), "Secular stagnation: Facts, causes, and cures – a new Vox eBook", URL: https://voxeu.org/article/secular-stagnation-facts-causes-and-cures-new-vox-ebook.

Visser, J. (2015), "The Institutional Characteristics of Trade Unions, Wage Setting, State Intervention and Social Pacts." ICTWSS Database, version 5.0. Amsterdam institute for Advanced Labour Studies, Amsterdam, http://www.aias-uvanet.nl.

Annex: Additional tables

Table A.1: Determinants of wage growth in various country groups, 1995-2017

Dependent variable: Growth rate of gross wages and salaries per employee	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Euro area 19			Euro area 12			Eastern Member States 11		
Unemployment rate	-0.126***	-0.323***	-0.314***	-0.125***	-0.358***	-0.329***	-0.371***	-0.546***	-0.824***
	(0.036)	(0.063)	(0.067)	(0.034)	(0.043)	(0.054)	(0.074)	(0.129)	(0.169)
Change in the unemployment rate	-0.675***	-0.610**	-0.643***	-0.210	-0.114	-0.181	-0.740**	-0.618**	-0.244
	(0.232)	(0.223)	(0.219)	(0.153)	(0.205)	(0.245)	(0.276)	(0.255)	(0.213)
Inflation rate	1.081***	0.913***	1.099***	0.665***	0.260**	0.550**	0.932***	0.920***	0.657**
	(0.172)	(0.156)	(0.124)	(0.137)	(0.113)	(0.185)	(0.175)	(0.156)	(0.210)
Trend productivity growth	0.935***	0.674***	0.736**	0.741***	0.876***	0.839***	1.089***	0.958**	1.093*
	(0.152)	(0.233)	(0.312)	(0.125)	(0.154)	(0.215)	(0.277)	(0.333)	(0.534)
Constant (presented if no country effects)	0.007*	.	.	0.015**	.	.	0.036***	.	.
	(0.004)	(.)	(.)	(0.005)	(.)	(.)	(0.010)	(.)	(.)
Country effects	no	yes	yes	no	yes	yes	no	yes	yes
Year effects	no	no	yes	no	no	yes	no	no	yes
Observations	407	407	407	269	269	269	205	205	205
R-squared	0.647	0.698	0.737	0.479	0.602	0.651	0.590	0.625	0.711

Notes: (1) Ordinary least squares estimations with appropriate dummy variables. Annual data. (2) Trend productivity growth is defined as the five-year trailing average of labour productivity growth rate. (3) Clustered standard errors in parentheses. Asterisks mark estimated coefficients which are statistically significant at the 10% (*), 5% (**) or the 1% level (***). (4) The country group "euro area 12" includes the first 12 members of the monetary union: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal and Spain. The country group "Eastern Member States 11" includes Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia.

Source: Own calculations based on Eurostat data.

Table A.2: Determinants of gross wage growth: Specifications with alternative measures of labour market reserves, EU28

Sample period:	(1) 1995-2017	(2) 2010-2017	(3) 2005-2017	(4) 2010-2017	(5) 1995-2017	(6) 2010-2017	(7) 2005-2017	(8) 2010-2017
Dependent variable: Growth rate of gross wages and salaries per employee								
Unemployment rate	-0.374***	-0.422**	-0.389***	-0.315**				
	(0.076)	(0.173)	(0.116)	(0.135)				
Change in unemployment rate	-0.389*	-0.128	-0.552**	-0.204				
	(0.198)	(0.237)	(0.253)	(0.203)				
Underemployed part-time workers, % labour force	0.073	0.248						
	(0.106)	(0.306)						
Those available but not seeking a job, % labour force			-0.073	-0.286				
			(0.163)	(0.387)				
Labour slack A: unemployment and underemployment					-0.253***	-0.284***		
					(0.042)	(0.098)		
Change in labour slack A					-0.450**	-0.250		
					(0.207)	(0.149)		
Labour slack B: unemployed, underemployed, available t							-0.291***	-0.251***
							(0.060)	(0.084)
Change in labour slack B							-0.448**	-0.177
							(0.192)	(0.146)
Inflation rate	0.645***	0.239	0.465***	0.234*	0.605***	0.220	0.420***	0.222
	(0.088)	(0.151)	(0.111)	(0.136)	(0.087)	(0.135)	(0.121)	(0.138)
Trend productivity growth	1.144***	0.728**	1.277***	0.676**	1.121***	0.628*	1.093***	0.610*
	(0.137)	(0.311)	(0.273)	(0.324)	(0.138)	(0.319)	(0.233)	(0.327)
Country effects	yes	yes	yes	yes	yes	yes	yes	yes
Year effects	no	no	no	no	no	no	no	no
Observations	569	223	349	220	558	222	316	217
R-squared	0.665	0.624	0.647	0.625	0.664	0.618	0.617	0.617

Notes: (1) Ordinary least squares estimations with appropriate dummy variables. Annual data. (2) Trend productivity growth is defined as the five-year trailing average of labour productivity growth rate. (3) Clustered standard errors in parentheses. Asterisks mark estimated coefficients which are statistically significant at the 10% (*), 5% (**) or the 1% level (***). (4) The variable on those available for work but not seeking is available only from 2005.

Source: Own calculations based on Eurostat data.

Table A.3: Determinants of gross wage growth: Specifications with demographic variables, EU28, 1995-2017

Sample period: 1995-2017 Dependent variable: Growth rate of gross wages and salaries per employee	(1) Net migration rate	(2)	(3) Trend net migration rate	(4)	(5) Older and young workers	(6)
Unemployment rate	-0.123*** (0.042)	-0.305*** (0.074)	-0.128*** (0.040)	-0.293*** (0.074)	-0.186*** (0.042)	-0.359*** (0.064)
Change in the unemployment rate	-0.660** (0.238)	-0.596** (0.220)	-0.667*** (0.227)	-0.667*** (0.236)	-0.483** (0.185)	-0.400** (0.191)
Inflation rate	0.983*** (0.175)	0.840*** (0.163)	1.049*** (0.173)	0.873*** (0.183)	0.786*** (0.081)	0.648*** (0.095)
Trend productivity growth	1.037*** (0.220)	0.824*** (0.289)	0.976*** (0.193)	0.762*** (0.260)	1.251*** (0.112)	1.165*** (0.194)
Crude rate of net migration (rescaled, per 100 inhabitants)	0.001 (0.004)	0.005 (0.003)				
Trend of crude rate of net migration (rescaled, per 100 inhabitants)			-0.001 (0.004)	0.009* (0.005)		
Difference between the share of older (55-64) and young (20-29) workers in the labour force					0.065** (0.031)	0.018 (0.056)
Constant (if no country effects)	0.007 (0.005)	. (.)	0.008 (0.005)	. (.)	0.019*** (0.004)	. (.)
Country effects	no	yes	no	yes	no	yes
Year effects	no	no	no	no	no	no
Observations	480	480	468	468	576	576
R-squared	0.618	0.657	0.585	0.630	0.626	0.664

Notes: (1) Ordinary least squares estimations with appropriate dummy variables. Annual data for a panel of 28 EU Member States. (2) Trend productivity growth is defined as the five-year trailing average of labour productivity growth rate. (3) Clustered standard errors in parentheses. Asterisks mark estimated coefficients which are statistically significant at the 10% (*), 5% (**) or the 1% level (***). (4) The "crude rate of net migration plus adjustment" is defined by Eurostat as the ratio of net migration (including statistical adjustment) during the year to the average population in that year. The value is rescaled in this analysis to be expressed per 100 inhabitants. (5) "Trend of crude rate of net migration" is defined as the five-year trailing average of the "crude rate of net migration". Bulgaria, Hungary, Poland and Slovakia were excluded from regressions involving the variable "crude rate of net migration. For these countries, the variable likely does not capture the magnitude of outward migration. For more information on these statistics see the analysis by European Commission (2015).

Source: Own calculations based on Eurostat data.

Table A.4: Determinants of gross wage growth: Specifications with institutional variables related to collective bargaining, EU28

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Change in collective bargaing coverage				Change in union density			
Sample period:	1995-2017		2010-2017		1995-2017		2010-2017	
Dependent variable: Growth rate of gross wages and salaries per employee								
Unemployment rate	-0.167***	-0.387***	-0.223***	-0.460***	-0.169***	-0.383***	-0.226***	-0.465***
	(0.045)	(0.067)	(0.047)	(0.157)	(0.039)	(0.065)	(0.054)	(0.163)
Change in unemployment rate	-0.590**	-0.494*	-0.275	-0.109	-0.539**	-0.436**	-0.337*	-0.131
	(0.246)	(0.252)	(0.192)	(0.167)	(0.211)	(0.206)	(0.189)	(0.209)
Inflation rate	0.799***	0.560***	0.470***	0.223	0.978***	0.873***	0.485***	0.232
	(0.102)	(0.123)	(0.111)	(0.134)	(0.123)	(0.125)	(0.131)	(0.186)
Trend productivity growth	1.209***	1.183***	1.181***	0.513**	1.014***	0.866***	1.082***	0.520
	(0.136)	(0.151)	(0.247)	(0.248)	(0.174)	(0.262)	(0.261)	(0.312)
Change in collective bargaining coverage	0.103***	0.098***	0.143***	0.158***				
	(0.036)	(0.033)	(0.019)	(0.019)				
Change in union density					0.033	-0.008	0.495**	0.185
					(0.274)	(0.297)	(0.228)	(0.262)
Constant	0.013***	.	0.027***	.	0.011***	.	0.028***	.
	(0.004)	(.)	(0.004)	(.)	(0.004)	(.)	(0.004)	(.)
Counry effects	no	yes	no	yes	no	yes	no	yes
Year effects	no	no	no	no	no	no	no	no
Observations	465	465	150	150	516	516	158	158
R-squared	0.598	0.655	0.510	0.720	0.628	0.664	0.407	0.621

Notes: (1) Ordinary least squares estimations with appropriate dummy variables. Annual data for a panel of 28 EU Member States. (2) Trend productivity growth is defined as the five-year trailing average of labour productivity growth rate. (3) Clustered standard errors in parentheses. Asterisks mark estimated coefficients which are statistically significant at the 10% (*), 5% (**) or the 1% level (***). (4) Information on "Collective bargaining coverage" and "Union density" were combined from OECD Statistics and Visser (2015). Missing values are approximated by linear interpolation.

Source: Own calculations based on Eurostat data.