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## Understanding low wage growth in the euro area and European countries

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# Contents

# Abstract

Despite notable improvements in the labour market since 2013, wage growth in the euro area was subdued and substantially overpredicted in 2013-17. This paper summarises the findings of an ESCB expert group on the reasons for low wage growth and provides comparable analyses on wage developments in the euro area as a whole and in individual EU countries. The paper finds that cyclical drivers, as captured by a standard Phillips curve, seem to explain much of the weakness in wage growth during this period, but not all of it. Going beyond the drivers included in standard Phillips curves, other factors are also found to have played a role, such as compositional effects, the possible non-linear reaction of wage growth to cyclical improvements, and structural and institutional factors. In order to increase the robustness of wage forecasts, the paper also proposes ready-to-use tools for cross-checking euro area wage growth forecasts based on wage Phillips curves. These are derived based on a comprehensive real-time forecast evaluation exercise.

**Keywords:** Wages, business cycles, structural factors, forecasting

**JEL codes:** J30, E24, E31, E32

# Executive summary

Why was wage growth so weak and overpredicted in the euro area?

**Despite notable improvements in the euro area labour market since 2013, wage growth was subdued and substantially overpredicted in 2013-17.** This provided the motivation for setting up the Working Group of Forecasting (WGF) expert group on low wage growth (Wage Expert Group – WEG). This Occasional Paper summarises the WEG's findings and provides comparable analyses on wage developments in the euro area as a whole and in individual EU countries.

**Cyclical drivers, as captured by a standard Phillips curve, seem to explain much of the weakness in wage growth during this period, but not all of it.** The combination of the amount of slack in the labour market, low inflation readings and subdued productivity growth kept a lid on wage growth. Besides conventional measures of slack, broader measures of labour underutilisation and a composite indicator of slack in the labour market brought some marginal gains in explaining the subdued wage growth. Regarding inflation expectations, the findings seem to suggest that, for the euro area, the backward-looking component has been relatively more important and the low inflation regime has acted as a drag on wage growth.

**Going beyond the drivers of standard Phillips curves, other factors have also contributed to the low wage growth.** First, compositional effects linked mainly to age and education contributed to the muted reaction of wage growth to cyclical developments. Second, there is some evidence of non-linearities in the reaction of wage growth to slack, i.e. wage growth seems to be more sensitive to cyclical conditions when the economy is booming and less so when it is not growing above potential. Third, from a structural perspective low wage growth in the euro area was also related to negative contributions of technological shocks and wage or bargaining shocks, which could reflect broader phenomena such as persistent weak productivity growth or the adoption of structural reforms in several euro area labour markets, affecting the negotiating power of employees. Fourth, trend wage growth appears to have moved somewhat downwards, reflecting secular movements in inflation and productivity growth. This holds true not only for the euro area, but also across countries, although these movements depend on the assumptions of the underlying models. Trend wage growth is also related to structural forces such as demographic change, digitalisation, globalisation and migration, as well as institutional factors (linked to wage bargaining or structural reforms). However, the findings do not point to conclusive evidence that these factors were the main culprits for the period of low wage growth in the euro area.

**The country dimension is crucial to understanding the drivers of euro area wage growth.** The wage formation process is still a national phenomenon that is driven by institutional set-up, tradition, preferences and policy responses to the Great Recession. This means that various drivers of wage growth have played different roles in each country and, more precisely, that there have been significant differences when it comes to which measure of slack matters more, which kind of inflation expectation (backward or forward-looking) is more relevant, and even which wage measure to look

at. Lessons derived from cross-country analyses take all these country-specific idiosyncrasies into account.

… and what can be done about it?

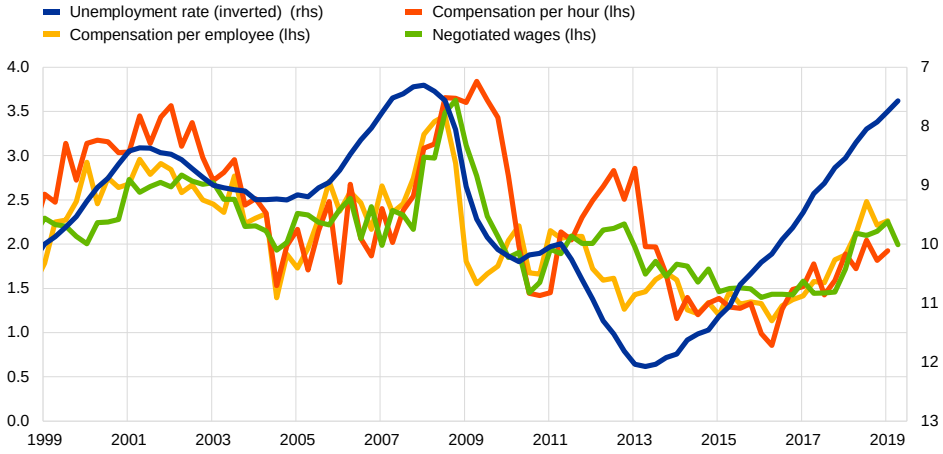
**A comprehensive real-time forecast evaluation exercise yielded valuable ready-to-use tools for cross-checking euro area wage growth forecasts.** This Occasional Paper highlights a set of Phillips curve specifications that seem to represent suitable cross-checking tools for medium-term wage forecasts for the euro area. The well-performing specifications identified are all relatively straightforward – with most of them relying on the unemployment rate as a measure of slack.

# 1 Introduction

**The euro area labour market improved strongly from 2013 onwards, while wage growth remained subdued until recently.** From the second quarter of 2013 to the first quarter of 2019, the unemployment rate in the euro area decreased from 12.1% to 7.7%. 10.8 million jobs were created in this period and many more people are now in employment than before the crisis. Wages, on the other hand, barely grew from 2013 to 2017, and wage growth has picked up only recently (see Chart 1). This observation holds true regardless of how nominal wage growth is measured or defined.

**Chart 1**
Measures of wage growth over the cycle

(left-hand scale: annual rates of change; right-hand scale: percentage of the labour force)

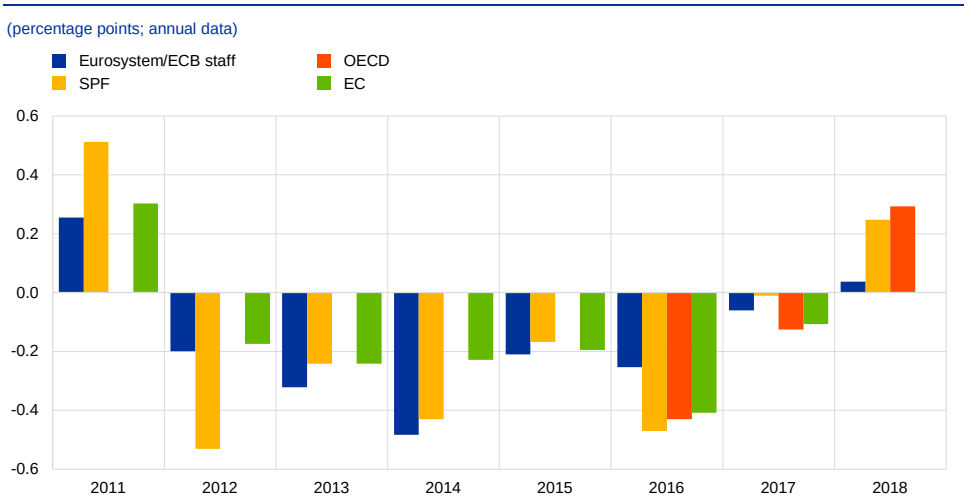



Sources: Eurostat, national statistical offices, NCB and ECB staff calculations.
Note: Latest observation: Q2 2019 for unemployment rate and negotiated wages and Q1 2019 for the rest.

**At the same time, wage growth was persistently and substantially overpredicted by international institutions and professional forecasters (see Chart 2), while employment grew more strongly than expected.** This raised concerns over whether the relationship between slack and wage growth had changed. Overpredicting wage growth was a widespread phenomenon in this period, also affecting other jurisdictions.

**Chart 2**

Wage forecast error comparison across different forecasters for one calendar year ahead (autumn forecasts)




Sources: Eurostat, Eurosystem/ECB calculations, ECB Survey of Professional Forecasters (SPF), OECD and European Commission (data included as available – e.g. OECD forecast data only available from 2016 onwards).

**These two conundrums – the disconnect between wage growth and the labour market recovery and the overprediction of wage growth – led to the establishment of an ESCB Wage Expert Group (WEG); this Occasional Paper highlights the main findings of this group.** As there is no such thing as a homogenous euro area labour market, the work of the group built on joint analyses and collaborative efforts of ESCB wage experts for each country. The strong country heterogeneity of labour markets across euro area countries and the far-reaching differences in economic and institutional forces behind the wage formation process mean that national experts have a crucial role to play in any attempt to understand wage developments in the euro area.

**The apparent disconnect between the strong decline in the unemployment rate and the low wage growth has led observers to question whether Phillips curve-type mechanisms are still alive in the euro area and EU countries.** Such a weakening of the relationship would imply that wage growth would not rise despite a continuously improving labour market, with implications for the pass-through of wage growth to inflation and, eventually, for monetary policy.

**This paper argues that cyclical drivers, as captured by a standard Phillips curve, seem to explain much of the weakness in wage growth during 2013-17.** A combination of slack in the labour market, low inflation readings and subdued productivity growth kept a lid on wage growth. Besides conventional measures of slack, broader measures of labour underutilisation and a composite indicator of slack in the labour market brought some marginal gains in explaining the subdued wage growth. Regarding inflation expectations, the findings suggest that, for the euro area, the backward-looking component might have been relatively more important and the low inflation regime acted as a drag on wage growth.

**Across countries there is considerable heterogeneity in the cyclical factors driving wage growth developments over the period from 2013 to 2017.** However, for most countries a combination of considerable labour market slack, low productivity growth and below-average inflation (and, potentially, inflation expectations) kept wage growth subdued. Nevertheless, country idiosyncrasies play an important role in the analyses when it comes to which measure of slack matters more, which kind of inflation expectation (backward- or forward-looking) is more relevant or even which wage measure to consider.

**However, standard Phillips curve-type mechanisms do not paint the entire picture, given sizeable residuals in the euro area as a whole and certain euro area countries in particular, especially in the period from 2016 to 2017.** This paper looks at factors beyond the standard Phillips curve mechanisms to shed some light on what else could have contributed to the period of low wage growth.

**Detailed analyses based on micro data find that substantial changes in the composition of the workforce contributed to low wage growth in the euro area.** Such compositional effects are assessed for every country in the euro area based on the best available harmonised set of micro data for EU countries – the Statistics on Income and Living Conditions (EU-SILC). The results suggest that composition effects especially based on age and education/skills pushed up wage growth in the euro area early in the crisis, but the effect decreased and thereby contributed to a relatively muted response of aggregate wage growth to cyclical improvements. This finding proves robust across a broad range of different specifications tested, despite strong cross-country heterogeneity.

**There is some evidence of non-linearities in the reaction of wage growth to slack.** One explanation for subdued low wage growth could be related to possible non-linearities in the Phillips curve. Empirical evidence presented in this paper seems to suggest that, during the low wage growth period, the Phillips curve was relatively flat compared with previous periods, suggesting that wage growth reacted less strongly to labour market conditions and that the relationship is therefore non-linear.

**From a more structural perspective, low wage growth in recent years can be explained mainly by technology and wage bargaining shocks.** In contrast to a reduced-form Phillips curve analysis, in a structural model it is possible to disentangle the main underlying economic shocks driving wage growth. While the negative influence of domestic demand and oil supply shocks has stalled since 2016, technology and wage bargaining shocks have continued to put a drag on wage growth until recently. This could reflect more general and broader phenomena that are difficult to capture in a reduced-form Phillips curve model, such as persistent weak productivity growth developments or the adoption of structural reforms, impacting the negotiating power of employees.

**Beyond cyclical factors, changes in the trend component of wage growth might also have contributed to low wage growth.** The analysis of trends is surrounded by a fair amount of uncertainty, but all available results in this paper point to some downward movement in trend wage growth during the low wage growth period. This can be linked to declines in trend inflation and trend productivity growth, although

these movements depend on the assumptions of the underlying models. The developments in trend inflation are in line with findings in Ciccarelli and Osbat (2017) showing that, over the period 2012-15, measures of trend inflation declined and inflation persistence increased. The productivity growth slowdown is a global tendency which can be linked to structural economic changes, such as the deceleration in the rate of technological progress and diffusion and declines in business dynamism.

**Based on the available evidence, the effects of structural drivers on wage growth are not clear cut, but they do not appear to be the main reason behind the period of low wage growth in the euro area.** While the potential impact of globalisation on wage growth is difficult to measure empirically, we find only limited support for including measures of global labour market slack in Phillips curve analyses of wage growth in the euro area. Ageing should have had a positive effect on wage growth in recent years, therefore it seems unlikely to have been a contributing factor to low wage growth in the euro area. The effects of migration on wage growth are very difficult to disentangle from other forces, but they seem to have played a role in low wage growth in some euro area countries, such as Germany. Finally, there is also no evidence so far that digitalisation has been a major contributing factor to subdued wage growth over recent years.

**A comprehensive real-time forecast evaluation exercise yielded valuable ready-to-use tools for cross-checking euro area wage growth forecasts.** As wage growth has not only been low, but also substantially overpredicted, cross-checking tools for wage forecasts need to be developed. To this end, this Occasional Paper identifies a set of Phillips curve specifications that seem to represent suitable cross-checking tools for medium-term wage forecasts for the euro area and illustrates their forecasting performance in real time. The well-performing specifications identified are all relatively straightforward, with most of them relying on the unemployment rate as a measure of slack.

**Overall, this Occasional Paper presents in-depth analyses of the drivers of the low wage growth period from 2013 to 2017, based on a consistent methodology, across both the euro area as a whole and individual countries.** Section 2 explores the extent to which low wage growth can be explained with the help of a standard wage Phillips curve. Section 3 moves on to consider factors beyond such a standard Phillips curve, including compositional effects, non-linearities and structural and institutional factors. Section 4 develops cross-checking tools for wage forecasts based on a comprehensive real-time forecasting exercise. Section 5 presents some conclusions.

# 2 Exploring wage growth through the lens of a standard wage Phillips curve

The Phillips curve is still the most widely used model to link the cyclical condition of the labour market to wage developments. First, this section shows that in the euro area and in most EU countries Phillips curve-type mechanisms are at play, though there is considerable variation across countries. Second, it investigates the relative importance of the standard wage growth drivers within a Phillips curve set-up, namely the cyclical position of the labour market, productivity growth and inflation expectations. Finally, this section sheds light on the role of two unobservable variables: slack and inflation expectations. It provides insights into whether unconventional slack measures better explain the period of low wage growth in the euro area and investigates whether wage formation is more backward or more forward-looking.

## 2.1 The role of slack, productivity growth and inflation expectations in wage growth

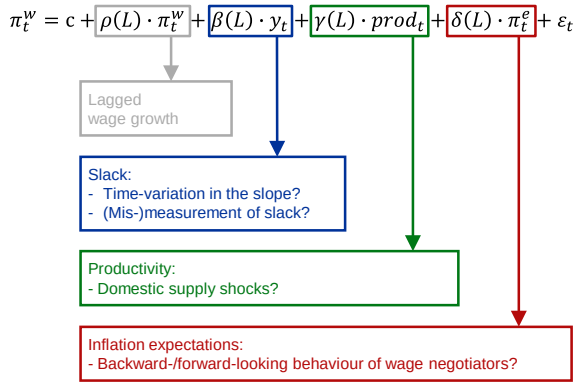
**The workhorse model for investigating the cyclical drivers of wage growth is the wage Phillips curve.**[1] The cyclical drivers typically included in the Phillips curve are the cyclical stance of the economy (so-called slack), inflation expectations and productivity growth developments. In practice the functional form of the wage Phillips curve (for example in terms of lag structure or linearity versus non-linearity) and the chosen determinants remain subject to discussion.[2] To address this model uncertainty, a large set of proxies for the labour market stance and inflation expectations is used in what is known as a "thick modelling" approach.[3] The degree of slack in the labour market and inflation expectations are unobservable variables. Using a comprehensive approach where many possible indicators are considered can mitigate the risk of not capturing the "true" wage drivers and avoid randomness or selection biases. Such an approach also allows cross-country idiosyncrasies to be evaluated, where various drivers might affect wage growth differently. The set-up follows a standard wage Phillips curve such as the one used by Galí (2011), augmented with productivity growth.[4] The specification used is as follows:

1 The original article by William Phillips (1958) was indeed a wage Phillips curve and linked "money wage rates" to unemployment. Later, this approach was adapted to a model linking inflation and unemployment by Samuelson and Solow (1960).

2 See Bobeica and Sokol (2019) for a detailed description of model uncertainties in Phillips curves.

3 See Granger and Jeon (2004).

4 The link between wage growth and productivity growth is more thoroughly discussed in Section 3.




$\pi_t^w$ is the growth rate of the considered wage measure, $y_t$ is an indicator reflecting the cyclical position of the labour market, $prod_t$ is the growth rate of the relevant labour productivity measure and $\pi_t^e$ captures inflation expectations. The chosen lag structure reflects goodness-of-fit criteria and can vary from country to country.

The following labour market indicators are considered, with the headline unemployment rate and its gap deemed to be "conventional" measures of labour market slack, while broader measures of unemployment are deemed to be more "unconventional".

*Conventional labour market stance measures:*

1. Unemployment rate (UR)
2. Model-based unemployment gap
3. European Commission (EC) unemployment gap
4. IMF unemployment gap
5. OECD unemployment gap
6. Unobserved Component Model (UCM) unemployment gap

*Unconventional labour market stance measures:*

1. Short term UR
2. Broad UR
3. Broad UR gap
4. The rate of unemployed and underemployed
5. Underemployment rate
6. Narrow broad UR
7. UCM narrow broad UR
8. UCM intensive margin gap

9. Labour shortage

10. UCM participation rate gap

11. Dynamic Factor Model (DFM) composite indicator.

The following measures are used to capture backward- and forward-looking inflation expectations.[5]

*Backward-looking inflation expectations:*

1. Average of the past four quarters of annual headline inflation.

2. - 6. Average of the past four quarters of annualized quarterly rate of HICP, HICP excluding energy and food, HICP excluding energy, GDP deflator and the private consumption deflator, respectively.

*Forward-looking inflation expectations:*

1. DG ECFIN consumer survey annual growth rate of balance of responses for price trends over the next 12 months.

2. - 6. Consensus expectations with a horizon from two to seven quarters ahead, respectively.

7. - 8. SPF one and two year ahead, respectively.

For the euro area, among all possible specifications a simple model using the headline unemployment rate and backward-looking inflation expectations was chosen to benchmark subsequent results. This model has the advantage of alleviating concerns regarding the estimation of a structural level of unemployment and it also fares well in forecasting (as will be shown in Section 4 ). The model is as follows:

$$\pi_t^w = c + \rho \cdot \pi_{t-1}^w + \beta \cdot UR_{t-1} + \gamma \cdot prod_t + \alpha \cdot pastinfl_t + \varepsilon_t \quad (1)$$

where the annualised quarterly growth rate of compensation per employee $\pi_t^w$ is regressed on a constant $c$, its own lag, the lagged unemployment rate $UR_{t-1}$, annualised quarterly productivity growth per employee $prod_t$ and the 4-quarters moving average of previous year-on-year inflation rates $pastinfl_t$ ; $\varepsilon_t$ denotes the residual.

More than 200 Phillips curve specifications for the euro area are estimated by ordinary least square (OLS).[6] The headline indicator for wage growth in the euro area used

[5] Market-based measures of inflation expectations were not considered because they only start to be available in the euro area from around 2005.

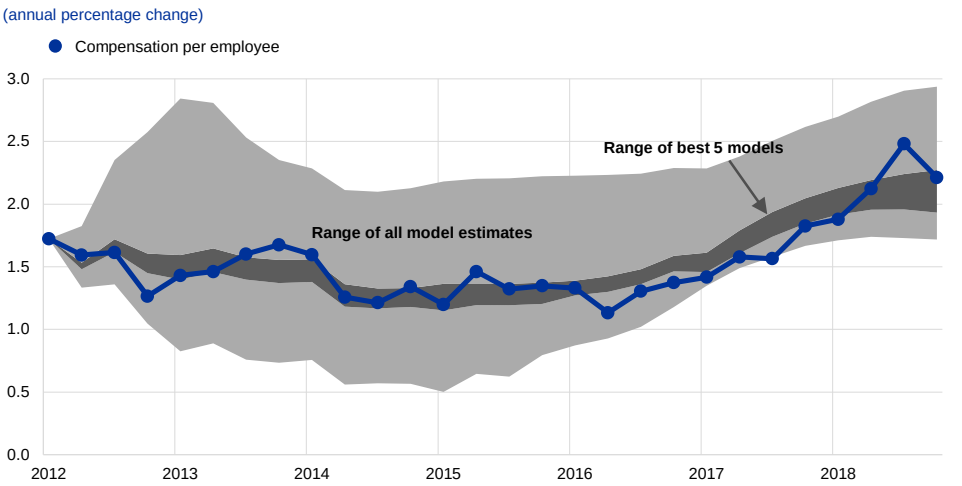
[6] This analysis has some limitations that are similar to those found in other reduced-form type models. For example, it does not distinguish between the underlying economic shocks driving the different regressors (see also McLeay and Tenreyro (2019) for a broader discussion of this issue). Section 3 takes this into account by also discussing results based on a structural VAR.

here is compensation per employee and most of the subsequent results and discussions will focus on this measure.[7]

**Ex post and despite high model uncertainty, wage dynamics in the euro area can be reconciled with the transmission mechanism embedded in economic drivers of a standard wage Phillips curve.** The range in chart 3 shows the out-of-sample forecasts conditional on the actual behaviour of the explanatory variables. Overall, the growth rate of compensation per employee lies well within the range of Phillips curve specifications and hence is in line with developments in its fundamentals over the analysed period. The range of estimates is relatively large though, pointing to high model uncertainty.

**Chart 3**

Actual wage growth versus range predicted by Phillips curve thick modelling




Sources: ECB calculations.
Notes: The range includes out-of-sample dynamic forecasts conditional on the actual outcomes of the labour market indicators, labour productivity and inflation expectations. The estimation sample is Q1 1995 to Q1 2012. Among all possible specifications, only the plausible were considered, based on the statistical significance of the slope and on the plausibility of the sign of the explanatory variables. The best five models were chosen based on their explanatory power over the period shown in the chart. Latest observation: Q4 2018.

**Actual wage growth was closer to the lower end of the Phillips curve range, especially in 2016-17, suggesting that factors beyond those in a standard Phillips curve set-up are playing a role.** The negative residuals suggest that even the best-performing standard Phillips curve models cannot fully explain wage growth developments in that period. Hence, other factors might have also contributed to the period of subdued wage growth, such as mismeasurement of the amount of slack (see Section 2.2), compositional effects, a change in trend wage growth, changes in country-specific institutional settings (e.g. the decline in collective bargaining coverage), the impact of structural factors (such as immigration and globalisation) or, more generally, other factors that may have led to changes in the relationship between

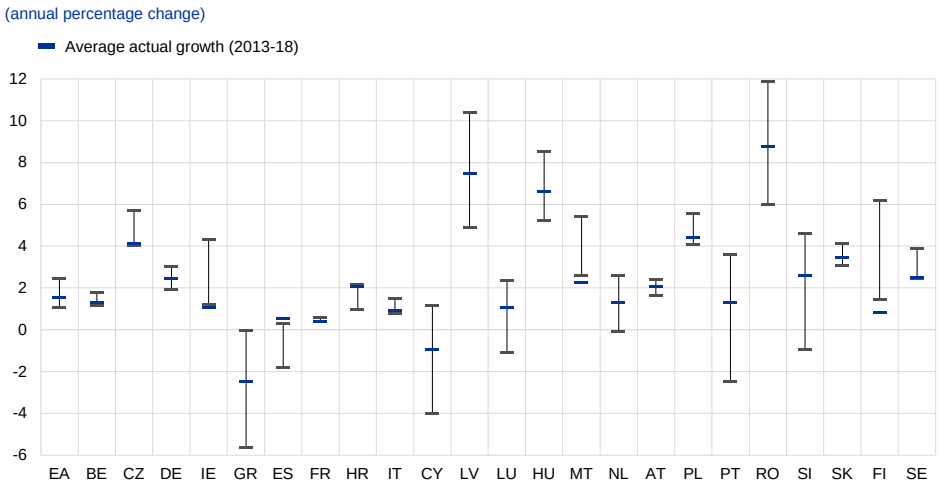
7 Nevertheless, robustness tests are performed by employing other indicators of wage growth like overall compensation per hour, compensation per hour and per employee in the private sector, and wages and salaries for the total economy and the private sector.

wage growth and labour market slack (see Section 3).[8] More recently, actual wage growth developments have been hovering in the middle of the range.

**Across individual countries, wage growth dynamics can be broadly reconciled with Phillips curve-type mechanisms when considering the country-specific selected Phillips curve specifications.** Table 1 demonstrates the diversity of selected specifications for each country. The selection of the country specification was based on a broad set of criteria whose importance varies across countries. These criteria included the economic plausibility of the sign of the coefficients, the statistical significance of the coefficients if deemed necessary by the respective NCB, good in-sample forecasting performance and expert knowledge.[9] The choice of the wage measure is based on the best reflection of the labour market stance (good in or out-of-sample fit), data quality issues and various administrative measures taken during the analysed period. Chart 4 shows that, for most countries, the average wage growth rate lies within the Phillips curve implied range over the analysed period.[10]

**Chart 4**

Average wage growth versus average Phillips curve forecast range for the period 2013-18




Sources: Eurostat, ECB and NCB calculations.
Notes: Wage measure = selected wage measure for each country. Phillips curve forecast range reflects the forecast of the selected wage measure based on plausible specifications. The number of plausible specifications varies from 4 to 255 by countries. CY forecast range spans from 2015 to 2018. The moments have been computed in each period and could reflect different specifications.

8 Other more country-specific factors might include working time developments, the impact of the sectoral shift towards services and legislative changes.

9 The specifications were chosen by the NCBs to best reflect wage growth developments during the period under review. This does not necessarily imply that these specifications will remain the ones the NCBs choose in future.

10 It is noteworthy that the width of the forecast range and, by consequence, the comparison with the average actual wage growth depends on the number of specifications assessed as plausible by each NCB.

**Table 1**

Phillips curve specification as selected by participating national central bank (NCB)

| Country | Selected wage measure | Slack | Inflation expectations | Country-specific relevant factor (of which some are included in the selected Phillips curves) |
|---|---|---|---|---|
| BE | Negotiated wages | Unemployment gap | Backward -looking | Wage moderation policies |
| CZ | Wage in market sector | Labour Utilization Composite Index | Forward-looking | |
| DE | Negotiated wages | UR | Forward-looking | Net immigration |
| IE | Hourly earnings | Unemployment gap | Backward- looking | Labour force, exchange rate |
| GR | Compensation per employee (LFS) | Unemployment gap (OECD) | Backward-looking | Austerity measures and labour market structural reforms |
| ES | Compensation per employee in the market economy | Unemployment gap | Backward-looking | |
| FR | Wages in private sector | UR | Backward-looking | Minimum wage |
| HR | Average nominal gross wages | Output gap | Backward- looking | |
| IT | Hourly wages in the private sector (excluding energy and agriculture) | Broad UR | Forward-looking | |
| CY | Compensation per employee | Real GDP | Backward- looking | Labour market reforms and transitory effects |
| LV | Compensation per employee | Unemployment gap (European Commission) | Forward-looking | Minimum wage |
| LU | Compensation per hour | Broad UR | Backward- looking | Indexation |
| HU | Gross average wages in the private sector | UR | Backward- looking | Administrative measures (e.g. minimum wage) |
| MT | Compensation per employee | Broad UR | Backward- looking | Migration |
| NL | Compensation per employee | Unemployment gap (European Commission) | Backward- looking | |
| AT | Compensation per employee | Broad UR | Backward- looking | |
| PL | Average monthly gross wages and salaries (corrected for tax changes) | Unemployment gap | Backward- looking | Immigration |
| PT | Compensation per employee (private) | Capacity utilisation | Backward- looking | Administrative measures (e.g. minimum wage) |
| RO | Private sector wages | Unemployment gap | Backward- looking | Administrative measures |
| SI | Compensation per employee (private) | Short term UR | Backward- looking | |
| SK | Compensation per employee | Common DFM cycle | Backward- looking | Migration |
| FI | Compensation per employee | Unemployment gap | Forward-looking | |
| SE | Short-term wage statistics | Resource utilisation indicator (NCB estimate) | Forward-looking | |

Sources: NCBs.
Notes: The country-specific selected Phillips curves are based on a broad set of criteria, the importance of which varies across countries. These criteria included the economic plausibility of the economic sign of the coefficients, the statistical significance of the coefficients if deemed necessary by the respective NCB, good in-sample forecasting performance, as well as expert knowledge. Some countries ran the regressions in year-on-year terms instead of quarter-on-quarter annualised terms.

## Box 1

### What drives wages in the central and eastern European (CEE) countries in the EU? A Phillips curve approach

**Prepared by P. Lopez-Garcia, I. Pablos Nuevo and T. Zumer (ECB)**[11]

**To explore the determinants of wage growth in the CEE EU countries, we estimate a standard reduced form wage Phillips curve in a panel framework, using macro and micro-based data.** The analysis focuses on the entire CEE region (i.e. 11 EU countries, consisting of six non-euro area and five euro area countries) in order to capture developments in a large and homogenous group of countries. If possible, non-CEE euro area results are shown for comparison in the micro analysis. The macro wage Phillips curves panels are estimated by regressing wage growth on labour market slack (measured as the unemployment gap), past inflation and labour productivity growth. In order to capture the possible impact of emigration flows observed across the CEE EU countries, the baseline specification is subsequently augmented by working age population growth. Other extensions of the Phillips curve include minimum wage growth as an additional factor pushing up wages.

**Wage growth in the CEE EU countries can be explained by the determinants in the Phillips curve context; the responsiveness of wages to labour market slack has declined in the post-crisis period (see Table A).** Compared with the euro area, in the CEE EU countries wage growth is more responsive to the level of slack (hence a steeper Phillips curve) and past inflation. However, in the post-crisis period the Phillips curve has also flattened in the CEE EU countries. In the augmented baseline specification we find that changes in working age population are indeed significantly negatively correlated with wage growth across the CEE EU countries (see Table A, column 4). The fact that the reduction in the working age population was associated with increasing wage growth is supported by the evidence of large emigration from the CEE EU countries, adverse demographics and labour shortages that were reported in this period. Furthermore, we find that increases in minimum wages have a positive impact on total economy wage growth, although the estimated impact is small.

[11] Comments by E. Bobeica and E. Lis (all ECB). Based on Aglio. et al. (2019).

**Table A**

Wage Phillips curves in the CEE EU countries, with pre- and post-crisis comparison and extensions

| Dependent variable: compensation per employee | 2000-18 | | | |
|---|---|---|---|---|
| **Inflation$_{t-1}$** | 0.732*** | 0.718*** | 0.715*** | 0.729*** |
| | (0.102) | (0.105) | (0.096) | (0.100) |
| **Productivity$_t$** | 0.354*** | 0.339*** | 0.347*** | 0.359*** |
| | (0.077) | (0.078) | (0.075) | (0.071) |
| **U gap$_{t-1}$** | -1.157*** | -1.228*** | -1.153*** | -1.156*** |
| | (0.244) | (0.295) | (0.246) | (0.248) |
| **U gap$_{t-1}$ * crisis** | | -0.199 | | |
| | | (0.441) | | |
| **U gap$_{t-1}$ * post-crisis** | | 0.884* | | |
| | | (0.404) | | |
| **Minimum wage$_{t-1}$** | | | 0.014** | |
| | | | (0.005) | |
| **Working age pop$_{t-1}$** | | | | -0.176** |
| | | | | (0.077) |
| **Constant** | 3.201*** | 4.351*** | 3.305*** | 3.037*** |
| | (0.875) | (0.902) | (0.858) | (0.847) |
| **Observations** | 787 | 787 | 754 | 781 |
| **R-squared** | 0.537 | 0.545 | 0.552 | 0.543 |

Notes: Dependent variable: compensation per employee annualised quarterly growth rate, four-quarter moving averages. Productivity is also defined as annualised quarterly growth rate, four-quarter moving averages. U gap = Unemployment rate – NAIRU. Inflation is included as four-quarter moving averages. Sample: Q1 2000-Q4 2018. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. "Crisis" refers to the period between 2009 and 2013, "post-crisis" to the period 2014 to 2018.

**Less downward rigidity of nominal wages in the CEE EU countries may be one of the factors contributing to wages responding more strongly to labour market conditions in the region.** To investigate the asymmetric response of wages to labour market slack, micro-based CompNet data are used. Unlike other studies, in this analysis we use a unique approach that defines labour market slack on the basis of job creation and job destruction rates. The idea behind this is that the sector-specific labour market tightens when the job creation rate is above the sector-specific trend. Similarly, there is slack in the labour market when the sector-specific job destruction rate is above its trend. Wages in the CEE EU countries react to both, but only to labour market tightening in non-CEE EU countries, suggesting that wages are less downwardly rigid in the former group of countries (see Table B). The ECB Wage Dynamics Network has also recently found that downward nominal wage rigidity is significantly correlated with the share of employees covered by collective agreements, which is much lower in non-euro area countries than in euro area countries (30% versus 75%).[12]

[12] See, for example, European Central Bank (2017a).

**Table B**

Estimated Phillips curve coefficients: micro-based analysis

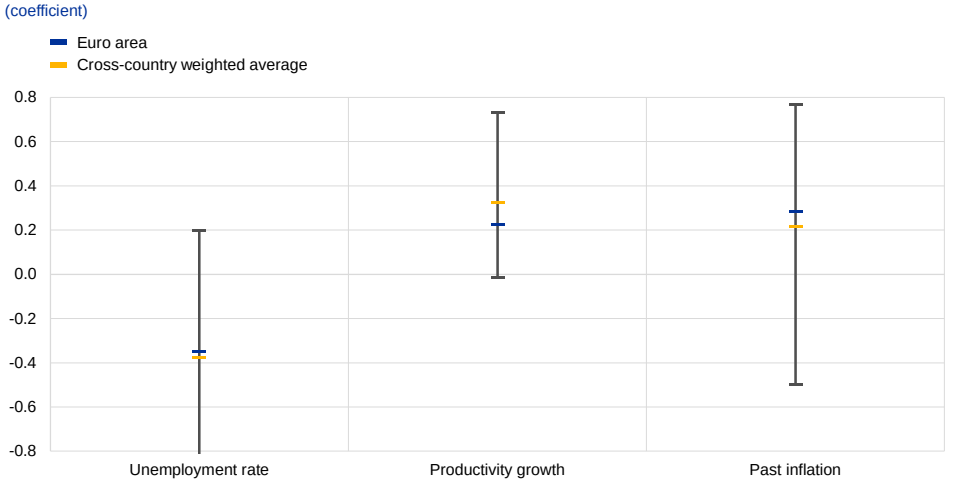
| Dependent variable: growth in mean nominal wage of sector | CEE EU | | non-CEE EU | |
|---|---|---|---|---|
| **Productivity growth** | 0.639*** | 0.621*** | 0.219*** | 0.213*** |
| | (0.023) | (0.025) | (0.028) | (0.030) |
| **Lagged HICP** | 1.741*** | 2.044*** | 0.096 | -0.045 |
| | (0.342) | (0.374) | (0.186) | (0.197) |
| **Lagged JC deviation to trend** | 0.161 | | 0.247*** | |
| | (0.101) | | (0.0661) | |
| **Lagged JD deviation to trend** | | -0.387*** | | -0.0524 |
| | | (0.119) | | (0.079) |
| **Constant** | 0.060*** | 0.051*** | 0.044*** | 0.042*** |
| | (0.010) | (0.011) | (0.008) | (0.008) |
| **Observations** | 2,907 | 3,018 | 3,071 | 3,151 |
| **R-squared** | 0.650 | 0.633 | 0.187 | 0.176 |

Source: Own calculations based on CompNet sixth vintage dataset, full sample. Six CEE EU countries and seven non-CEE euro area countries.
Notes: Two-way FE estimation with errors clustered at the country*sector level. Data at the country-sector-year level. Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1. The period covered is 2004-15.

**Despite some cross-country variation, wage growth appears to be responsive to the cyclical position of the labour market, as well as to the other drivers.** A cross-country exploration of the wage drivers shows that the average country-by-country estimated coefficients are broadly consistent with euro area coefficients using the benchmark Phillips curve specification (see Chart 5) (see Box 1 on a Phillips curve analysis for the CEE EU countries).

**Chart 5**

Estimated coefficients of the considered wage drivers



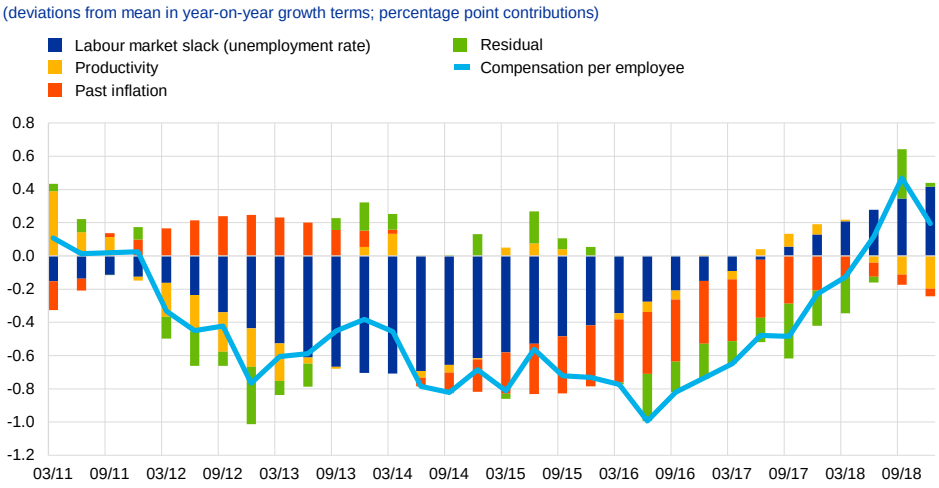

Sources: Eurostat, ECB and NCB calculations.
Notes: Yellow markers show the simple average of the estimated country-by-country Phillips curve coefficients based on a benchmark specification (annualised quarterly compensation per employee is regressed on its own lag, the lagged unemployment rate, four quarters moving average of previous year-on–year inflation rates, annualised quarterly productivity growth and a constant.). Lines display maximum and minimum of the cross-country dispersion. The cross-country average is weighted and weights are based on the proportion of employment of each country being considered over the total countries' employment. All countries' results are included but for Ireland, which conducted the PC exercises based on wage per hour measures. Blue markers show the coefficients for the euro area based on the benchmark specification. Some countries estimate the benchmark specification in year-on-year terms.

**Slack in the labour market, relatively weak productivity growth and the impact of the prolonged period of low inflation have been holding back wage growth in the euro area.** Decomposing wage growth into the contributions of its main

determinants based on a benchmark Phillips curve specification with unemployment rate and past inflation shows that there are three key factors explaining wage growth developments in the past few years, with changing importance over time (see Chart 6)[13]: (i) Labour market slack exerted a substantial negative drag on wage growth until the end of 2016, while more recently increasing labour market tightness has pushed wages up, (ii) In 2016-17 low past inflation became the dominant driver of low wage growth, but that drag has been dissipating as well, (iii) Between 2014 and 2016 as well as in 2018 low productivity growth also contributed to low wage growth – albeit to a smaller degree than the other two factors, especially during the subdued wage growth period (Box 2 presents the results of a panel Phillips curve analysis that broadly supports the findings here). In 2016-17 persistent negative residuals remain in the decomposition of wage growth – also highlighting to the importance of other factors beyond cyclical drivers as discussed above. In the course of 2018 wage growth was above mean and the negative residuals disappeared.

**Chart 6**

Decomposition of latest wage growth into its main drivers in the euro area




Sources: Eurostat and ECB staff calculations.
Notes: Sample: Q1 1995-Q4 2018. The light blue line shows deviations of compensation per employee growth from its model-implied mean. Contributions (including residuals) are also shown as deviations from their model-implied mean. Contributions are derived as in Yellen, J.L. (2015).

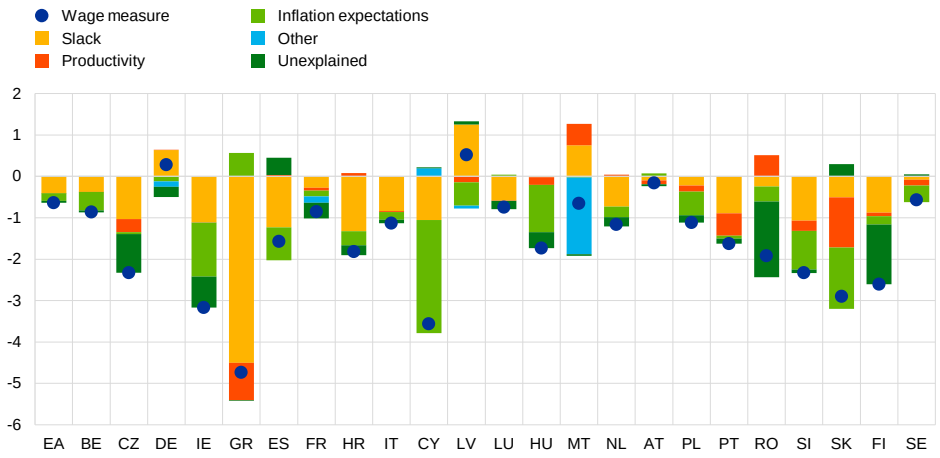
**The relative importance of the various wage growth drivers differs markedly across countries.** The euro area Phillips curve decomposition might conceal country-specific developments, which could offset each other at the aggregate level. To this end, Chart 7 focuses on the relative average contributions of each driver for each country over the euro area low wage growth period (2013 – 17). For most countries a combination of considerable labour market slack, low productivity growth and below-average inflation (expectations) kept wage growth below its sample mean.

[13] The messages also hold for compensation per hour.

**Chart 7**

Decomposition of wage growth into its main drivers across EU countries over the period 2013-17

(deviations from country model-implied mean in year-on-year growth terms; percentage point contributions; averaged over 2013- 2017)




Sources: Eurostat and ECB/NCB staff calculations.
Notes: The dark blue dots show changes in the selected wage growth measure. 'Other' includes additional country specific relevant factors that some countries deem as relevant regressors for the Phillips curve (see also Table 1). Contributions are derived as in Yellen, J.L. (2015). For CZ the period is 2013-15 and for CY the period is 2014-17.

**Some countries exhibit large negative residuals pointing that underline the need to go beyond cyclical drivers when analysing wage growth.** The part of the weakness in wage growth during the analysed period which remains unexplained by the Phillips curve type mechanisms highlights the importance of considering additional country-specific factors. These factors include institutional set-up, adjustment programmes and increased labour flows between EU countries, which would render wage outcomes less sensitive to domestic labour market situations.[14] Other idiosyncratic country factors could also have played a role as discussed in the subsections below and Section 3.

## Box 2

Wage growth in the euro area: a Phillips curve analysis using panel data

**Prepared by Federico Tagliati (Bank of Spain)[15]**

**This box investigates to the extent to which conclusions drawn for the euro area aggregate hold true when pooling country-specific data.**[16] It focuses on two aspects (i) whether the identified drivers have played a similar role in driving wages over the recent past in a panel framework and in a euro area Phillips curve with aggregate data and (ii) incorporating of unconventional slack measures increases the explanatory power of the Phillips curve model. The empirical framework is represented by a wage Phillips curve in which wage growth depends on the slack in the labour market, past inflation and labour productivity growth:

14 As documented empirically for example for Sweden (Sveriges Riksbank (2017) and Germany (Deutsche Bundesbank (2018)). In the euro area, Ireland and Germany also explicitly included migration in their Phillips curve specification (see Table 1).

15 Comments from E. Bobeica, and E. Lis (ECB).

16 19 euro area countries were considered over the period Q1 2000 to Q4 2018.

$$\pi_{it}^{w} = \alpha_0 + \alpha_1 slack_{it} + \alpha_2 \pi_{it-1}^{P} + \alpha_3 gprod_{it} + \theta_i + \varepsilon_{it} \quad (1)$$

where $\pi_{it}^{w}$ is the year-on-year growth rate of compensation per employee for country i in quarter $t$;[17] $slack_{it}$ is a variable capturing the degree of slack/tightness in the labour market; $\pi_{it-1}^{P}$ is the average of the past four quarters of the year-on-year inflation rate; $gprod_{it}$ is the growth rate of labour productivity per employee; $\theta_i$ are country fixed effects; and $\varepsilon_{it}$ is an error term. Table A presents the estimation results for three conventional measures of slack (columns 1-3) and for three unconventional measures (columns 4-6).

**Table A**

Phillips curve estimation with conventional and unconventional measures of slack

| | Conventional measures | | | Unconventional measures | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| **Unemployment rate** | -0.317*** (0.050) | | | | | |
| **Unemployment gap** | | -0.364*** (0.085) | | | | |
| **Output gap** | | | 0.315*** (0.026) | | | |
| **Broad unemployment rate** | | | | -0.252*** (0.020) | | |
| **Narrow broad UR** | | | | | -0.255*** (0.023) | |
| **Rate of unemployed and underemployed** | | | | | | -0.260*** (0.036) |
| **Past inflation** | 0.390*** (0.076) | 0.422*** (0.096) | 0.394** (0.108) | 0.329** (0.085) | 0.322** (0.088) | 0.351*** (0.069) |
| **Labor productivity growth** | 0.318*** (0.077) | 0.326** (0.087) | 0.189** (0.083) | 0.303*** (0.069) | 0.300*** (0.071) | 0.307*** (0.072) |
| **Country fixed effects** | YES | YES | YES | YES | YES | YES |
| **R-squared** | 0.533 | 0.486 | 0.463 | 0.558 | 0.556 | 0.542 |
| **N** | 1436 | 1419 | 1428 | 1436 | 1436 | 1435 |

Notes: The table shows estimation results of equation (1) on a panel comprising the 19 countries of the Euro Area over the period Q1 2000-Q4 2018. The dependent variable is the year-on-year growth rate of compensation per employee. Observations are weighted by the share of GDP of each country in a given quarter. Standard errors in parenthesis are clustered at the country level. *** p<0.1, ** p<0.05, * p<0.01.

**The period of low wage growth in the euro area is mainly driven by high unemployment, low inflation and low productivity growth.** The estimated coefficients presented in Table 1 are in line with estimates using euro area aggregate data. This suggests that while cross-country differences are noteworthy, the extent to which aggregation biases affect empirical estimates is more limited. All estimated coefficients have the expected sign and are statistically significant. Despite the model having a satisfying fit overall, there are some persistent negative residuals in the recent recovery period between the first quarter of 2016 and the first quarter of 2018 (see Chart A). The picture is very much in line with results based on models with euro area aggregate data.

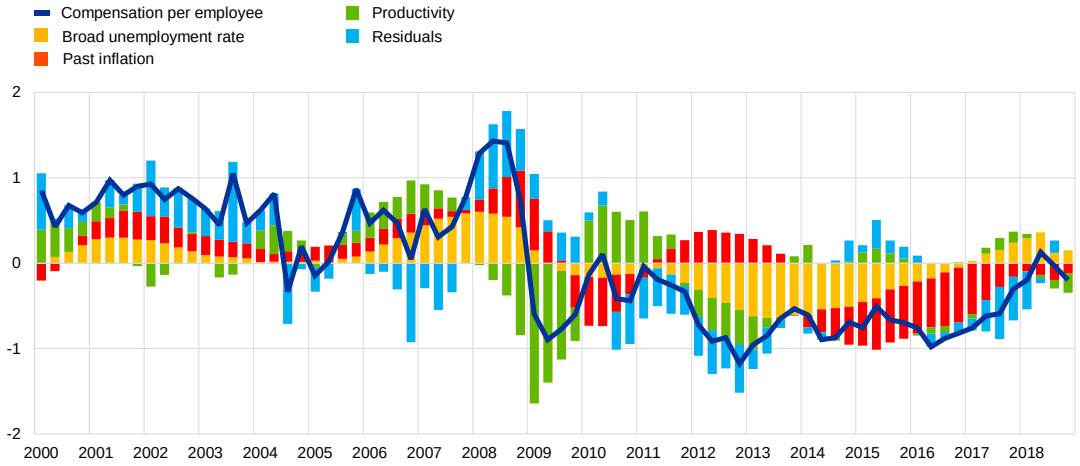
[17] Results are robust to using compensation per hour instead of compensation per employee.

**Chart A**

Phillips curve decomposition

**Labour market indicator: unemployment rate**

(deviations from sample mean; percentage point contributions)




Notes: Sample: Q1 2000- Q4 2018. Contributions are derived as in Yellen, J.L. (2015).

**Broader measures of slack are also found to be relevant for wage growth in the euro area, but their performance is broadly similar to that of conventional indicators.** Chart B replicates the decomposition exercise for a panel Phillips curve model which uses the broad unemployment rate. The chart shows that the evolution of wage determinants is similar to the benchmark model shown in Chart A. Focusing on the more recent period, both Phillips curve models exhibits residuals for 2016 and 2017 which are on average equal to -0.3 percentage points. It is worth noting that, despite being persistently negative in more recent years, the magnitude of the residuals is rather low. This seems to suggest that the recent evolution of wage growth can mostly be explained by traditional measures of slack, whereas the labour market dynamics of involuntary part-time workers or workers marginally attached to the labour force, while relevant, do not lead to a sizeable improvement in the fit of the model.[18]

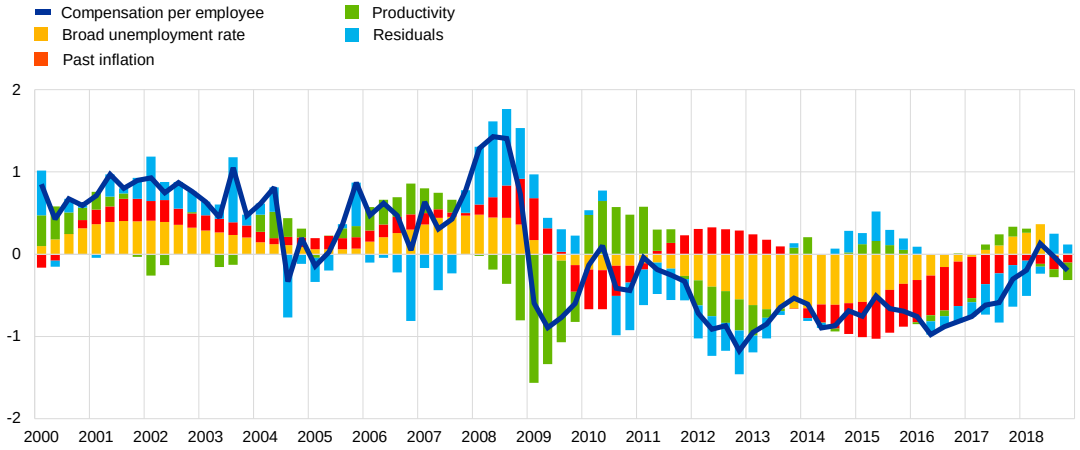
[18] It is worth noting that other studies for the euro area found larger improvements in the fit of the Phillips curve augmented with additional slack measures (see Cuadrado and Tagliati (2018) and Cormier et al. (2018)). This might be due to the fact that both studies used longer time series on the broad unemployment rate indicator and other measures of slack which were constructed by interpolating annual data at the quarterly frequency.

**Chart B**

Phillips curve decomposition

**Labour market indicator: broad unemployment rate**

(deviations from sample mean; percentage point contributions)




Notes: Sample: Q1 2000- Q4 2018. Contributions are derived as in Yellen, J.L. (2015).

## 2.2 Can unconventional slack explain missing wage growth?[19]

**Recent studies have brought unconventional measures of slack into the picture as a possible explanation for the observed low wage growth (see the literature Table A.1 in the Appendix).** The single most prominent measure of the state of the labour market is traditionally the unemployment rate. Yet the headline unemployment rate may not capture the actual cyclical position of the labour market and, hence, the full degree of labour utilisation. This is because it depicts what is commonly referred to as the extensive margin of labour underutilisation, whereas underutilisation can also take the form of insufficient numbers of hours of work demanded by firms. During recessions, for example, large numbers of workers often exit the labour force (e.g. discouraged workers), but they remain a possible pool of workers that could return directly to employment should the economic conditions improve. They are not counted in the unemployment rate, but their degree of attachment to the labour force differs to that of various other non-employed groups (see Box 3 for a measure of a non-employment index for several euro area countries taking that into account). As a result, to measure the cyclical position of the labour market it is important to consider a broad range of labour market indicators (both conventional and unconventional) related to under and overutilization in the labour market, such as the broad measure of labour underutilisation (broad UR)[20], average hours worked, and labour shortage indicators (see the table above on labour market indicators).

[19] Includes contributions by Katalin Bodnar, Bela Szörfi, and Mate Toth (ECB).

[20] See Szörfi, B. and Tóth, M. (2018). The components of broad UR for the euro area are not all available before 2008 and are affected by methodological changes, making meaningful econometric analysis a challenge. To circumvent this challenge in the subsequent analysis, the components of the broad UR have been corrected for the impact of country-specific methodological changes, and back-casted by ECB staff, using annual data based on a similar concept, as well as a DFM consisting of more than 50 labour market variables. This exercise was conducted for all euro area economies.

**Numerous other indicators also contain information on the labour market stance.** "Average hours worked", for example, contains information on slack by showing the degree of utilisation of people in employment. "Average hours worked per person employed" shows a continuous decline that even began before the crisis and is likely to mainly reflect structural factors related to labour supply. Nevertheless, cyclical factors also influence the patterns in average hours worked. These can reflect fluctuations in firms' demand for labour along the business cycle, or changes in workers' preferences. In addition, survey indicators contain very timely information about the labour demand of firms; their main drawback is that the historical comparability of the survey indicators can be questioned when the firm churn rate is high (i.e. when the population of firms changes and there are a lot of new firms), like in the aftermath of the Great Recession. Moreover, job-to-job transition flows can be an indicator for the strength of labour demand.[21] New indicators of labour market tightness are also developed using online data, which reveal the skills employers look for and the jobs workers search for at a highly granular level.[22] Given the richness of information that various labour market indicators contain, the analysis which follows in this section also considers a composite indicator extracting information from the cyclical component of over 50 labour market indicators using the dynamic factor model (DFM) approach.[23]

**Over the period 2013-16, several unconventional measures suggest a larger degree of labour market slack in the euro area than conventional measures.** Comparing the unemployment gap with the cyclical component of the broad UR (both derived with the help of an unobserved components model or UCM, see Box4 in Chapter 3) for the euro area shows that, particularly after the sovereign debt crisis, the difference between the two widened, with the degree of labour market slack in the euro area being larger when looking at the broad UR (see Chart 8). The difference between the two started to recede in 2015 due to strong declines in the number of discouraged workers and the number of underemployed part-time workers. More recently, the broad UR would even suggest a tighter labour market than the unemployment gap. Other unconventional measures, such as the DFM composite indicator and the cyclical UCM component of average hours worked, also suggest considerable slack in the low wage growth period.[24] [25]

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21 Recent empirical literature confirms that, in the United States, wage cyclicality is very well explained by changes in job-to-job flows (see, for example, Hahn et al. (2017) and Moscarini and Postel-Vinay (2016; 2017a; 2017b, 2018).)). For euro area countries, see Berson et al. (2018).

22 See Adrjan and Lydon (2019) for such an indicator for the Irish labour market.

23 It is important to stress that the common cyclical components estimated by the DFM depend crucially on the type of univariate filter used to de-trend the labour market indicators. While a range of univariate filters were used for robustness checks, only the results with the best performance in terms of forecasting wage growth in the euro area are reported here.

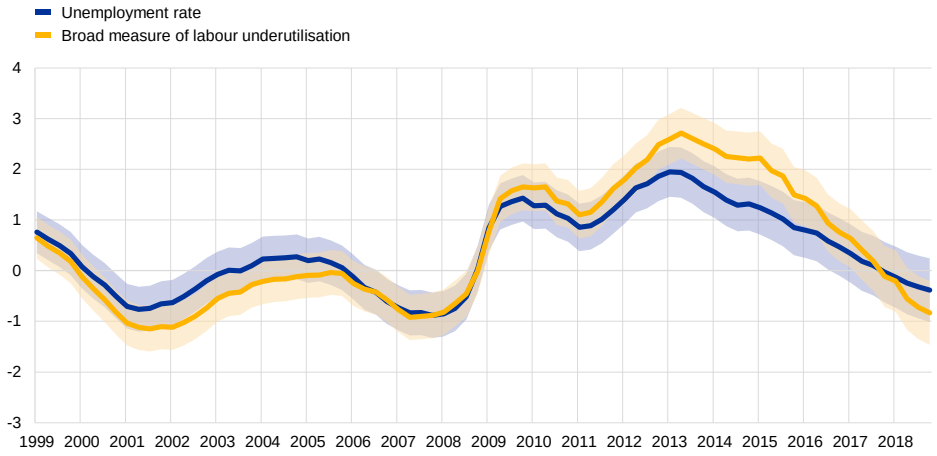
24 It is difficult to say whether these measures point to higher slack than the conventional ones as they are not directly comparable.

25 See Bulligan et al. (2019) on how adjustments along the intensive margin have affected wage growth in the euro area.

**Chart 8**

Labour market utilisation in the euro area according to different measures

(percentage of the labour force; broad measure of labour underutilisation as a percentage of the potential additional labour force)




Sources: Eurostat and ECB staff calculations.
Notes: The gap estimates are based on the unobserved components model. The shaded areas denote +/-2 standard deviation estimation uncertainty bands. The blue shaded area relates to the unemployment gap and the cream shaded area relates to the broad UR gap. See also Szörfi, B. and Tóth, M. (2018), "Measures of slack in the euro area", *Economic Bulletin*, Issue 3, ECB. Last observation: Q4 2018.

**Euro area estimates of slack mask large differences across countries, in particular in the period between the sovereign debt crisis and 2016.**[26] As shown in Chart 9, the broad measure of labour underutilisation increased more than the unemployment rate, in particular in economies which were most severely hit by the financial and sovereign debt crisis and also underwent structural reforms of the labour market (red diamonds).[27] In these countries, none of these measures had recovered in 2016 to pre-crisis levels. In a few countries where the unemployment rate was already close to the pre-crisis average in 2016, the broader measure of labour underutilisation still indicated remaining slack (blue diamonds). Finally, there is a small group of euro area countries where both the broad measure of labour underutilisation and the unemployment rate were below the pre-crisis average, suggesting very tight labour markets and/or structural improvements in the labour market already in 2016 (green diamonds).

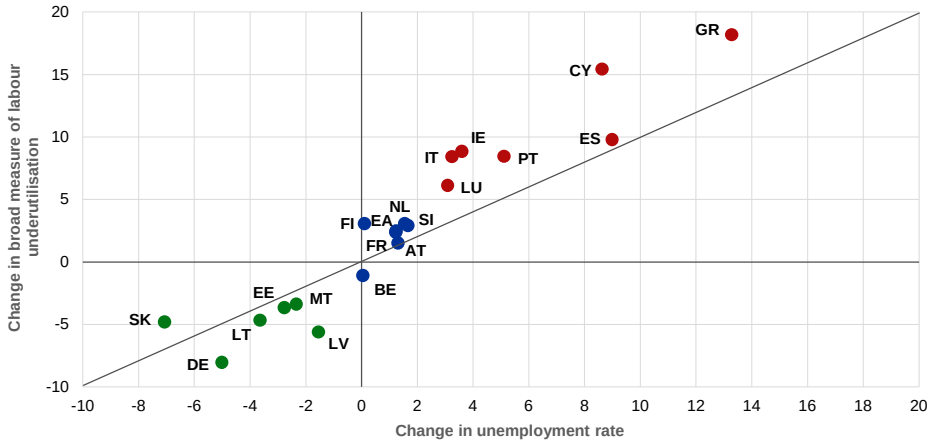
[26] We refer here to data up to 2016 as the employment and wage growth conundrum was particularly pronounced in the period 2012 to 2016.

[27] In Luxembourg, the rise of the unemployment rate to unprecedented levels mirrors the impact of the crisis but also, and to a large extent, structural factors which became evident before the crisis.

## Chart 9

Cross plot changes in unemployment rate and broad measure of labour underutilisation

(percentage points; x-axis: change in the unemployment rate; y-axis: change in the broad measure of labour underutilisation as a percentage of the potential additional labour force)




Sources: Eurostat and ECB staff calculations.
Notes: Changes shown are 2016 values relative to the 1999-2007 average. Black line represents a 45 degree line. The broad UR has been back-casted by ECB staff, using annual data based on a similar concept, as well as a Dynamic Factor Model (DFM) consisting of more than 50 labour market variables.

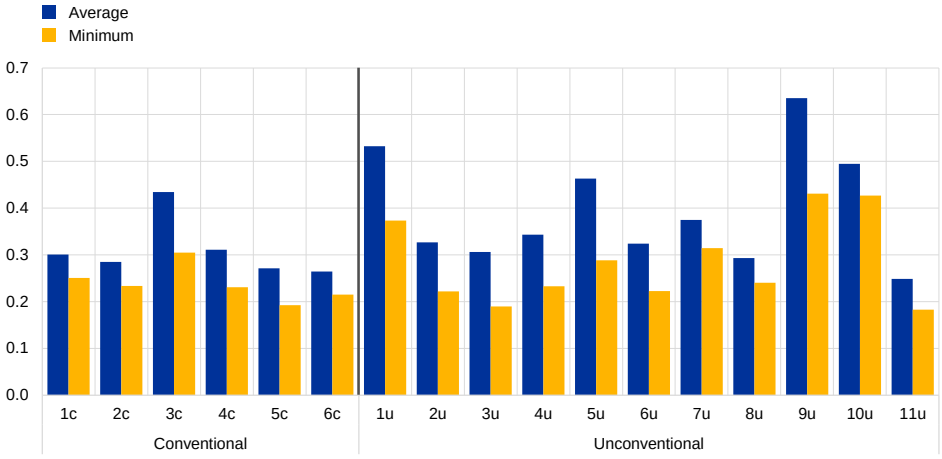
**Unconventional measures of slack seem to yield some marginal gains in explaining the low wage growth period in the euro area.** The explanatory power of different estimates of slack is assessed by comparing the out-of-sample forecasting performance of Phillips curve models when they are conditioned on the actual path of the labour market and other explanatory variables.[28] Among conventional labour market indicators, the model-based, OECD unemployment gap and UCM unemployment gap indicators, as well as the simple unemployment rate, fare reasonably well in explaining wage growth over this period (see Chart 10). Also, a set of unconventional measures, such as the broad unemployment rate, its gap and the intensive margin gap yield low levels for the root mean square error (RMSE) for the forecasts. The picture is not clear cut as to which is the best indicator to look at, which suggests that there is value in monitoring a wide range of labour market indicators. This is confirmed by the superior performance of the common cycle extracted based on a dynamic factor model. Overall, the differences in the RMSE are small, as these labour market indicators are highly correlated and caution is therefore warranted when ranking the usefulness of different measures of slack.

[28] Chart 10 shows the RMSE of these models for the period 2012-18 by averaging across different specifications for each slack measure and depicting the smallest RMSE across all specifications for each slack measure. For each slack measure, several specifications were considered depending on the different variables used for inflation expectations.

**Chart 10**

RMSE of conditional wage growth forecast vs actual wage growth in the euro area

(Q2 2012 to Q4 2018)




Sources: Eurostat and ECB staff calculations.
Notes: Wage = compensation of employees (whole economy); 1c = unemployment rate, 2c = model-based unemployment gap, 3c = European Commission unemployment gap, 4c = IMF unemployment gap, 5c = OECD unemployment gap, 6c = UCM unemployment gap, 1u = Short term UR, 2u = Broad UR, 3u = Broad UR gap, 4u = The rate of unemployed and underemployed, 5u = Underemployment rate, 6u = Narrow broad UR,7u = UCM narrow broad UR gap, 8u = UCM intensive margin gap, 9u = Labour shortage, 10u = UCM participation rate gap, 11u = Common DFM cycle.

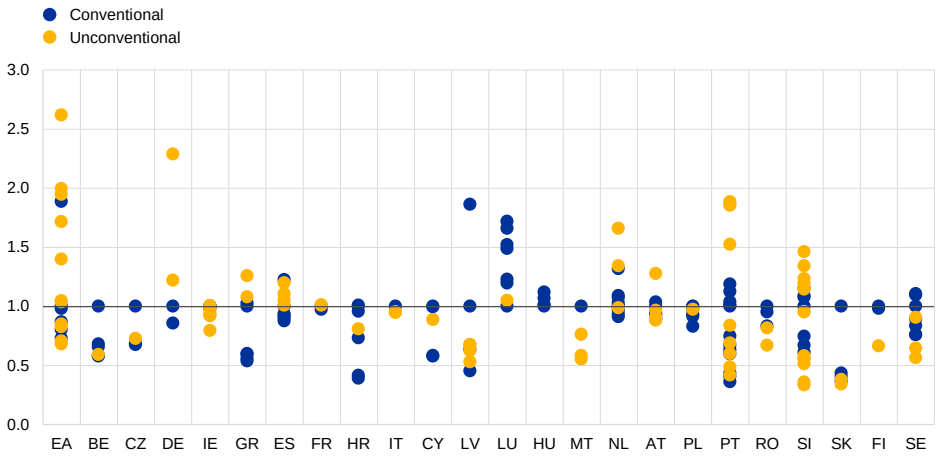
**The limited gains of using unconventional slack measures to explain the low wage growth period is also reflected in the case of individual euro area countries (see Chart 11).**[29] There is quite some heterogeneity as to whether models with unconventional measures generally exhibit a better forecast performance. In a few countries (such as Ireland, Malta, Slovenia and Sweden) some specifications with unconventional measures of slack do appear clearly to improve the explanatory power for wage growth over the period 2012-18 when compared with the benchmark specification. In other countries, such as Italy the improvements are still present, but marginal. As also shown in Table 1 most NCBs mainly link their selected wage measures mainly to conventional measures of slack, while only a few countries consider an unconventional measure of slack to be more relevant (such as Italy and Malta).

[29] The chart shows the relative RMSE which is presented as a ratio of all the plausible specifications with different slack to the RMSE associated with the benchmark Phillips curve model including the unemployment rate and the selected inflation expectations measure (for example, in the case of the euro area it is the average of the past four quarters of annual headline inflation). If this ratio is higher than one, this means that the benchmark specification is superior, otherwise the alternative specification performs better.

**Chart 11**

Relative RMSE of conditional wage growth forecast – different measures of slack

(Q2 2012 to Q4 2018, y-axis: relative RMSE)




Sources: Eurostat and ECB/NCB staff calculations.
Notes: Wage = selected wage measure of each country. The relative RMSE is presented as a ratio of all the plausible specifications with different slack to the RMSE associated with the Phillips curve model including the unemployment rate and the selected inflation expectations measure. The estimation sample is1995 to Q1 2012 (CY 1995 to Q4 2013). Plausible specifications are based on the statistical significance of the slope and on the plausibility of the sign of the explanatory variables.

## Box 3

## Alternative measures for assessing labour utilisation in selected EU countries: Non-employment index and structural unemployment based on unemployment flows

**Prepared by S. Byrne, T. Conefrey and S. Zakipour Saber (Central Bank of Ireland); M.Obstbaum and P. Juvonen (Bank of Finland)**[30]

This box introduces some less conventional methodologies to take a second look at estimates of labour utilisation in selected EU countries: a non-employment index (NEI) and an estimate of structural unemployment based on unemployment flows (natural rate of unemployment – NARU).

**Broader measures of unemployment do not take into account the substantial differences in the degree of labour force attachment of different cohorts.** The NEI takes account of each cohort's respective transition rates into employment. By including tailored weights that take into account persistent differences in each group's likelihood of regaining employment, the NEI is arguably a more comprehensive measure of labour market slack than other measures which assign the same weight to each cohort. A further advantage of the NEI over the broader measures of labour underutilisation is that it includes all non-employed individuals.[31] The Labour Force Survey's (LFS) longitudinal nature means the labour market status of individuals can be tracked over consecutive quarters, during which they remain in the survey sample. This makes it possible to calculate the probability of workers moving between different states[32] and is used when calculating the NEI.

**The level and dynamics of non-employment are very heterogeneous across countries and driven both by varying labour market structures and by the extent to which countries were hit by the crisis.** Chart A shows the median and range of the NEI across selected euro area countries,

30 Input by E. Bobeica, E. Lis (all ECB) and NCB experts.

31 The NEI is constructed following closely the methodology of Hornstein, Kudlyak and Lange (2015) and Kudlyak (2017), who were the first to publish a non-employment index for the United States.

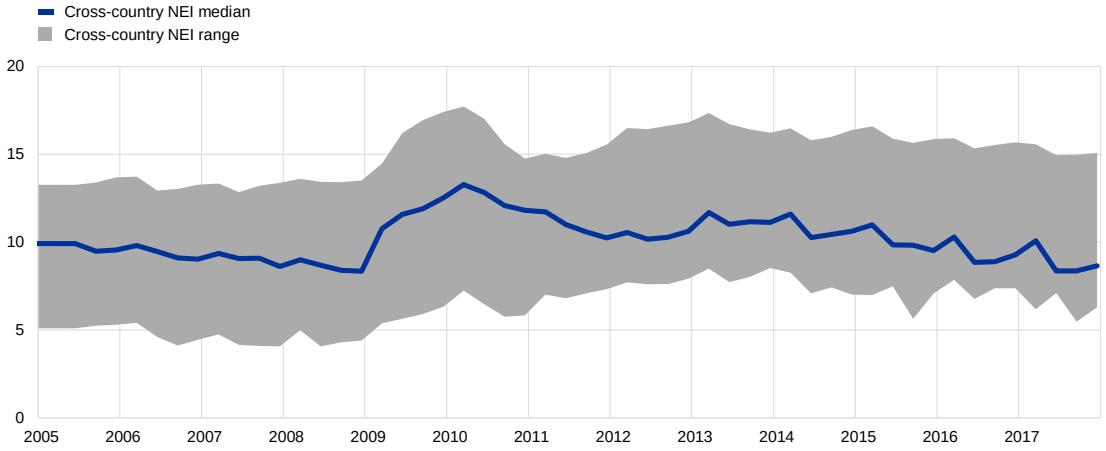
32 For example, from unemployment to employment or from inactivity to unemployment.

with the range clearly shifting upwards after 2009. The increase in the NEI was most significant in crisis-hit countries (such as Ireland, Spain and Portugal[33]), mainly due to a considerable rise in the number of individuals who were "available but not seeking". While the number of short and long-term unemployed has decreased as the impact from the crisis has waned, these discouraged workers have remained outside of the labour force and have therefore kept the NEI higher than would have otherwise been the case. In other countries that were less affected by the crisis (such as Austria and France), the NEI remained relatively stable in the same period.

**Chart A**

The non-employment index (NEI) across selected euro area countries

(percentage of working age population)




Sources: Eurostat and National Central Banks.
Notes: The blue line depicts the median of the cross-country NEI. The range includes the following countries: Austria, Cyprus, Estonia, Finland, France, Ireland, Italy, Latvia, Lithuania, Netherlands, Portugal, Slovenia, Slovakia and Spain. Latest observation: Q4 2017.

**An alternative measure of the structural rate of unemployment (NARU) is based on the trends of job finding and separation rates for different European countries.**[34] Structural unemployment is typically identified with the non-accelerating wage rate of unemployment (NAWRU). However, there might have been factors other than labour market slack causing subdued wage growth dynamics (see the discussion in Section 3), which might bias NAWRU estimates. NARU[35] estimates, on the other hand, are not affected by short-term changes in wage and price inflation or by inflation expectations. Rather, NARU reflects the structural factors underlying structural unemployment, such as the economic environment and labour market institutions.

**For some countries, the results based on estimates of the NARU signal different degrees of labour utilisation compared with the unemployment gaps based on NAWRU estimates provided by the European Commission (see Chart B).** Focusing on the big four euro area countries, the NARU gap estimate suggests more labour market slack than the NAWRU gap estimate for France, while for Germany and Spain the NARU suggests a tighter labour market than the NAWRU. For Italy, the estimates indicate a similar labour market stance. For the rest of the countries

33 The LFS data for Portugal have a structural break in 2011, which changed the level of all major variables.

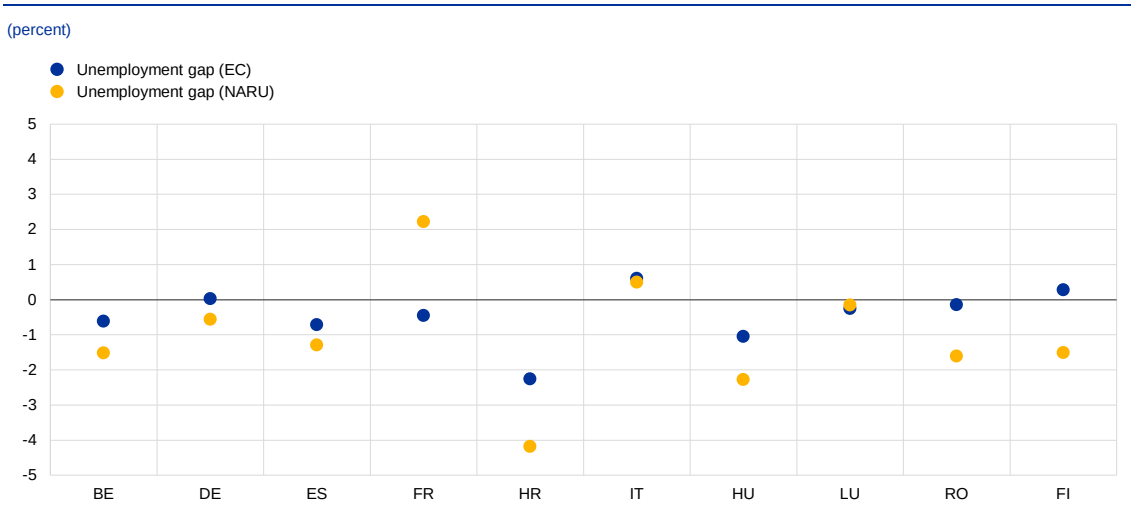
34 In accordance with research by Tasci (2012), trends are estimates from transition probabilities. The transition probability trends determine the trend of equilibrium unemployment, which can be referred to as structural unemployment.

35 The abbreviation NARU is chosen for this structural rate of unemployment to signal its conceptual links to the NAWRU (as indicators that make it possible to derive slack), while at the same time keeping it separate from the NAWRU.

the NARU gap estimates point to either similar or more negative unemployment gaps than the NAWRU gap estimates.

**Chart B**

Unemployment gaps based on NARU and European Commission NAWRU estimates across selected EU countries in 2018Q4.




Sources: EC, BoFI calculations based on data from Eurostat, national ministries and national statistical offices.
Notes: The European Commission unemployment gap is calculated as the unemployment rate (Eurostat) minus the European Commission estimate of the NAIRU, whereas the NARU unemployment gap is calculated as the unemployment rate (based on national data) minus the NARU. Latest observation: Q4 2018.

## 2.3 Is the low wage growth period characterised by backward- or forward-looking wage formation?

**A low inflation environment can have a direct negative impact on wage growth via formal indexation mechanisms, but also an indirect negative impact via changes in wage-setters' inflation expectations.** Even when no formal indexation schemes are in place, informal indexation may play an important role, establishing a direct pass-through from low price increases to low wage gains. A prolonged low inflation regime can also affect firms' and workers' inflation expectations, with implications for wage negotiation rounds. If agents' expectation formation is rather backward-looking, firms are likely to offer lower wage increases to preserve their margins and workers will not push for higher wage growth as low past price inflation has boosted their real incomes. If the low inflation environment becomes entrenched in agents' expectations, the central bank's ability to meet its inflation target is more difficult, making the low inflation/low wage environment more persistent.[36]

**The low inflation environment in the euro area seems to have kept wage growth subdued via the backward-looking component in the wage formation process.**[37] The relevance of measures of backward or forward-looking inflation expectations is

[36] See Ciccarelli and Osbat (2017).

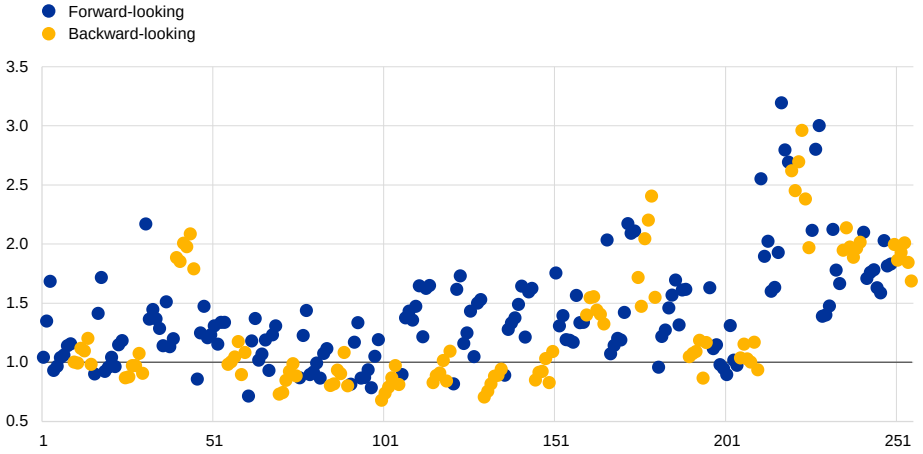
[37] This can be reconciled with findings according to which households and firms are likely to form their expectations in a largely backward-looking manner (see Łyziak (2010)). The findings from the Phillips curve analysis are supported by information from the WDN on the evolution of the countries' institutional framework with respect to wage-setting.

examined by looking at the out-of-sample forecasting performance of their Phillips curve models when they are conditioned on the actual path of these measures of inflation expectations. Chart 12 displays the RMSE of all the plausible euro area specifications, normalised by the RMSE of a benchmark specification which includes the unemployment rate and the average of the past four quarters of annual headline inflation.

**Chart 12**

Relative average RMSE of conditional forecast of wage growth – euro area

(x-axis: all plausible specifications; y-axis: relative RMSE, Q2 2012 to Q4 2018)



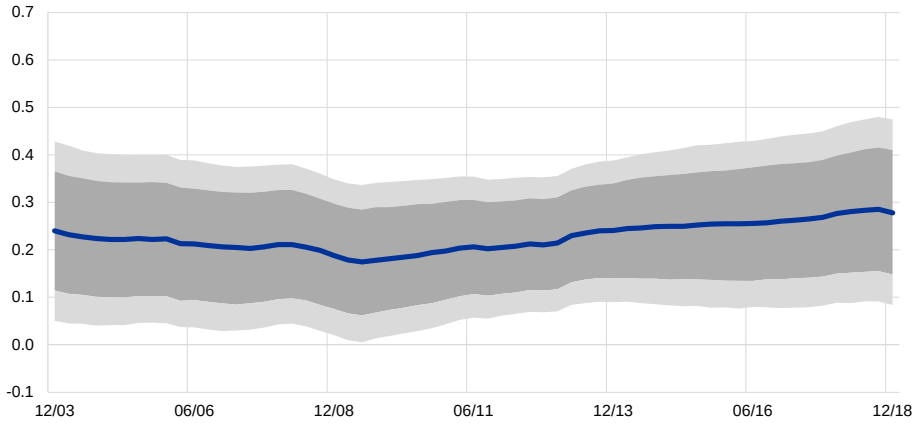

Source: ECB calculations.
Notes: The RMSE is presented as a ratio of all the plausible specifications with different slack and inflation expectations measures to the RMSE associated with the benchmark Phillips curve model including the unemployment rate and average of the past four quarters of annual headline inflation. The estimation sample is 1995:Q1 2012. Plausible specifications are based on the statistical significance of the slope and on the plausibility of the sign of the explanatory variables. Dots above the black line indicate worse performance and below the line better performance.

**Three main messages emerge from the euro area exercise:** (i) it is not easy to outperform this benchmark specification based on past inflation; (ii) models including measures of past inflation tend to fare better than those with forward-looking expectations; and (iii) models with past inflation are not always better as the outcome depends on the slack and inflation measures considered.

**The role of past inflation in wage formation remained relatively stable over time in the euro area.** This is confirmed by estimating a time-varying version of the Phillips curve (see Chart 13) where coefficients and the log-volatility of errors are assumed to follow a random walk. There is a slight increase in the coefficient of past inflation since 2009, but this change is not statistically significant.

**Chart 13**

Time-variation in the backward looking component of wage growth in the euro area




Sources: Eurostat and ECB staff calculations.
Notes: Based on a specification with unemployment gap as a slack measure. The shaded areas show the confidence bands. Last observation: Q4 2018.

**For most EU countries backward looking inflation expectations seem to perform better than forward-looking ones (see Table 1).** This result could also be related to data limitations regarding the availability of the relevant expectations to consider in many countries. Still, in some countries forward looking expectation measures were preferred (such as Germany and Italy). This result is in line with institutional wage-setting behaviour in these countries.

**The findings from the Phillips curve analysis are supported by information from the Wage Dynamics Network (WDN) survey on the evolution of the countries' institutional framework.** Based on the 2008 wave of the WDN, there are more firms (21.6%) reporting that they adjust base wages to past inflation (formal and informal indexation) than those who report that they adjust wages with respect to expected inflation (8%).[38] According to the latest wave of the WDN conducted during 2014 and the beginning of 2015, the percentage of firms adapting base wages to inflation changes in general remained stable compared to the period before 2010. However, this masks increases in Germany and France, and decreases in Spain.

**There are limitations to what an empirical approach can reveal about the backward- or forward-looking nature of the wage formation process.** First, inflation expectations are unobservable. The expectations of households and firms are what matters in the wage formation process. Reliable data on either one are not readily available for the euro area. Only survey-based inflation expectations of professional forecasters and financial market participants are easily accessible for the euro area and some of its member countries. Second, available measures of inflation expectations contain both purely forward-looking and backward-looking information. This can be rationalised within a model with heterogeneous agents where a fraction of the agents are backward-looking and a fraction are forward-looking. Disentangling the purely forward-looking element included in these measures is not a trivial task. For this reason, results based on broad co-movements at the macro level should be

38 See Druant et al. (2009).

complemented with insights based on the institutional settings prevailing in each country and based on disaggregated information coming from firms.[39]

[39] For a discussion of the institutional settings and their impact on wage growth, see subsection 3.6.

# 3 Factors beyond the standard wage Phillips curve

As shown in Section 2, analyses based on standard wage Phillips curves can help to explain low wage growth in the euro area from 2013 to 2017. But they are unlikely to paint the whole picture: other factors might have played a role. These could include compositional effects and non-linearities in the reaction of wage growth to slack. Additionally, trend and structural developments and changes to institutional settings might also have had an impact. This section reviews the potential role of these other factors.

## 3.1 The role of compositional effects for wage growth[40]

**In the euro area, significant changes in the composition of the workforce have taken place since the start of the crisis.** Chart 14 illustrates the developments based on EU Survey of Income and Living Conditions (SILC) data. The EU SILC data-set is the most comprehensive micro dataset available for studying compositional effects.[41] It includes not only details on employees' characteristics but also wage data for all EU countries. Since 2006, the first year for which a comprehensive set of EU SILC data is available, the share of older employees rose, while the share of younger workers fell. At the same time, the share of employees with low education decreased, while the share of highly educated employees increased. These developments can partly be attributed to longer-term trends (such as demographic change, reforms of the pension system and the trend towards longer/higher education), but they can also be related to cyclical developments in some countries: younger and less educated/skilled workers lost their jobs first during the crisis, further increasing the share of older and highly educated employees.

[40] Includes contributions by Friderike Kuik (ECB), Omiros Kouvavas (University of Warwick) and Styliani Christodoulopoulou (ECB).

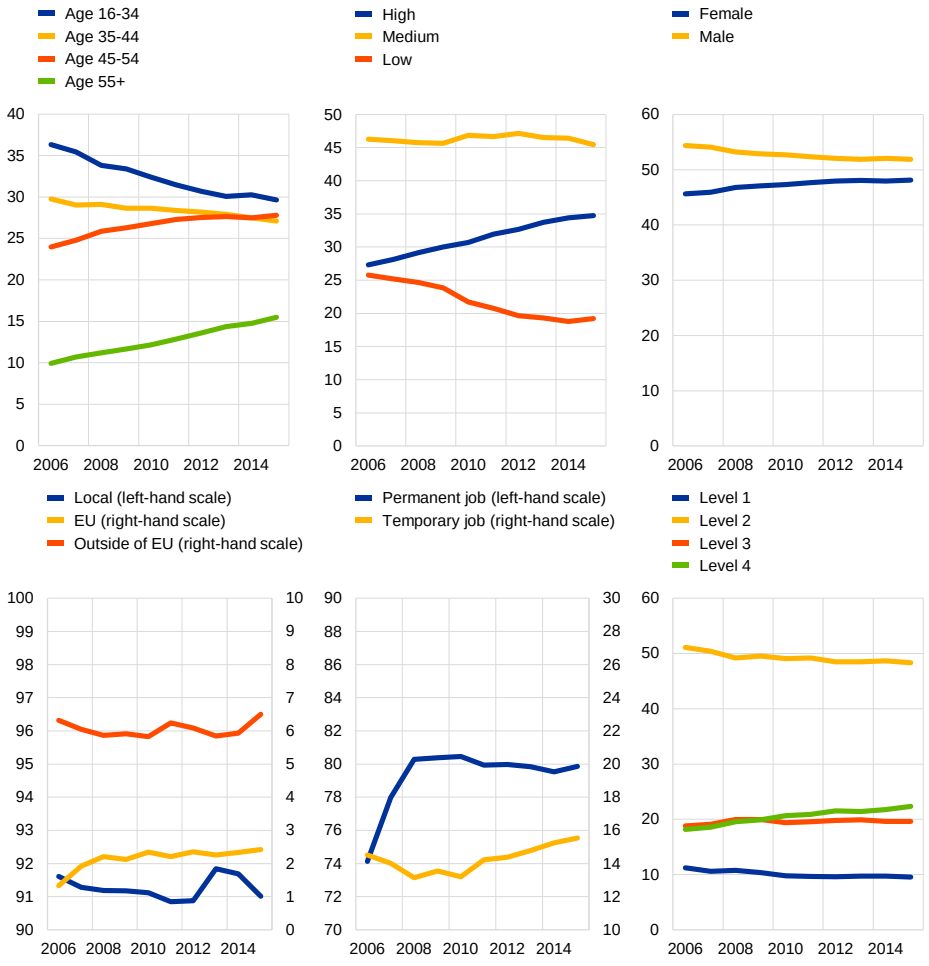
[41] See Eurostat website for details on EU SILC.

**Chart 14**

Development of main characteristics of employees in the euro area according to EU SILC

**Characteristics (from left to right): age, education, gender, nationality, contract type, skill level (low = 1 to high = 4)**

(percent of employees)




Sources: EU SILC (Eurostat) and ECB calculations.
Note: Euro area aggregate weighted by hours worked; numbers not adding up to 100% indicate missing data.

**As wages vary strongly with employees' characteristics such as age and education, changes in the composition of the workforce might have affected wage growth.** Younger and less educated/skilled workers usually earn less than older and highly educated employees. So if the first group lost their jobs during the crisis and thus further increased the share of older and highly educated employees this should lead to higher wages and thus a positive compositional effect.

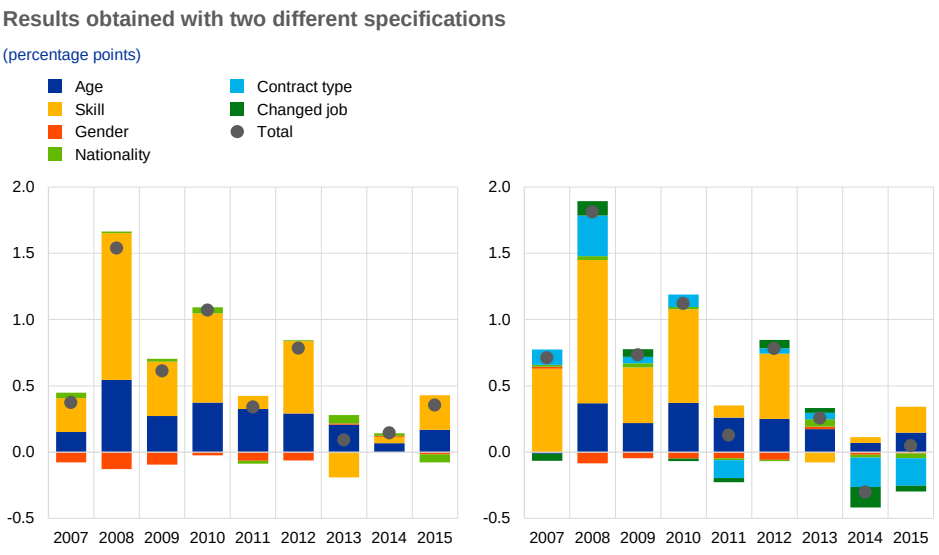
**In this section, an Oaxaca-Blinder decomposition is applied to calculate the impact of compositional effects on wage growth in the euro area.** In the analyses the dependent variable is hourly gross wage growth. In line with the literature on compositional effects and the most important changes to the workforce in the period analysed, the independent variables in the baseline regression include age, education, gender and nationality – using dummies for different sub-groups of each

characteristic. In order to increase the robustness of the results, alternative specifications are also analysed, including combinations of the contract type, changed job/tenure and skill level variables.[42]

**Euro area aggregate[43] results suggest that compositional effects pushed up wage growth early in the crisis, but the effect has been decreasing and might thereby have contributed to a relatively muted response of aggregate wage growth to cyclical improvements.** According to the results from the baseline configuration (see Chart 15, left-hand side), the largest positive contribution of compositional effects can be observed in 2008-12, with compositional effects contributing up to around 1.5 percentage points per year to wage growth. The impact of compositional effects has been declining since then, with a positive effect of just above 0.25 percentage points in 2015. The overall pattern of a decrease in compositional effects in 2013-15 when compared with 2008-12 is robust across several alternative specifications. When including contract type and a variable on whether the individual changed job in the last year as proxy for tenure and particularly short tenure, compositional effects even become negative in 2014 and 2015 (see Chart 15, right-hand side). Compositional effects are smaller and somewhat more volatile when including skill level or occupation instead of education, but the overall pattern also remains unchanged in these specifications (not shown in chart).[44]

**Chart 15**

Euro area average compositional effects on wage growth




Sources: EU SILC (Eurostat) and ECB calculations.
Notes: The charts show the contribution of compositional effects to the annual rate of change in hourly wages derived based on EU-SILC data. The results on the left-hand side are derived based on a specification taking age, education, gender and nationality into account. For the specification underlying the results on the right-hand side the variables "contract type" (permanent/temporary) and "changed job" since the last year are also included.

42 The applied approach is based on recent work by Christodoulopoulou and Kouvavas (2018), which includes a detailed description of the methodology.

43 The results for euro area countries are obtained by aggregating country results using hours worked as weights.

44 As a cross-check, data from the LFS were applied and matched with wage data from EU-SILC. This cross-check supported the findings derived based on EU-SILC data.

**Looking more closely, the most important contributions to compositional effects seem to be related to changes in the share of young (aged 16-34) and highly educated employees.** While a negative compositional effect is observed with an increase in the share of young, low educated or female employees, the results show a positive compositional effect with an increase in the share of older (all other age groups), highly educated, male and non-foreign employees.[45]

**The declining impact of compositional effects over the period 2008 to 2015 is consistent with compositional effects having contributed to a decrease of wage growth in the euro area over recent years.** Netting out compositional effects seems to bring wage growth somewhat more in line with the cycle, especially based on lower wage growth net of compositional effects in 2008-12.

**Conceptually, it would be appealing to estimate a Phillips curve for wage growth net of compositional effects, but this seems to be very difficult to implement.** With respect to data availability, such an approach is complicated by (i) the annual frequency of data needed to calculate compositional effects, (ii) the short length of the time series and (iii) the substantial time lags in publication of the data. Additionally, parts of compositional effects are likely to affect average labour productivity developments but are already integrated in Phillips curve analysis, and therefore risk being double counted.

## 3.2 Is the relationship between wage growth and the cyclical position of the labour market non-linear?[46]

**So far a linear relationship between wage growth and the slack in the labour market has been assumed in this paper.** Such a relationship implies that the reaction of wage growth to changes in slack would be the same regardless of the state of the labour market (i.e. whether slack is high or low) or the state of other economic factors (such as low inflation versus high inflation).

**This subsection discusses approaches in which the relationship between wage growth and the labour market cycle is allowed to vary over time, adding to the uncertainty surrounding estimates of the Phillips curve slope.** As yet there is no consensus on the sources of potential non-linearities or on whether the Phillips curve is steeper in a boom, in a recession, or when the economy is close to equilibrium. Some theories suggest that the Phillips curve might be convex, i.e. it steepens as output rises relative to potential and it flattens in a downturn.[47] Such convexity is

[45] The results of this decomposition exercise are subject to the caveat that they would not directly reflect compositional effects stemming from developments that affect the distribution of more than one characteristic. For example, the composition effect on wages stemming from immigration might occur via changes to the distributions of age, education, gender, skill or nationality, or a combination of all of them. Therefore, the contribution from nationality, all else being equal, would not necessarily fully capture the compositional wage impact of immigration. To capture the total effect, the contributions of immigration to changes in the distributions of the remaining correlated characteristics would need to be taken into account.

[46] Includes contributions by Dennis Bonam (De Nederlandsche Bank), Gabriel Perez Quiros (ECB), David Byrne and Zivile Zekaite (Central Bank of Ireland).

[47] See Laxton et al. (1995).

theoretically in line with the most prominent source of non-linearities: downward nominal rigidities. Other theories suggest that the Phillips curve might be concave, i.e. it flattens as the economy recovers. This is consistent with firms exhibiting greater willingness to reduce prices under weak demand to avoid being undercut by rival firms, and with workers giving up wage gains to keep their jobs.[48]

**This subsection considers several methodologies to test for the existence of non-linearities in the euro area wage Phillips curve.** As a first step, models with time-varying parameters, which change continuously over time, are estimated.[49] The resulting time-varying slope estimates are then correlated with the amount of slack in the economy at each point in time to provide some first-pass evidence of state dependence. As a second step, non-linearity is modelled within a Markov-switching model with two regimes, where the slope of the Phillips curve is allowed to switch abruptly instead of assuming smooth changes. Finally, the simple linear Phillips curve model is augmented with a term capturing the distribution of the slack measure.

**There is some indication that the steepness of the Phillips curve depends on the state of the economy.**[50] The left panel of Chart 16 plots the time-varying estimate of the Phillips curve slope against the model-based unemployment gap as a measure of labour market stance. It shows the greater the amount of slack in the economy, the less steep the slope, i.e. there is a positive relationship between the slope and the unemployment gap.[51] This observation is in line with theories of downward nominal wage rigidities that predict wage cuts to be less likely than wage hikes.[52] Indeed, an implication of downward nominal wage rigidities is that changes to wages will be less frequent during periods of weak economic activity and low inflation, resulting in a weaker Phillips curve relationship, than in times when the economy is booming and inflation is high. Yet, this model does not offer a smoking gun argument in favour of non-linearities, as the changes identified in the slope of the Phillips curve over time are not that big and the uncertainty surrounding the time-varying estimates is considerable.

48 See Stiglitz (1997).

49 The methodology is similar to the one employed in Bonam et al. (2018); the parameters of the wage Phillips curve, but also the log volatility of the residuals are assumed to follow a random walk, as in Primiceri (2005).

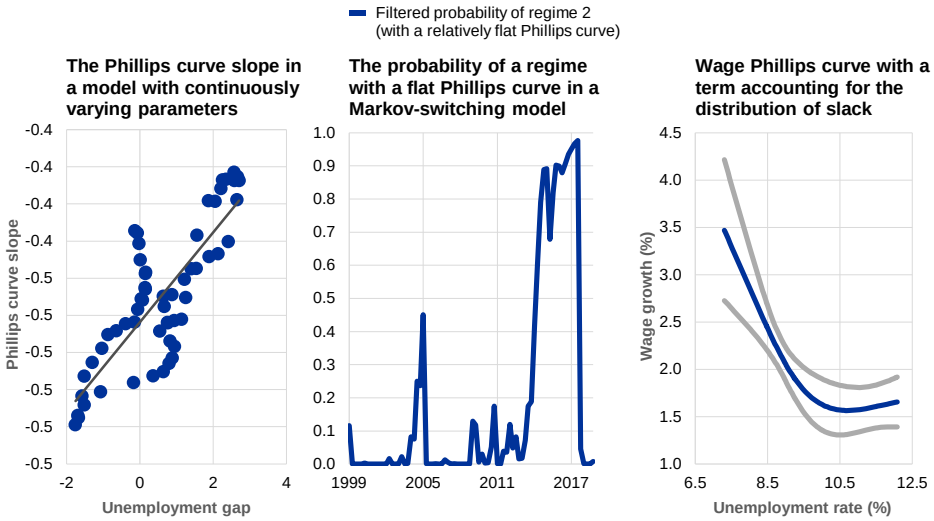
50 See also Hooper et al. (2019) for a discussion on non-linear wage Phillips curves in the United States.

51 The chart plots the median estimate of the Phillips curve slope from the posterior distribution.

52 See Daly and Hobijn (2014).

**Chart 16**

Three explorations of non-linearities in the wage Phillips Cure




Sources: Based on calculations of Dennis Bonam (De Nederlandsche Bank), Gabriel Perez Quiros (ECB), David Byrne and Zivile Zekaite (Central Bank of Ireland).
Notes: Left panel: The slope is derived from a time-varying model where all the coefficients and the log-variance of the residuals are assumed to follow a random walk. Estimation sample: Q1 1995 – Q4 2018. Middle panel: Based on a MS model where three parameters are allowed to switch across two regimes: the intercept, the slope and the variance. Estimation sample: Q1 1999 – Q4 2018. Right panel: PC analysis with a term accounting for the distribution of slack. Non-linearity in labour market slack variables is captured by using restricted cubic spline functions. Estimation sample: Q1 1999 – Q2 2018.

**Next, a Markov-switching model is applied to test more directly for state dependency in the Phillips curve slope.** A Markov-switching model identifies two distinct regimes, the first being characterised by a relatively steep Phillips curve and the second by a relatively flat Phillips curve.[53] The probability of the second regime appears to be higher when the economy is performing worse (see the middle panel of Chart 16). The euro area has gone through both regimes over the entire sample period, yet in recent years (up to the fourth quarter of 2017) the second regime has dominated. It also shows that, in the most recent period, the euro area is more likely to have been in the first regime than the second, suggesting that wage growth should respond more strongly to improvements in labour market conditions.

**Using a different approach, Byrne and Zekaite (2018) also find some support for non-linear specifications of the wage Phillips curve.** They estimate a suite of linear and non-linear Phillips curve models since 1999 and compare the models' in-sample fit and out-of-sample forecasting performance.[54] Non-linearity in labour market slack variables is captured by using restricted cubic spline functions. The right panel of Chart 16 depicts the implied slope of the euro area wage Phillips curve from Byrne and Zekaite's best-performing model.[55] The Phillips curve is flat for

[53] The Markov-switching model uses the same Phillips curve specification as before, but allows for the intercept, the slope and the variance of the residuals to switch across two regimes, with a probability estimated via Maximum Likelihood. By not relying on the random walk behaviour assumed under the time-varying parameter model, which is generally slow to capture time variation in the parameters, this approach enables us to capture more sudden changes in the Phillips curve.

[54] Compensation per employee is used to proxy for wage growth. Slack measures include a standard unemployment rate, short-term and long-term unemployment, unemployment gap, a broad unemployment rate and a measure of underemployment. For details about data and transformations see Table 1 in the Appendix in Byrne and Zekaite (2018).

[55] This non-linear specification uses the unemployment rate as the slack measure and also includes a measure of labour underutilisation.

unemployment rates higher than 9.5%. The euro area labour market tightened between 2013 and 2016, but the unemployment rate nevertheless remained within this flat region. This tightening did not lead to greater wage growth over this period. Since 2017, however, the unemployment rate reached values in the steeper region of the non-linear Phillips curve.

**Nevertheless, caution is needed when ascertaining any kind of non-linearity.** Uncertainty is high owing to limited sample size and the possibility variables having been omitted. Even though the time variation seems to be limited, models explicitly including state dependency would suggest there to be convexity in the euro area wage Phillips curve, which, at the current juncture, supports a stronger recovery in wage growth as the labour market continues to improve than it has done in recent years.

## 3.3 A structural approach to understand wage growth[56]

**Structural analysis has helped to identify the underlying economic shocks that have driven wage growth in recent years.** While a reduced-form Phillips curve model can help to identify the contribution of inflation expectations, labour market slack or productivity growth to wage growth, a structural model can help to distinguish the underlying economic shocks driving the variables of interest (global factors, labour supply changes or structural reforms, among others). Using a structural model also overcomes potential simultaneity biases in identifying the Phillips curve slope when correlated demand and supply shocks are hitting the economy.[57]

**A structural vector autoregressive (SVAR) model is used to disentangle the main underlying economic shocks that affected the labour market in the euro area.** Six types of shocks are considered and are related to domestic and global demand, domestic technology (supply), labour supply, wage bargaining and oil supply shocks. The restrictions imposed to identify this model are in line with the literature on identifying labour market structural shocks and domestic versus global shocks (see Table 2).[58] More precisely, the shocks are identified as follows:

- following a *positive domestic demand shock* employment, inflation and real GDP unambiguously increase, and the unemployment rate decreases;
- a *domestic technology shock* which reduces the marginal cost for firms would push inflation down, but owing to the increase in productivity, there is also an increase in employment and real GDP (with respect to the rest of the world);
- a *labour supply shock* increasing the labour force participation would lead to a fall in wages and an increase in the unemployment rate, as new people entering the labour force do not find a job immediately;

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56 This section includes contributions from Carlos Montes-Galdon and Styliani Christodoulopoulou (both ECB).

57 Also, as Galí and Gambetti (2019) discuss, the disturbance term in a reduced form relationship might not be orthogonal to the right–hand-side variables; it might capture shocks to the natural wage markup, which in turn affects the rest of the macro variables.

58 See Foroni et al. (2015) and Bobeica and Jarociński (2019).

- a *wage bargaining shock* that leads firms to capture a larger share of the bargaining surplus (and workers to lose bargaining power) implies a reduction in wages and the marginal cost of production for firms, leading to a reduction in prices but an increase in real production and employment;
- a *global demand shock* that would have a negative impact on global inflation and activity would have a similar impact on euro area inflation and activity, but to a lesser extent;
- an *oil supply shock* that would decrease oil prices would also decrease domestic inflation but improve economic activity (unemployment unambiguously goes down).

**Table 2**

Restrictions used to identify the structural shocks

| | Domestic demand | Technology | Labour supply | Wage bargaining | Global Demand | Oil supply |
|---|---|---|---|---|---|---|
| **Employment** | + | + | + | + | | |
| **Inflation** | + | - | | - | - | - |
| **Real wages** | | + | - | - | | |
| **UR** | - | | + | - | + | - |
| **Oil price** | 0 | 0 | 0 | 0 | - | - |
| **Share of euro area GDP in the world** | + | + | + | + | + | |

Note: Restrictions imposed on contemporaneous relationships; empty cells show that a sign restriction was not imposed.

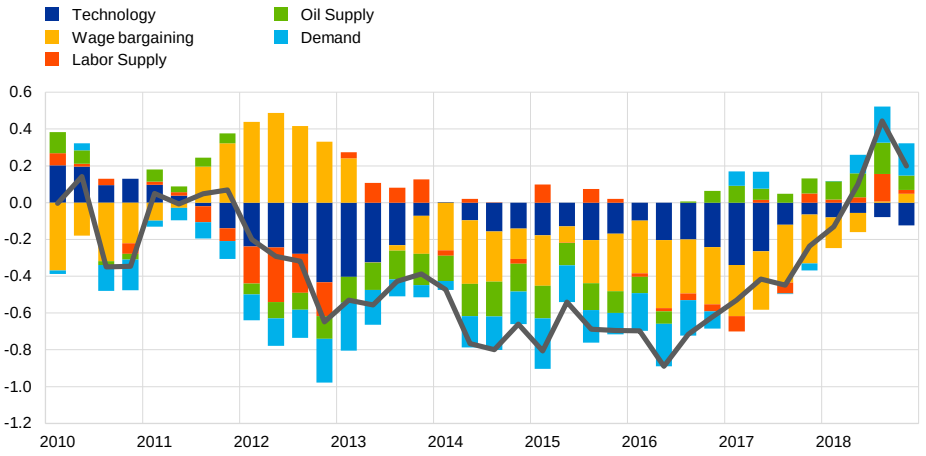
**Based on this SVAR model, low wage growth over recent years can be explained mainly by technology and wage bargaining shocks (see Chart 17).** The historical decomposition of the euro area wage growth suggests that while the negative influence of domestic demand and oil supply shocks have stalled, technology and wage bargaining shocks have continued to put a drag on wage growth until recently. The technology shocks could reflect that productivity advancements in the euro area are relatively subdued, or that technological absorption is occurring at a diminishing pace. The wage bargaining shocks could capture the longer-lasting impact of labour market reforms and/or some loss in workers' bargaining power.[59] In the immediate aftermath of the crisis, the positive contribution from wage bargaining shocks could reflect pent-up wage restraints, whereby nominal wage rigidities prevented wages from falling in tandem with economic fundamentals. The sizeable contribution from wage bargaining shocks that reduce wage growth and increase employment in the short run could help to rationalise the disconnect between wage growth and employment growth observed over recent years.

[59] See Masuch et al. (2018) and the discussion in subsection 3.6.1 of this Occasional Paper.

**Chart 17**

Shock decomposition of wage growth in the euro area

(percentage point deviation from model mean, annual percentage change)




Source: ECB calculations.
Notes: wage growth = compensation per employee. Domestic and global demand shocks have been combined in one shock for presentation purposes.

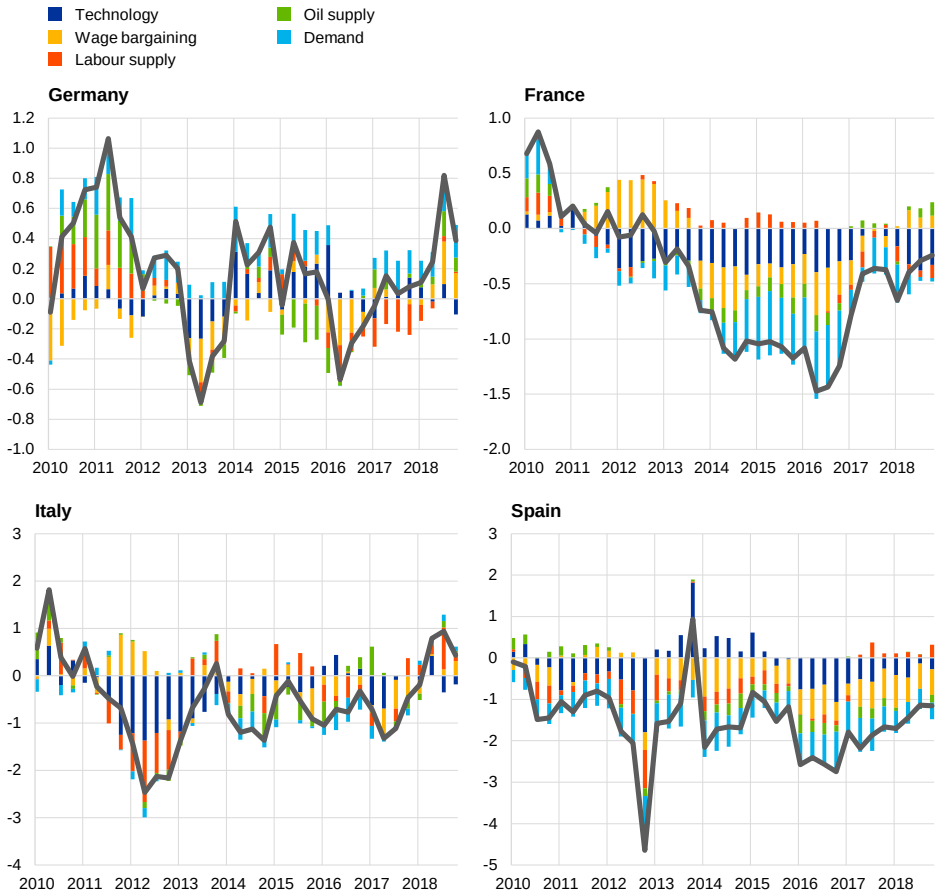
**Marked differences in terms of shocks driving wage growth arise for the largest euro area countries (see Chart 18).** While in Germany the wage gap (wage growth minus the unconditional forecast) has been positive for most of the period analysed, apart from in 2013 and 2016, in the other three large Member States (France, Italy and Spain) this gap has been negative throughout, with very few exceptions. In Germany, demand shocks have put upward pressure on wage growth, while in the other countries they have dragged wage growth down. Contributions from wage bargaining shocks have been increasingly positive in the last few quarters in Germany, with some evidence of higher union bargaining power in major industries displayed by higher strike activity in 2018 compared to the previous years. In the rest of the countries, these contributions tended to be negative in the period 2014-17 and could reflect, to some extent, the impact of labour market structural reforms.[60] Labour supply shocks seem to have negatively influenced wages in Germany over the last couple of years (potentially linked to immigration). Low contributions from technology (supply) shocks (which is also reflected by weak productivity developments) have held back wage growth across all four countries.

[60] The positive contributions from wage bargaining shocks in 2011-12 could reflect downward wage rigidities.

**Chart 18**

Shock decomposition of wage growth in Germany, France, Italy and Spain

(percentage point deviation from model mean, annual percentage change)




Notes: wage growth = compensation per employee. Domestic and global demand shocks have been combined in one shock for presentation purposes.

## 3.4 Trend determinants of low wage growth[61]

**Cyclical and slow-moving drivers of wage growth coexist over the short and medium term.** It is therefore important to disentangle the relative contributions of cyclical factors from trend developments in nominal wage growth. This is because changes in trends are normally associated with amore long-lasting adjustment and might, for example, capture the impact of persistent shocks to productivity growth as well as shifts in inflation expectations and thus have different policy implications compared to cyclical fluctuations.

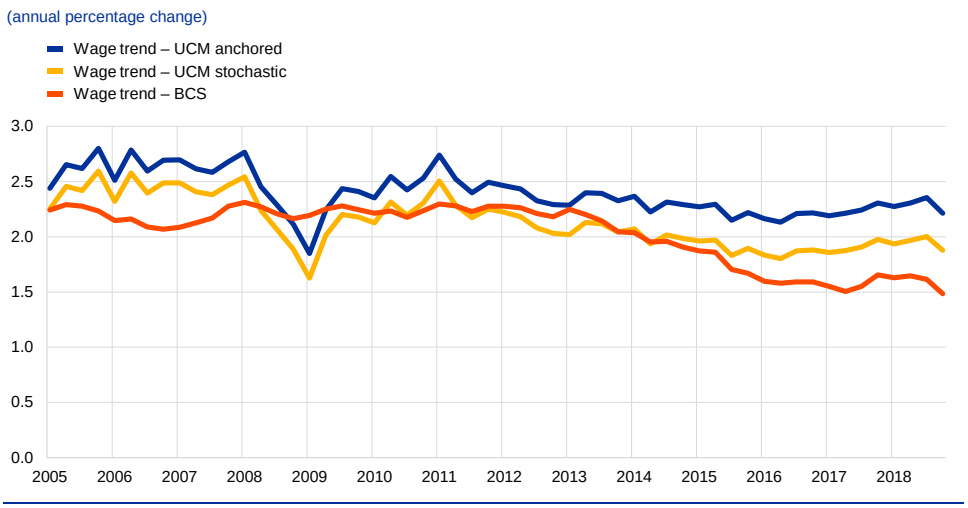
**Trend wage growth in the euro area appears to have been moving downwards.** The trend component in wage growth is an unobservable variable surrounded by high estimation and model uncertainty. With the aim of hedging against model uncertainty, Chart 19 shows the estimated trend component of wage growth stemming from two different models: a multivariate unobserved components model (UCM) that has been

[61] This section includes contributions from Carlos Montes-Galdon and Máté Tóth (ECB).

used in the calculations of Chapter 2 as well, and an extended version of the Blanchard, Cerutti and Summers (2015) model (extended BCS model). [62] In the UCM the wage growth trend consists of the inflation trend,[63] trend total factor productivity (TFP) growth and capital deepening (where the sum of the latter two corresponds to trend labour productivity growth, measured as output divided by the number of employed persons). In the extended BCS model, trend wage growth is explicitly the sum of the inflation trend and the labour productivity growth trend.[64] The essential difference between the two models is that the extended BCS model has time-varying parameters, whereas the UCM has fixed coefficients. Furthermore, the UCM covers a richer economic structure and features an embedded production function. In this section two sets of estimates based on the UCM are reported: one includes an explicit inflation anchor corresponding to a value below, but close to, 2% ('anchored'), while the other features a stochastic trend process that allows for more variability in trend inflation ('stochastic'). Both models show a downward movement in the trend wage component over the last two decades, which is especially pronounced in the period 2013-17 and most clearly visible in the extended BCS model.

**Chart 19**

Estimated trend component of wage growth for the euro area




Sources: Eurostat and ECB calculations.
Notes: "UCM" stands for an Unobserved Components Model and "BCS"stands for an extended version of the Blanchard, Cerutti and Summers (2015) model. See Box 4 for more details on these models. Latest data: Q4 2018.

**Trend wage developments in the euro area appear to be part of a rather generalised phenomenon across countries.** Chart 20 shows the range of the estimated trend component of wage growth for the euro area countries based on the

62 For an overview of the two models, see Box 4.

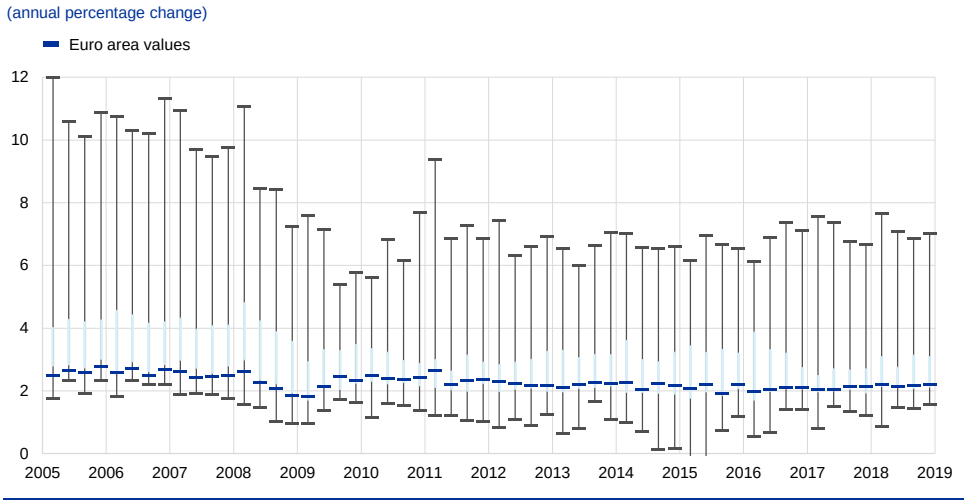
63 The inflation trend in the anchored UCM version is the trend for HICP inflation excluding food and energy (HICPX) plus two discrepancy terms accounting for (i) the difference in the sample averages of HICP inflation and HICPX inflation and (ii) the difference in the sample average of HICP inflation and 1.9 (i.e. a number below, but close to, 2%).).

64 There are two trends in the model: one for underlying inflation and one for productivity growth. Trend nominal wage growth is the sum of those trends. It is therefore imposed that in the long run, real wage growth is in line with productivity growth. As a result, trend unit labour costs mirror the changes in trend inflation (which is modelled as a univariate process, similarly to the productivity growth trend).

UCM[65]. Starting in 2008, there is some downward tendency in wage growth when compared to the pre-crisis period and there is some evidence of cross-country convergence in wage trends. Nevertheless, with respect to trend developments, cross-country heterogeneity remains considerable.

**Chart 20**

Estimated trend component of wage growth based on the UCM in euro area countries




Sources: ECB and NCBs calculations.
Notes: Light blue captures the 30th and 70th percentiles across countries. Grey lines show the min-max across countries.

**Both cyclical and trend factors have contributed to the period of low wage growth in the euro area.** Although the underlying structure of the two models applied here differs, Chart 21 and Chart 22 show that both factors played a role for subdued wage growth in the UCM and the extended BCS model. The cyclical contributions to wage growth turned from a positive contribution of around 0.0 percentage points (UCM, anchored) and 0.23 percentage points (extended BCS model) on average between 2001 and 2008 to a negative contribution of around -0.6 percentage points (extended BCS model) and -0.9 percentage points (UCM, anchored) on average for the period 2013-16.[66] Since the end of 2017 the cyclical contributions have reverted to slightly positive contributions in the extended BCS model. In the anchored UCM version the contributions from the cyclical part turned positive only towards the end of 2018, while the stochastic trend version is more similar to the results of the extended BCS model. This analysis also suggests that a decline in the contributions from trend factors by about 0.3 percentage points (UCM and extended BCS model) has weighed on wage growth until recently when the decline stabilised compared to the period 2001-08. In relative terms, the decline in wage growth mainly stemmed from the cyclical components when comparing to 2008, but in the more recent period, between 2013 and 2016, it was more related to the trend component.

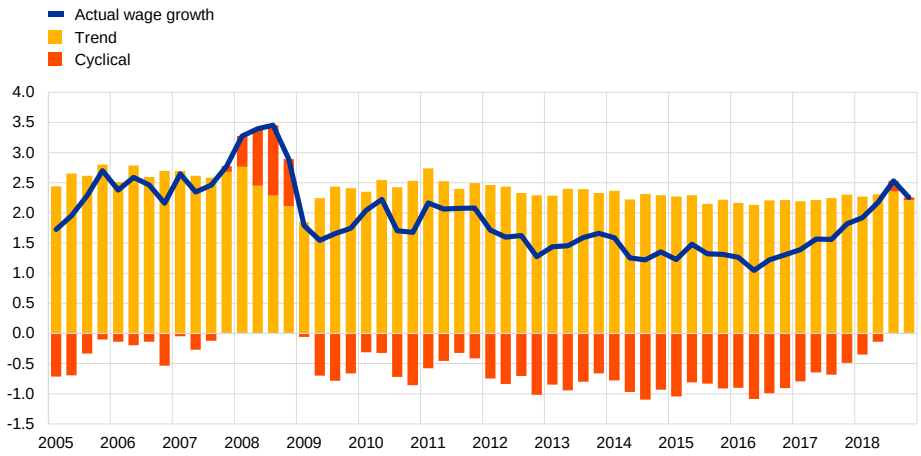
65 This model has been chosen for comparability reasons, as the extended BSC model with time-varying parameters requires a long history of data, which are not available for some of the small countries in the sample.

66 The precise estimates change with the estimation sample, but qualitatively, the lessons remain.

**Chart 21**

Trend/cycle decomposition of wage growth – UCM, anchored

(annual percentage change and percentage point contributions)

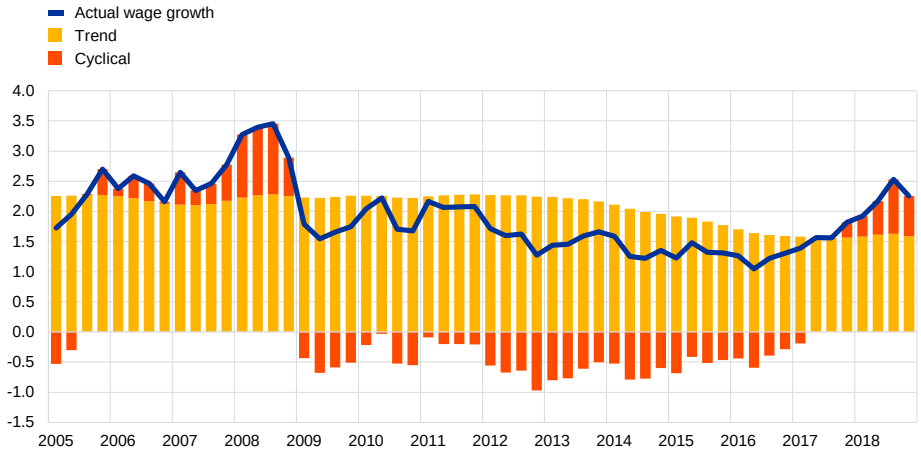



Source: ECB calculations.
Notes: See Box 4 for more details on these models. Latest data: Q4 2018.

**Chart 22**

Trend/cycle decomposition of wage growth – extended BCS model

(annual percentage change and percentage point contributions)




Source: ECB calculations.
Notes: See Box 4 for more details on these models. Latest data: Q4 2018.

**The downward movement in trend wage growth can be linked to developments in trend inflation and trend productivity growth.** In theory, nominal trend wage growth should reflect the trend increase in prices of goods and services and the trend growth of labour productivity. Estimates for the euro area based on the extended BCS model and the UCM version with the stochastic trend indicate a decline in trend inflation (Chart 23). The smaller contributions from trend inflation are in line with findings in Ciccarelli and Osbat (2017) showing that over the period 2012-15 measures of trend inflation declined and inflation persistence increased.[67] Estimates based on the anchored UCM version show a very marginal decline compared to the

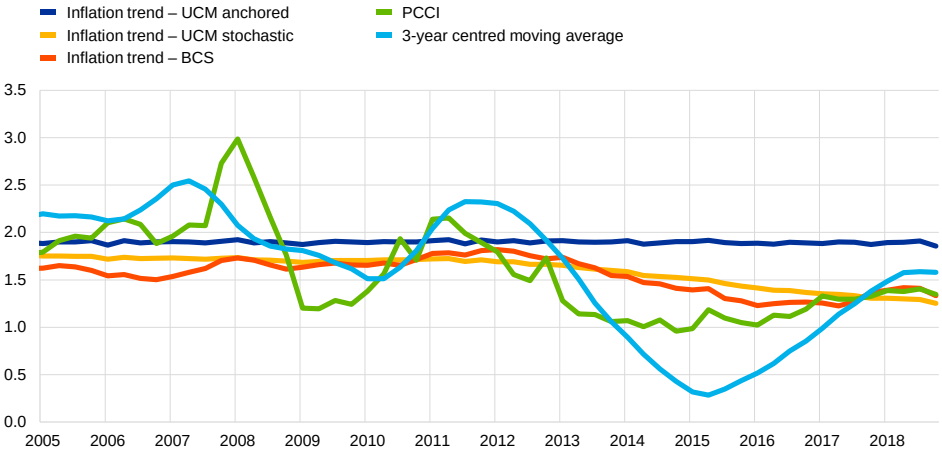
[67] In addition to aspects more closely related to monetary policy, such as the role of inflation expectations, the authors discuss the impact of structural processes such as demographic change and e-commerce.

other two models, as they include an effective anchor for inflation. Chart 24 shows that trend productivity growth has been on a downward path in the euro area, which could reflect a more persistent trend. The productivity slowdown is a global tendency[68], which has been traced back to the deceleration in the rate of technological progress and diffusion, declines in business dynamism, and ageing. In the case of the two UCM versions, this downward path has receded or even reversed to some extent in the most recent periods.

**Chart 23**

Estimated trend component of inflation for the euro area

(annual percentage change and three-month moving average annualized (PCCI))

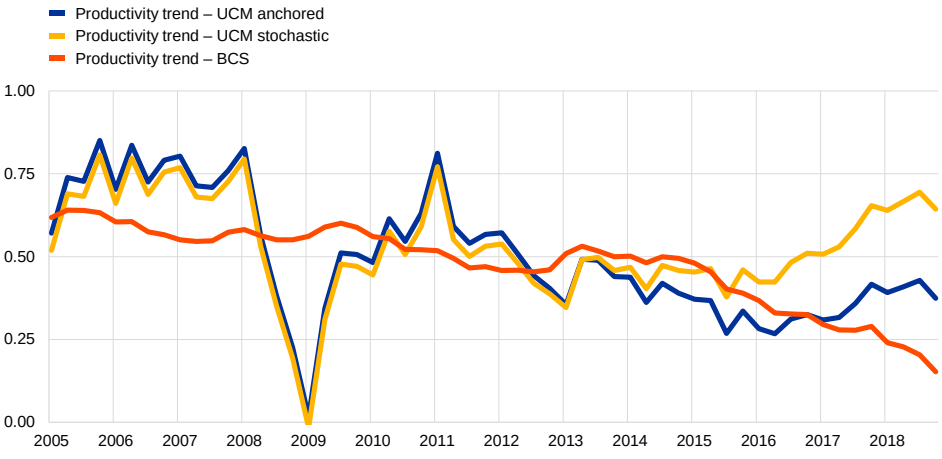



Source: ECB calculations.
Note: See Box 4 for more details on the models. PCCI refers to the HICP – Persistent and Common Component of Inflation (frequency exclusion measure of underlying inflation – all items). Latest data: Q4 2018.

**Chart 24**

Estimated trend component of productivity growth for the euro area

(annual percentage change)




Source: ECB calculations.
Notes: See Box 4 for more details on the models. Latest data: Q4 2018.

[68] See European Central Bank (2017b).

**In addition to the decline in trend productivity growth, there is some evidence of the link between productivity and wage growth weakening (see Box 5).** This could be related to a number of factors, such as a decline in workers' bargaining power resulting from institutional changes, technological progress and global integration.

## Box 4
Models used for extracting the wage growth trend

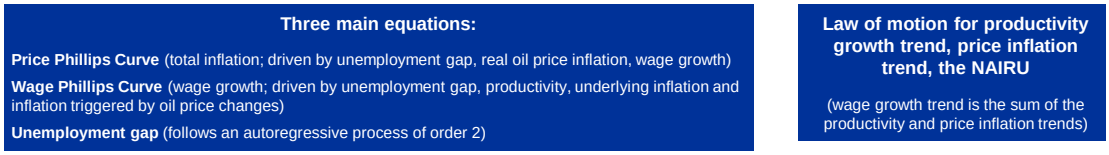
**Prepared by Carlos Montes-Galdon and by Máté Tóth (ECB)**

This box provides an overview of the set-up of the models used to extract the trend component in wage growth and its drivers. The use of several models is warranted by the fact that trend wage growth is an unobserved variable subject to considerable model uncertainty. Two complementary models are considered which assume a reduced form structure of the economy governing the links between the key macroeconomic variables. The main elements of these models are described below.

### The extended Blanchard-Cerrutti-Summers (BCS)[69] model

**As in the original BCS model, a time-varying parameter Phillips curve with stochastic volatility characterises the dynamics of inflation and the slack measure is endogenously determined. The model also includes a wage Phillips curve and links between the various trends (see Figure A).** The wage trend is assumed to be the sum of a productivity trend and an inflation trend. The model also exploits the economic relationships between wage growth, price inflation and the unemployment rate to help identify the non-accelerating inflation rate of unemployment (NAIRU). Most of the literature focuses on a NAIRU that relates only to price inflation. However, economic slack can also have an important impact on wage growth, which in turn affects price inflation. Estimating the parameters in a wage Phillips curve together with the NAIRU could help to tackle the apparent disconnect between labour market conditions and wage growth seen in the past few years, since the model estimates what level of NAIRU is consistent with observed wage inflation.

**Figure A**
The extended BCS model. A reduced form model with behavioural equations derived from a New Keynesian structural model




Notes: Allows parameters and variance of shocks to vary over time; allows variation in long-term trends; NAIRU is estimated endogenously; Estimation using a non-linear constrained Kalman filter.

### A multivariate unobserved components model with an embedded production function[70]

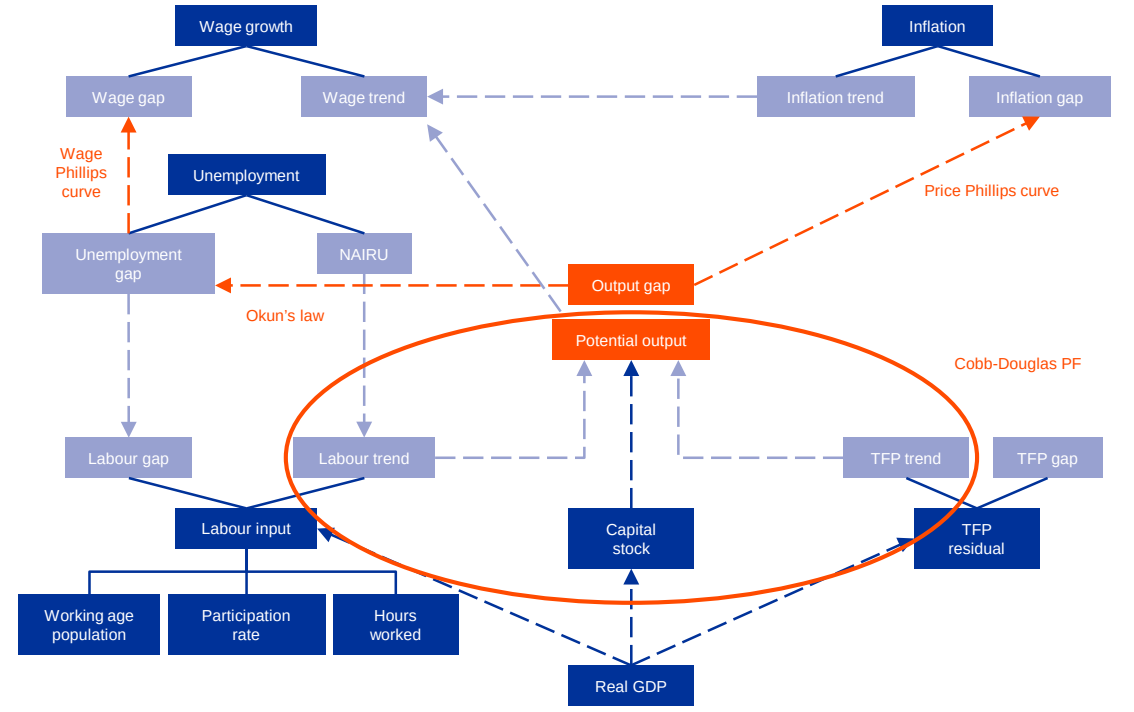
**A multivariate unobserved components model (UCM) with time-invariant coefficients is also used to estimate a measure of trend wage inflation.** This UCM combines a multivariate filter with a Cobb-Douglas production function and thus allows potential output estimates to incorporate more economic structure than the traditional production function approach does while retaining the ability to

69 Blanchard, O. et al. (2015).
70 Tóth, M. (2019) and Andersson et al. (2018)

conduct growth accounting exercises. The model is a backward-looking state space model estimated with Bayesian methods employing the Kalman filter to jointly decompose six key observable variables (real GDP, unemployment rate, labour force participation rate, hours worked per person, a measure of core inflation and wage inflation) into trend and cyclical components. To do so, it relies on several economic relationships, such as a wage Phillips curve and a price Phillips curve and Okun's law type relationship. Three additional variables enter the model as exogenously determined observables: capital stock, working age population and the long-term unemployment rate.

From the perspective of this paper, the most important features of the UCM are price and wage determination. Both inflation and wage growth are decomposed to trend and cycle. The cyclical component of wage growth is assumed to be driven by a wage Phillips curve, which relates the former to its lagged value and labour market slack, as defined by the unemployment gap. The wage inflation trend is determined by trend inflation and trend labour productivity growth, where the latter can be further decomposed to trend TFP growth and capital deepening. Trend inflation is modelled as either a mean reverting process anchored by a target value or a stochastic trend. The cyclical component of inflation is related to its lag(s) and the output gap via a price Phillips curve.

**Figure B**
The stylised representation of the UCM used in this paper




Source: ECB.

## Box 5
Assessing the link between productivity and wage growth

**Prepared by M.-S. Pagliari, P. López-Garcia, E. Bobeica, and E. Lis (all ECB)**

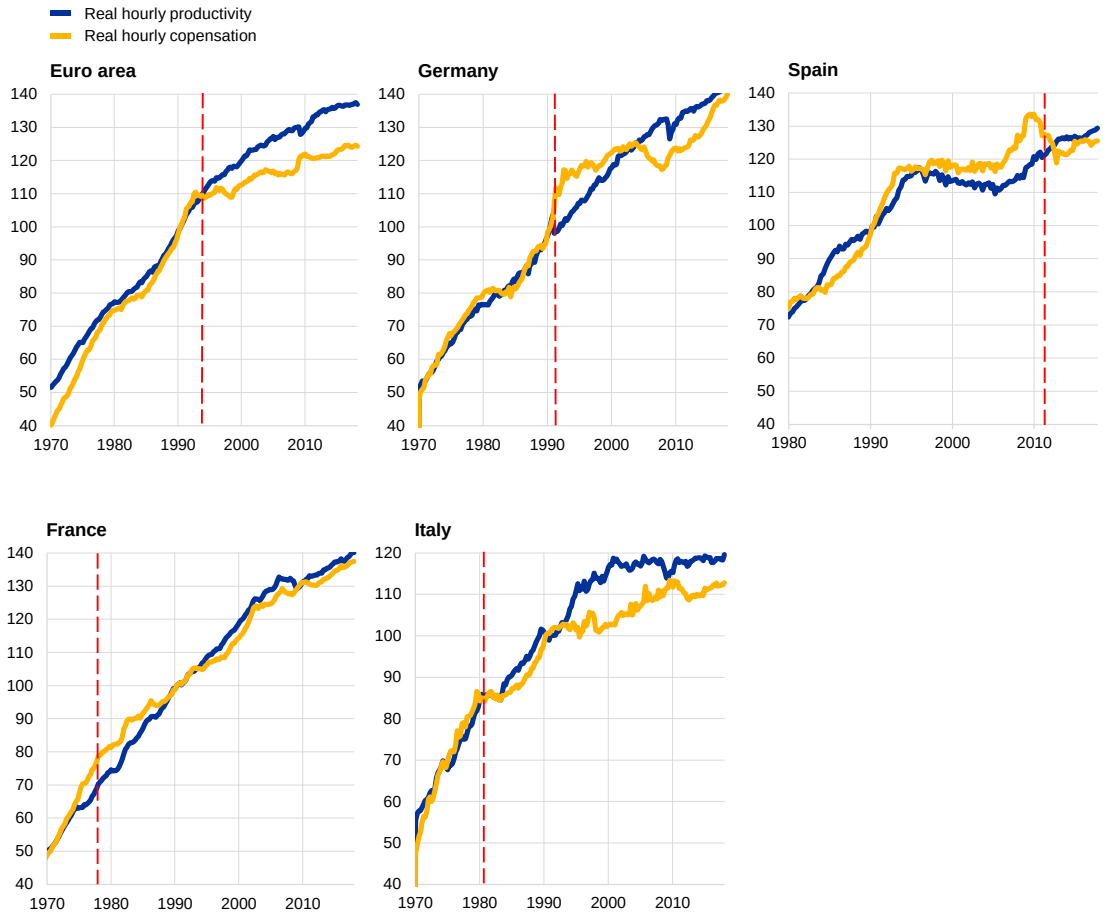
**There is some evidence that during recent decades the link between productivity and wage growth in the euro area has been weaker than it was before.** Standard economic theory suggests

that productivity gains should translate into real wage gains for workers.[71] This was also the case in the euro area from the early 1970s to the 1990s – as shown in **Chart A**: real hourly compensation increased very much in tandem with labour productivity. From the early 1990s, however, the link between productivity and real wage growth weakened considerably in the euro area, leading also to a substantial fall in the labour share.

**Chart A**

Real hourly compensation and productivity

(index, 1990 = 100)




Sources: Eurostat and national authorities.
Note: Compensation is deflated using the consumer price index, while productivity is deflated using the GDP deflator.

**At the euro area country level, large heterogeneity characterises the relationship between productivity and real wage growth so that the picture at the aggregate may not be representative for each country.** As also pointed out by the IMF (2017a, 2017b) and the OECD (2018a), this heterogeneity applies to the existence, extent and timing of a decoupling of productivity and wage growth. A decoupling is particularly marked for the overall euro area and Italy, though literature provides mixed evidence of the phenomenon[72]. In other countries compensation growth only fell behind productivity increases more recently. By means of break and variance ratio tests, we find statistically significant breaks in the link between productivity and compensation in the euro area and

[71] We take a long-term perspective and thus we complement existing analyses which cover more recent samples.

[72] For instance, Torrini (2016) finds no evidence for a marked decoupling in Italy.

the largest euro area countries, also accompanied by a change in the volatility of both productivity and compensation growth rates. However, the timing of such breaks varies from country to country. Notably, in the aggregate euro area economy the break is identified in around 1993; in Germany the most prominent break is detected in 1991; in Italy and France the break occurs earlier, more in line with the existing literature on the United States; whereas in Spain the break is detected in 2010.[73] The different timing across countries could reflect differences in technological advancements, global integration and institutions or regulations (see IMF (2017b)).

**Empirical analyses for the euro area support the view that productivity growth has been passed through less strongly to wage growth – thereby contributing to more moderate wage dynamics since the early 1990s.** We investigate how the relationship between compensation and productivity has changed over time based on an autoregressive distributed lag (ARDL) model with year-on-year compensation growth as dependent variable. We also include the (lagged) unemployment rate among the regressors and control for cointegration between wage and productivity growth. The results indicate that in the euro area the link was very strong before 1993, but a stark decoupling has occurred since then (see Table A).

**Table A**

Regression results – euro area

(index, 1990 = 100)

| | (1) ARDL(5,0) | (2) ARDL(1,0) | (3) ARDL(5,0) |
|---|---|---|---|
| $\Delta comp_t$ | Q1 1970 – Q1 2018 | Q1 1970 – Q2 1993 | Q4 1993 – Q1 2018 |
| prodt | 0.878*** (0.232) | 1.353*** (0.403) | 0.190 (0.275) |
| compt-1 | -0.197*** (0.0421) | -0.225*** (0.0659) | -0.288*** (0.0726) |
| Ut-1 | -0.0772** (0.0317) | -0.0332 (0.0481) | -0.0627 (0.0429) |
| Observations | 176 | 79 | 98 |
| R-squared | 0.285 | 0.152 | 0.365 |
| F-test – H0: long-run coefficient equal to 1 | | | |
| Test statistic | 0.28 | 0.77 | 8.66 |
| P-value | 0.60 | 0.38 | 0.00 |

Notes: ***p < 0.01, **p < 0.05, *p < 0.1. Standard errors in parentheses. Break dates are detected via a Supremum Wald test on the coefficients of the regression $comp_t = \alpha_0 + \alpha_1 prod_t + \varepsilon_t$. Lag lengths of the model are selected using the Schwartz information criterion (SIC). Not all the lags are depicted in this table here. Legend – Long-run effect of productivity growth on compensation growth: red; Speed of adjustment factor : blue. Short-run coefficients: green.

**We complement the long-term macro perspective with a more granular view based on firm-based data, zooming in on the changes in the aftermath of the Great Recession.** Analyses that attempt to link productivity and wages at the macro level are missing out on how this relationship may be influenced by individual firms' characteristics. Current research shows that firms' size and productivity seem to be the most relevant characteristics for wage-setting.[74] Bigger and more productive firms pay higher wages. Going beyond these well-established stylised facts, this box answers the following questions: (i) Is the link between wage and productivity growth dependant on firm characteristics such as size or productivity? (ii) Has the link between wage and productivity growth adjusted in different ways in different firms since the crisis? We explore the firm-based

[73] Detailed results are not shown here and are available upon request.

[74] See Berlingieri, Calligaris and Criscuolo (2018).

CompNet database, which pools detailed information on indicators related to competitiveness, including the full distribution of variables in a given sector, obtained from administrative sources.[75]

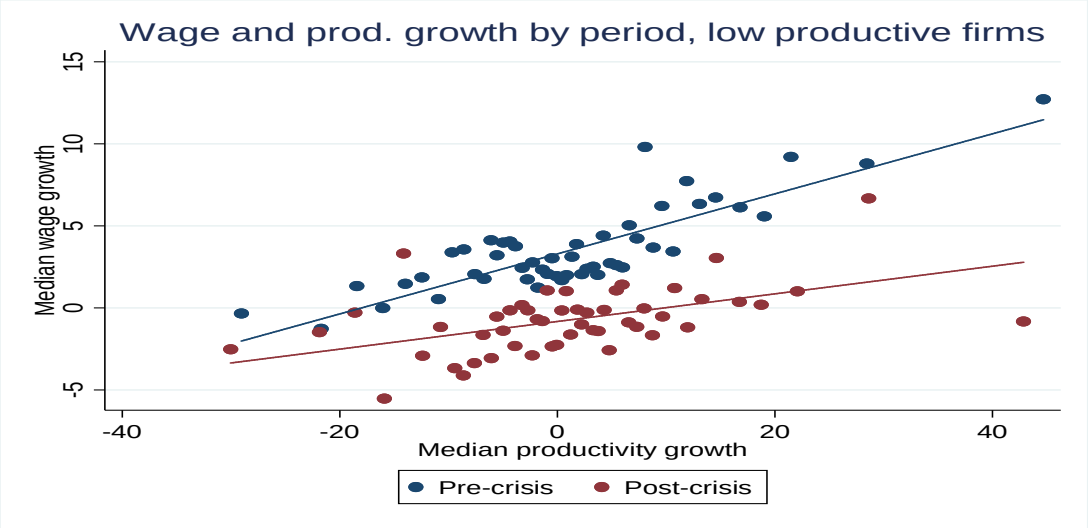
**First, descriptive evidence shows that there is a positive productivity-wage growth pass-through both in less productive and highly productive firms operating in the same industry (see Chart B and Chart C).** Nevertheless, for any level of productivity growth wage growth is lower than it was before the crisis across all firms.

**Chart B**

Real average wage and labour productivity in less productive firms

**Within each 2-digit industry, pre-crisis and post-crisis**

(annual growth rate)




Source: CompNet database.
Notes: Low productive firms are those at the bottom tercile of the Total Factor Productivity (TFP) distribution of the sector. TFP is computed as firm's real value added over a weighted average of capital and labour. Pre-crisis is defined as 2004-2007 and post-crisis as 2013-2015.

**Second, the two charts also show that the extent to which firms pass productivity gains through to their workers has changed since the crisis, but only in less productive firms.** For less productive firms the curve has flattened and shifted down by more (see Chart B) than it has for the highly productive firms (see Chart C).[76] Similarly, only small firms in any given industry have decreased their pass-through since the crisis.

[75] The data are available from the early 2000s to 2015 for France, Italy, Spain, the Netherlands, Belgium and Portugal (data for Germany were not included, as they only covers large firms). The samples cover about 40%, on average, of firms and employment in the given country and are based on information from balance sheets and loss and income accounts of non-financial corporations with employees operating in business sectors. Firm-level information has been weighted to be representative of the population by macro sector and size class. For more information on the dataset, please refer to Lopez-Garcia et al. (2015), Lopez-Garcia (2018) and CompNet (2018), all available on CompNet's website.

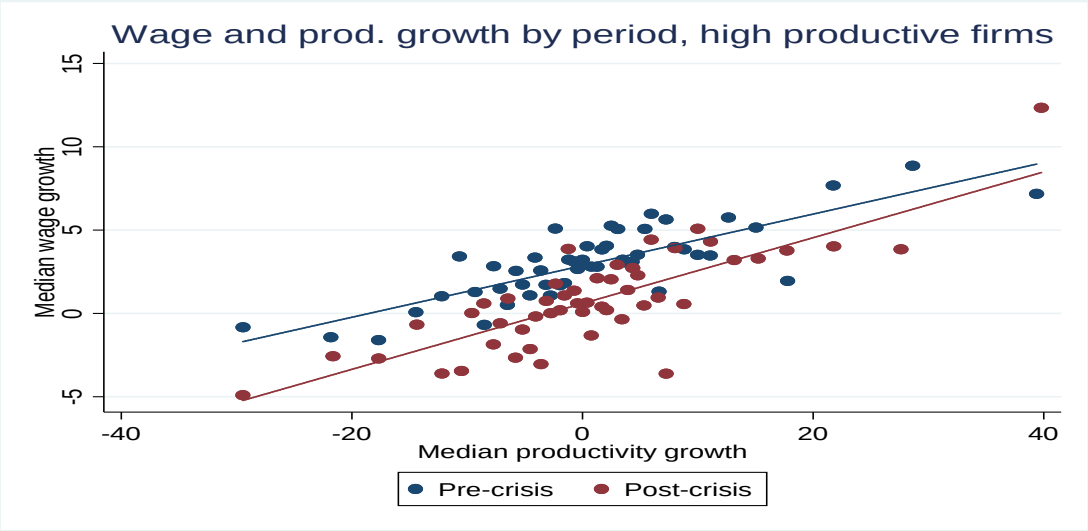
[76] We focus on firm productivity as a driving firm characteristic throughout the box, but the results are similar when looking at firm size.

**Chart C**

Real average wage and labour productivity in highly productive firms

**Within each 2-digit industry, pre-crisis and post-crisis**

(annual growth rate)




Source: CompNet database.
Notes: High productive firms are those at the top tercile of the Total Factor Productivity (TFP) distribution of the sector. TFP is computed as firm's real value added over a weighted average of capital and labour. Pre-crisis is defined as 2004-2007 and post-crisis as 2013-2015.

**More formal evidence also confirms a positive, but incomplete pass-through from productivity to real wages, with a flattening for smaller/less productive firms.** We employ a panel Phillips curve where we control for economic slack (as given by the unemployment gap). Chart D shows the results for a fixed-effects regression where we look at the sector-productivity tercile variations in each country and we also investigate whether the relationship has changed since the crisis.[77] The slack term has the negative expected sign. The results pre-empted by the scatter plots are confirmed, namely that there is a positive link between productivity growth and real wage growth, but the pass-through is less than one. These estimates confirm the result based on macro data that over the past two decades real average wage growth fell short of productivity growth (i.e. falling labour shares). Note as well that over the pre-crisis period (and also on average over the whole) workers in the most productive firms reap the benefits from productivity growth to a lesser extent than their counterparts do in less productive firms, even after controlling for the sector of activity. This could be related to the fact that frontier firms tend to have lower labour shares, as they rely a great deal on capital-intensive technologies (see IMF (2017b)). These are known as "winner-takes-most" dynamics.[78] Moreover, the link between productivity growth and real wage growth has changed more dramatically for less productive firms since the crisis. Unlike in less productive firms, the crisis did not affect the wage-productivity correlation in large and more productive firms. The reasons for this difference are not entirely clear cut but could be related to a composition effect whereby small firms hired lower-wage lower-skilled labour after the crisis whereas large, more productive firms did not alter their hiring practices.

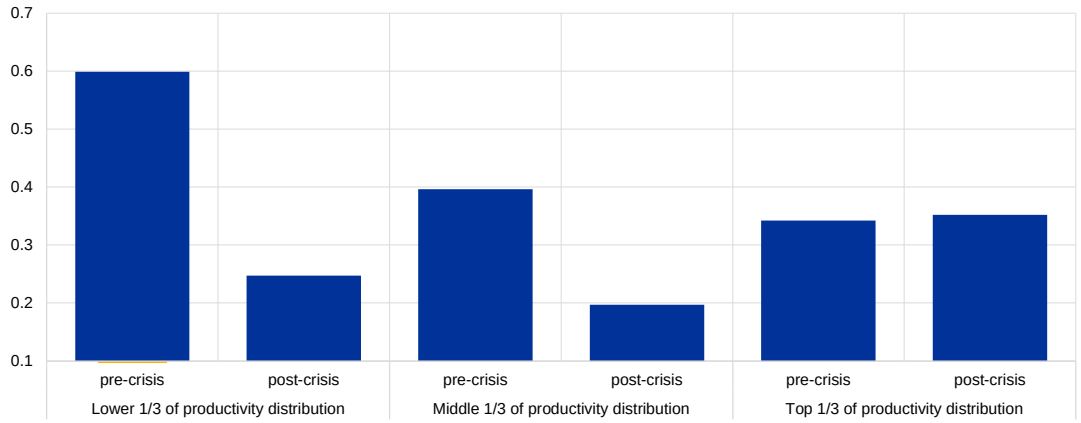
[77] Several robustness checks have been performed, such as looking at sectors or including dummies for the productivity category instead of the time period.

[78] OECD (2018a) shows that the decoupling at the technological frontier mainly reflects the entry of firms with low labour shares into the frontier rather than decoupling in incumbent frontier firms, suggesting that thus far "winner-takes-most" dynamics are mainly explained by technological dynamism.

**Chart D**

Estimated pass-through from productivity growth to real wage growth

(median of the sector for firms in different productivity terciles, pre-crisis versus post-crisis)




Source: Author's calculations based on CompNet database.
Notes: Countries included are Belgium, France, Italy, Netherlands, Portugal and Spain. Pre-crisis is defined as the period 2002-07 and post-crisis as the period 2012-15. Sample of non-financial corporations with employees operating in all business sectors. Fixed-effects regression (at the country-sector-productivity tercile level) with errors clustered at the country-sector-productivity tercile. The pass-through is the estimated coefficient of labour productivity growth in a regression where the dependent variable is the median wage growth in the country-sector-year and labour market slack and year dummies are included.

**These micro-based results can help to explain the relatively subdued wage growth since the crisis.** We find, first, that small or less productive firms have diminished their productivity-wage pass-through significantly since the crisis. Second, the estimated pass-through is positive, but rather small for highly productive firms. Given that these innovative, frontier firms have recently been driving productivity (see OECD (2018b)), these two concurrent trends could be behind the observed macroeconomic dynamics. However, more research is needed to fully understand and disentangle the underlying causes of the observed phenomena.

## 3.5 The impact of long-term structural changes on wage growth

**In addition to cyclical developments, "structural drivers" could also affect wages.** These structural drivers could include, for example, the effects of globalisation, migration, demographic change or digitalisation.

**Analysing the effects of such structural drivers in detail goes well beyond the scope of this Occasional Paper and would merit a paper of its own.** This section reviews the existing literature on the role of major structural forces for wage growth and new evidence on selected issues, such as an expansion of standard wage Phillips curve approaches by foreign slack.

### 3.5.1 Globalisation[79]

**Global economic integration has increased strongly over the past 25 years.** Global trade relative to GDP has almost doubled, financial openness has quadrupled and global value chains have emerged as a worldwide phenomenon.[80]

**Global economic integration might have made national price and wage inflation less responsive to domestic capacity constraints.** There are two possible theories for this conclusion: either any sudden expansion in demand for goods would translate into higher imports rather than higher prices; or foreign competition would constrain wage or price increases in industries open to global competition, lowering the sensitivity of wages to domestic demand pressures. This could follow, for example, from the increase in competition from firms in lower-cost countries, including because of further integration in global value chains, which may be significant determinants for domestic price and wage inflation dynamics.

**One way of assessing whether globalisation has changed the role of foreign factors for domestic wage inflation is to augment the traditional Phillips curve with a measure of foreign slack.** The simplest indicator of global wage pressures is provided by a foreign unemployment gap, which measures the difference between the unemployment rate and the NAIRU for countries outside the euro area. Like any slack measure, it is surrounded by considerable uncertainty because the NAIRU is unobserved and must be estimated.

**A thick modelling approach addresses the uncertainty about the most appropriate specification of the Phillips curve by estimating a large set of specifications, including several different measures of (domestic and foreign) economic slack and inflation expectations.**[81] Including foreign slack is complicated by the fact that domestic and foreign slack are highly correlated. To tackle the problem of multicollinearity, an auxiliary regression is run to obtain the part of domestic slack which is not explained by foreign slack. These residuals are then used as a measure of domestic slack. Chart 25 shows the development of foreign and domestic slack (in terms of the respective unemployment gaps), as well as the series with the residual of domestic slack resulting from the auxiliary regression.[82]

79 Includes contributions by Alex Tagliabracci (BdI).

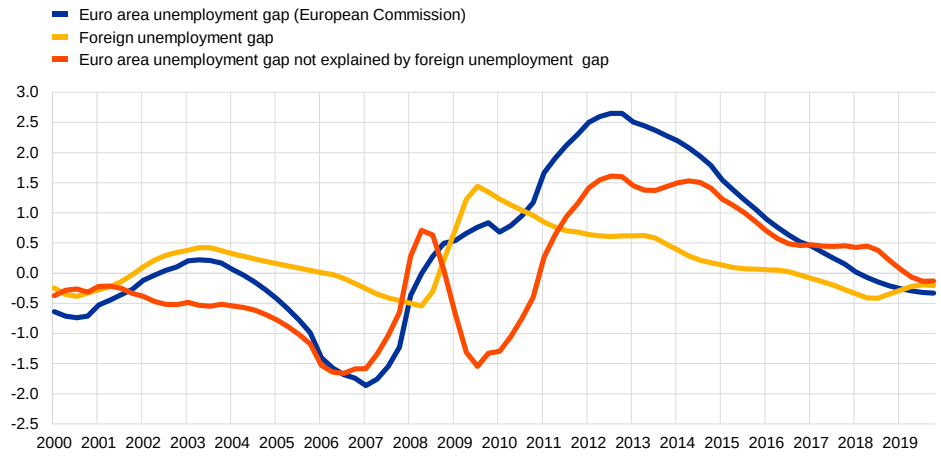
80 See ECB – working group on Global Value Chains (2019).

81 See for example Nickel (2017), ECB (2017c) or Tagliabracci, Osbat and Koester (forthcoming).

82 An alternative approach could be to directly include foreign inflation or wages.

**Chart 25**

Domestic and foreign labour market slack

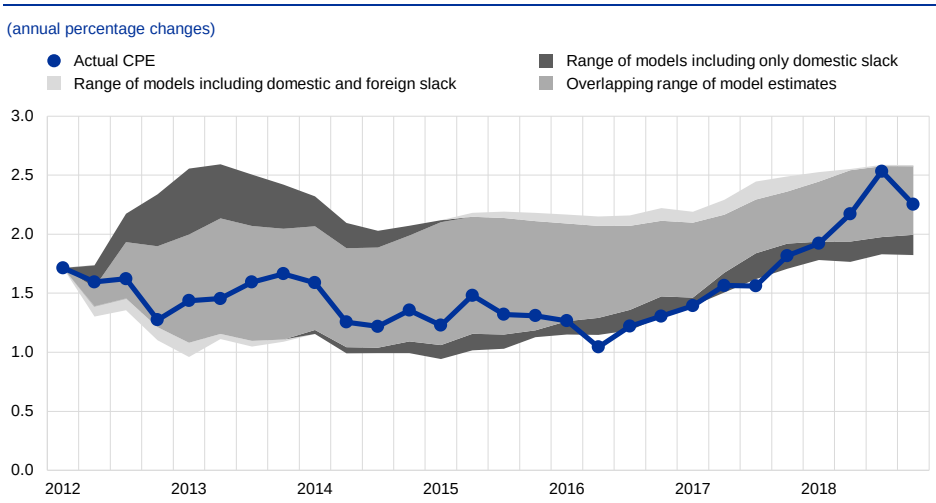



Sources: European Commission, IMF, Eurostat, ECB calculations.

**Augmenting traditional wage Phillips curve approaches in a thick modelling approach by measures of foreign labour market slack would have only very slightly improved the fit of Phillips-curve-based forecasts for compensation per employee growth over recent years on and mainly only in the period 2012-14.** Chart 26 illustrates that, especially from 2014 onwards, actual developments in compensation per employee have tended to be more at the lower bound of forecasts based on a broad range of fixed coefficient Phillips curve specifications conditioned on the outturns for different measures of domestic labour market slack. Also, including foreign labour market slack slightly shifts the range of forecasts in the period 2012-14 downwards and actual developments are then somewhat more in the middle of the range of estimates. However, these results have to be interpreted with some caution. First, they are driven only by a small share of specifications, at the upper and lower bound of the range of model estimates of a thick modelling approach, while the majority of specifications with and without foreign slack yield very similar results (as reflected in the overlapping range of model estimates). Furthermore, even for a period when developments in domestic slack differed substantially from developments in foreign slack, the effects seem to be minimal. Looking ahead, further analysis is needed for a solid assessment of the potential role of foreign slack for domestic inflation in the euro area and at the country level.

**Chart 26**

Phillips curve thick-modelling: Conditional forecast of compensation per employee growth in the euro area




Sources: Eurostat, ECB calculations.

**The theoretically appealing idea that domestic wage and price pressures are increasingly affected by global developments as a result of higher integration and the increasing contestability of labour and product markets is hence difficult to capture empirically.** In this respect, there is only limited support for including measures of global labour market slack and the integration in global value chains in Phillips curve analyses of wage growth in the euro area.

### 3.5.2 The role of ageing for low wage growth

**The euro area population has been ageing in recent decades.** Since the early 1980s falling fertility rates and increasing longevity have led to a decreasing growth rate of the working age population as a share in the total population, and the growth rate has even turned negative during the current decade. This has led to an increase in the share of older age groups in the workforce (see also the discussion on compositional effects in this section), which has been amplified by increases in the retirement age in many euro area countries.

**Compositional effects of ageing do not seem to have contributed to low wage growth in the euro area during recent years.** Wages tend, on average, to be higher for older employees, and to increase particularly strongly in the early years of a career and less so in the later phases. Changes in the age structure of employment can therefore have substantial effects on wage growth. The main channel for such effects seems to be the different wage levels, given that the average hourly wage of an employee aged 60 or older is more than 50% higher than that of an employee under 30.[83] The fact that wage growth tends to decrease with age works in the opposite direction. However, this effect tends to be more gradual and is therefore often less

[83] See also Bodnar (2018) and Dossche and Koester (2018).

important. In the euro area, the steady increase in the share of older employees before and after the crisis has supported average wage growth. The ageing of the baby boom generation and the strong increase in the participation rates of older people have pushed up the share of older workers in employment and – as these people typically work in higher wage categories – average wage growth as well. Hence, the compositional effects of ageing are unlikely to have played an important role for subdued wage growth in the euro area over recent years.[84]

**Ageing might also have an indirect impact on wage growth, although this is hard to identify.** Demographic change might also, for example, have an impact on relative prices as it raises demand for non-tradable old-age-related services relative to tradable commodities. This demand shift should increase the relative price of non-tradables[85], with knock-on effects on wages, which represent the largest share of input costs for services. However, such effects would support rather than depress wages. In any case, these effects are very hard to identify quantitatively and there is very little literature on them.

### 3.5.3 Migration[86]

**For some countries in the EU migration has played an important role for labour market developments – with possible knock-on effects on wage growth.** The role of migration can be illustrated, for example, by the contribution of foreign citizens to employment growth since 2013 (see Chart 27). In Malta, Austria, Luxembourg and Germany foreign citizens contributed more than 50% to total employment growth between the second quarter of 2013 and the first quarter of 2019.

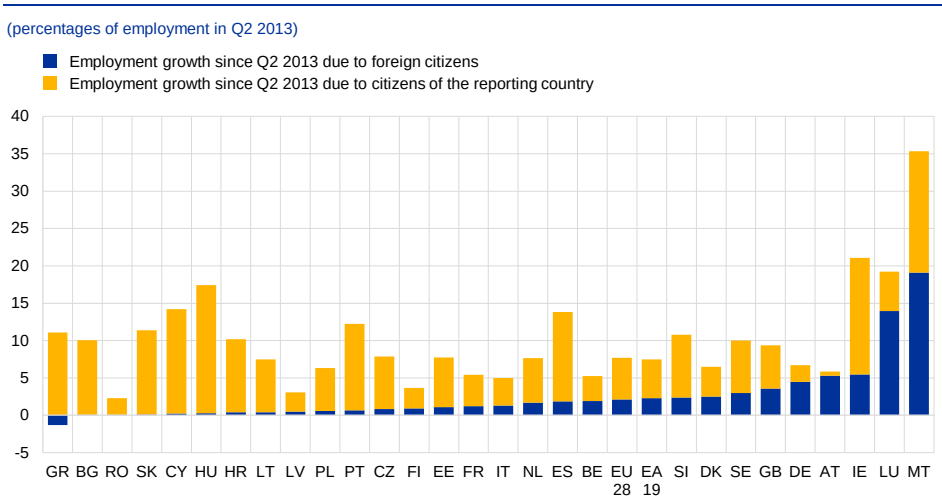
[84] See section on compositional effects in this report for a more comprehensive analysis of a change in the age composition of the workforce on wage growth, which includes not only ageing but also cyclical fluctuations in the employment of different age groups.

[85] See, for example, Groneck and Kaufmann (2017).

[86] Includes contributions by Katalin Bodnár (ECB).

**Chart 27**

Contribution of workers to employment growth by citizenship between the second quarter of 2013 and the first quarter of 2019




Sources: Eurostat, EU-LFS, ECB calculations.
Notes: 15-74 age group. The EU and euro area aggregates do not net out intra-EU/intra-euro area migration. The figures simply add up the employment of foreign citizens in EU/euro area countries. Seasonally adjusted by ECB staff.

**The impact of migration on wages has three main theoretical channels: changing the size of the labour force; changing the composition of the labour force; and more general equilibrium effects, which include the causal impact on the wages of non-migrants.**[87] The latter may reflect effects on the tightness of the labour market or effects linked to the differences between skill and age distribution of migrants relative to non-migrants. These effects could potentially be non-linear and change over time. Potential non-linearity and time variation, as well as model and parameter uncertainty, might (partly) explain the substantial differences in the results of empirical studies on the impact of migration on wages. In general, the overall impact of migration on wage growth is usually found to be small in the literature, while disentangling the impact of migration on wage growth from other determinants is quite challenging.

**For some countries in the euro area there is evidence that immigration might have contributed to low wage growth.** In Germany, for example, the Deutsche Bundesbank estimated an augmented Phillips curve, which shows that strong labour market-oriented net immigration from other EU Member States seems to have dampened aggregate wage growth since 2013.[88]

## Box 6

### The role of digitalisation for wage developments

**Prepared by Nicole Venus (CEMFI and ECB); Christiane Nickel and Gerrit Koester (ECB)**

Digitalisation is one of the major drivers of long-term changes in the labour market. A prominent concern is that automation in particular is endangering a large number of jobs and thereby putting

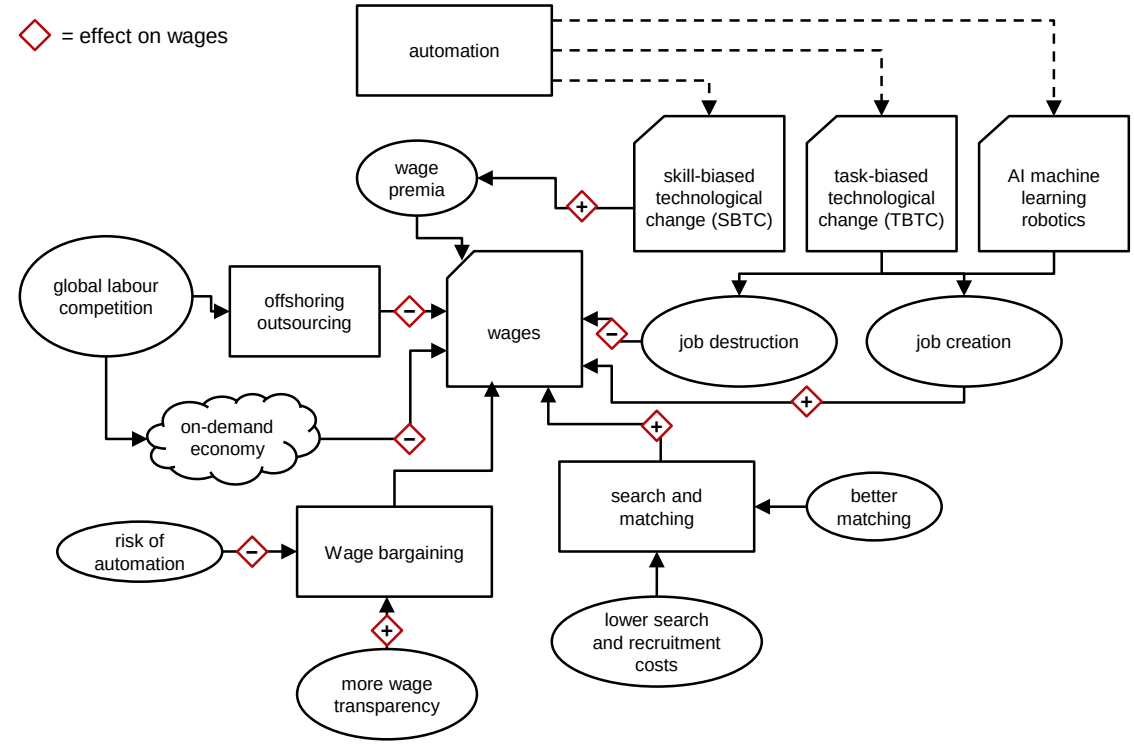
87 See, for example, Blanchflower et al. (2007), Ottaviano and Peri (2012), D'Amuri et al. (2008) and Dustmann et al. (2013).

88 See Deutsche Bundesbank (2018).

downward pressure on wage growth. However, digitalisation affects wage growth in many ways and via numerous channels, which often work in different directions. This box reviews these channels (see also Figure 1) and discusses available evidence relating to their potential effects on wage growth.

**Figure A**

Effects of digitalisation on wages – stylised overview of important channels




Source: Authors' visualisation.

### Automation

The best-documented channel through which digital advancement can affect wage growth is automation. However, the equilibrium effects of automation on wages and employment do not seem to be clear cut, but rather they depend on whether technology substitutes or complements labour input (see Autor (2015)). In this respect, the skill-biased technological change hypothesis stresses that technological advancement raises the labour productivity of highly skilled workers relative to lower-skilled workers, therefore increasing firms' demand for highly skilled employees. This implies – assuming that labour supply remains constant – that the relative wages of highly skilled employees increase (see Goldin and Katz (2007)). Along similar lines, the task-biased technological change[89] hypothesis distinguishes between routine tasks, which can be performed by a computer program and are thus prone to automation (such as arithmetic operations or repetitive manual tasks), and non-routine tasks which cannot be automated (see Autor et al. (2003)). Non-routine tasks can be further divided into abstract tasks like problem-solving, where digitalisation tends to increase labour productivity and puts upward pressure on wages; and manual non-routine tasks like hairdressing, where digital technology is typically neither a substitute nor a complement to human labour and is therefore unlikely to have major effects on wage developments. Similarly, the use of industrial robots

89 In some sources this is also called routine-biased technological change.

can, on the one hand, lower employment levels and wages because robots substitute human labour input. This is known as the "displacement effect" (see Acemoglu and Restrepo (2017)). On the other hand, employment levels and wages can also rise as the industries using robots become more productive and so labour demand from other industries (or for other tasks within the same industry) can increase (the productivity effect).

While the overall impact of skill-based and task-based technological change and the use of industrial robots is hard to assess because of offsetting effects and data limitations, one would expect that digitalisation visibly increases occupational wage polarisation (especially via stronger wage growth in high-paying occupations). However, so far, there is also only very limited evidence for such polarisation.[90]

Looking ahead, the relevance of digitalisation for wage dynamics might increase based on new technologies such as artificial intelligence and machine learning, which could, in the future, substitute human labour even in non-routine tasks.[91]Offsetting effects can be expected for these new technologies as, for example, technological advancement can also create new occupations[92] and translate into positive spillovers to sectors which are not directly affected. Net employment can even increase as a result, as suggested in Autor and Salomons (2017).

**Effects via offshoring or outsourcing, changes to search and matching and wage bargaining**

Since digital technology, by its very nature, facilitates the transmission of data, it can also change the way work is organised. Tasks can be moved abroad (offshoring), outside the company (outsourcing), or both. Digital technology has also facilitated the development of a new way of organising work known as the "on-demand economy". The available evidence suggests that offshoring and the growing on-demand economy have a negative effect on wages in advanced economies.[93] However, based on their relatively limited importance in the economy, the effect on overall wages seems to have been relatively minimal so far.

Furthermore, digitalisation lowers search costs and facilitates better matching. This can be expected to push wages up,[94] but the literature so far fails to provide evidence about the potential size of the effects.

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90 Autor (2015) finds there to be wage polarisation in the United States for the 1980s and 1990s but not afterwards. For Europe, Naticchioni et al. (2014) report a monotonic increase in wage growth along the overall wage distribution in a sample of euro area countries. Using industry-country level data on robots, Acemoglu and Restrepo (2017) find a negative effect on both US wages and employment to population ratio. However, using the same dataset but a slightly modified empirical strategy, Graetz and Michaels (2018) find a positive effect on labour productivity and – to a smaller extent – on wages, but no significant effect on employment in a large sample of advanced economies.

91 Frey and Osborne (2017) estimate that machine learning and mobile robotics endanger the jobs of roughly half of US employees. While the previous wave of automation has predominantly affected medium-pay occupations, future advancements are expected to specifically affect low-wage jobs such as low-skill service occupations (see Berger and Frey (2016b)). The World Bank (2016) estimates that almost 60% of jobs in OECD countries are at risk.

92 Berger and Frey (2016a) show that while before the 1980s most new occupations were requiring routine skills, more and more occupations that have emerged since then rely on abstract skills. In the 2000s many new job titles emerged around the fields of ICT, natural sciences and big data, such as biostatisticians or database architects (see Berger and Frey (2016b)).

93 See, for example, Goos et al. (2014), Blinder (2009), Firpo et al. (2011), Naticchioni et al. (2014), de Groen et al. (2017) and Adams et al. (2018).

94 See, for the United States, Kuhn and Skuterut (2004) and Kuhn and Masour (2014) or, for Germany, Mang (2012).

Finally, digitalisation also affects the wage negotiation process: higher transparency raises employees' bargaining power, while the risk of automation strengthens the employers' position.[95]

To conclude, taken together, the overall impact of digitalisation on wages still remains unclear, partly because of offsetting positive and negative effects and partly because of measurement issues, which could be – at least to some degree – overcome with micro data.

### 3.5.4 Summary

**Based on the available evidence, the effects of structural drivers on wage growth are not clear cut, but do not appear to be the main reason behind the period of low wage growth in the euro area.** With respect to the potential impact of globalisation on wage growth, which is, however, difficult to measure empirically, there is limited support for including measures of global labour market slack in Phillips curve analyses of wage growth in the euro area. Ageing should have had more of a positive effect on wage growth over recent years and therefore does not seem to be a factor that contributed to low wage growth in the euro area. The effects of migration on wage growth are very difficult to disentangle from other forces, but seem to have played a role for low wage growth in some euro area countries, such as Germany. Finally, there is, so far, no evidence that digitalisation has been a major factor contributing to subdued wage growth over recent years.

## 3.6 Institutional factors

**Quite a few euro area countries have introduced far-reaching structural reforms, reduced pay increases in public wages and experienced changes in wage bargaining structures and strategies in recent years.** The changes in wage bargaining were partly the results of structural reforms and partly of changes introduced by the negotiating parties. The following parts will first briefly touch upon the role of structural reforms and then discuss the role of public wages for low wage growth in the euro area.

### 3.6.1 Structural reforms in euro area countries

**Changes in wage bargaining structures and labour market regulations do indeed seem to have contributed to low wage growth in the euro area – mainly in countries most affected by the global economic and financial crisis.**[96] With respect to the overall wage bargaining structure, there has been a trend towards a decentralisation of wage bargaining and less union coverage. At the same time,

[95] Experiments have shown that employees who learn that they earn less than the average wage of their peers become less satisfied with their job and more likely to search for a new job which yields them a higher wage (see Card et al. (2012)). As a result, wage distribution becomes more compressed.

[96] See Masuch at al. (2018) for details.

opening clauses became more prevalent, the role of non-pay elements increased and wage indexation schemes were suspended or adjusted in some countries. The important role of changes in wage bargaining and labour market institutions coincided with low wage growth in the period 2013-16 – especially in Italy, Greece, Spain and Cyprus. This supports the view that changes in wage bargaining structures and labour market regulations might have played a role for low wage growth in countries that underwent important labour market reforms.

**There is also tentative evidence that structural reforms were associated with lower wage growth than was implied by cyclical developments via an increase in labour market flexibility.** As shown by studies based on the latest Wage Dynamics Network survey of firms, employment and wages became easier to adjust, which increased the flexibility of the labour market. Structural reforms have contributed to the employment-rich recovery via this channel, while at the same time contributing to subdued wage growth.[97]

### 3.6.2 The role of public wages

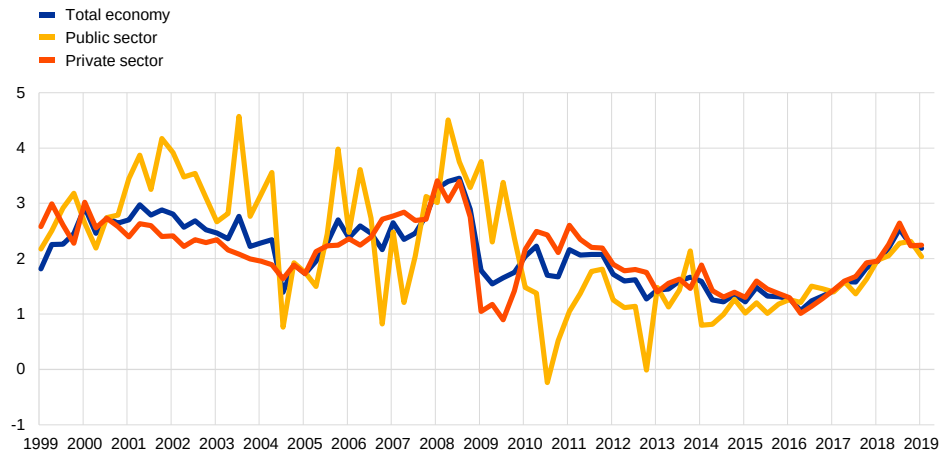
**Public wages can influence overall wage developments via direct and indirect effects.** As public sector wages account for a substantial share of euro area wages (around 19%), public sector wage developments have a direct influence on overall wage growth in the euro area. Public wage developments can also influence private sector wages indirectly via knock-on effects.

**Concerning the direct effects, low public wage growth contributed to the overall low wage growth period after the crisis.** From 2010 to 2016 public wages tended to grow at lower rates than private sector wages (see Chart 28) and have only tended to converge with private wage growth more recently.

[97] See ECB (2016) and ECB (2017a) for details.

**Chart 28**

Private and public sector compensation per employee growth in the euro area




Sources: Eurostat and ECB calculations, national accounts data.
Note: Latest observations: Q1 2019.

**In addition to direct effects, weak growth in public wages during the period of low wages might have contributed to subdued wage growth in the private sector.** These knock-on effects are discussed in Box 7. Focusing on the five largest euro area countries, the box finds a significant effect of a public wages shock on private wages in the same direction for the period 1997-2017, which suggests that public wages may have non-negligible effects on private wage growth.

## Box 7

## The role of public wages in explaining private sector wage developments[98]

**Prepared by Maria Grazia Attinasi, Alessandra Palazzo and Francesco Berardini (ECB)**

This box focuses on analysing the effects of public wage developments on private wage developments and abstracts from the potential effects of private wage growth on public wages. In the context of this Occasional Paper, which aims to understand low wage growth in the euro area, this can be justified by the fact that the reduction in wage growth since the crisis in the euro area has been far more pronounced in the public sector than in the private sector. Public sector wage growth has tended to be lower than private sector wage growth since the crisis.

This box analyses the role of public wages in explaining private sector wage developments in the five largest euro area countries over the period 1997-2017 using three complementary empirical approaches. First, the average response of private wages to a public wage shock is analysed in a Bayesian panel vector autoregression (BVAR) model.[99] Second, in order to analyse country

98 For a detailed explanation of the underlying methodology sere Attinasi, Palazzo and Berardini (2019).

99 BEAR toolbox v.3.0 is used. The model is estimated by Bayesian pooled estimator using a traditional Normal-Wishart prior distribution. The identification strategy is a Cholesky factorisation with the following order: productivity, private wages, HICP, public wages. Use of the Cholesky identification is common in similar empirical studies (e.g. Linnemann (2009) and European Commission (2014)).

heterogeneity, a BVAR approach is applied to each of the five countries.[100] Finally, possible asymmetries in the response of private wages to public wage shocks (i.e. cuts versus hikes) are addressed using a local projection method such as the one used by Jordà (2005).[101]

On average, the BVAR analysis finds that a shock to public wages affects private wages with a lag; this effect is temporary and differs across countries (Table A and Table B). In response to a 1% increase in public wages, private sector wages increase on average by around 0.1% after one year. In cumulative terms, the peak effect of 0.2% is reached after five years. This effect slowly wanes afterwards. Consistent with the literature, the effect of a shock to public wages on private wage growth is temporary. Effects on HICP are significant for France and yet very small for Italy. The response of private wages to a public wage shock is positive and statistically significant for Italy, Spain and France, but not for Germany or the Netherlands (Table A). For Italy, a 1% public wage shock is estimated to have an impact of around 0.13% on private wages in the first year, and remains broadly at that level afterwards. In Spain, the effect picks up, gradually reaching 0.1% after two years and loses significance afterwards. For France, the estimated response of private wages to a public wage shock is somewhat higher, at 0.3% in the first year, which cumulates to 0.5% after two years. This result can be explained partly by the larger size of public sector employment in France and partly by the fact that the levels of per capita compensation in the public and private sectors are very close. Therefore, and in line with the literature, it seems plausible to expect that an increase in public sector compensation, by opening up a gap vis-à-vis the private sector, puts upward pressure on private wages as this would have a stronger influence on the search direction of workers. This result is robust to a number of alternative specifications that control for the impact of the minimum wage, and the role of cyclical factors (e.g. the unemployment gap). For Germany and the Netherlands, the absence of a significant response from private wages to a public wage shock is consistent with the existing literature, according to which the degree of public wage leadership over private wages decreases with trade openness. Private wages are found to respond asymmetrically to a public wage shock (see Table B), as shown based on the local projection method approach which allows for a distinction to be made between the effects of a positive and a negative shock for a panel of the five largest euro area countries. A positive and statistically significant response from private wages is found in the case of a positive shock to public wages, while no statistically significant effects are detected in the case of public wage cuts. This suggests that in periods of public wage freezes or cuts, there are no knock-on effects on private wage developments. This finding is robust also when extending the panel to other euro area countries, which allows the number of episodes of actual wage cuts to be increased.

[100] See Giannone et al. (2015). A Cholesky factorisation identification strategy similar to footnote 100 is used. As shown by Lamo et al. (2008), among others, causality from the private to the public sector cannot be excluded a priori. In the light of this, public wages are ordered last as private wages do not react contemporaneously to a public wages shock. Results of the median effect of a public wages shock on private wages are robust, in the medium term, to a specification where public wages are ordered first. For the purpose of this analysis quarterly data are obtained from interpolated annual data for public sector wages.

[101] This approach derives the IRFs at horizon k=5 by directly regressing the change in private wages in the period ranging from t to t+k over a measure of the shock in public wages at time t. State-dependent IRFs can be evaluated because, for example, the regression can allow for possibly different coefficients according to the sign of the shock to public wages. Since specification of the model in changes (as opposed to the specification in levels in the VAR) allows short-run dynamics in private wage developments to be captured, a measure of slack (i.e. unemployment gap) is added to the model specification.

## Table A

Private wage response to a 1% shock to public wages – average and country-specific effects

(percentage deviation from baseline level)

| Years | Panel BVAR | Country-specific BVAR | | | | |
|---|---|---|---|---|---|---|
| | | DE | FR | IT | ES | NL |
| 1 | **0.10** | 0.00 | **0.32** | **0.13** | **0.09** | -0.01 |
| 2 | **0.16** | 0.01 | **0.50** | **0.12** | **0.12** | -0.02 |
| 5 | **0.19** | 0.02 | **0.49** | **0.11** | **0.13** | -0.05 |

Notes: Significant results in bold. Shock to public wages is 1%. Variables are specified in (log) levels.

## Table B

Response of private wages growth rate to a 1percentage point shock to public wages growth

(percentage points deviation)

| Years | Local projection method | | | |
|---|---|---|---|---|
| | Linear | SD | SD positive | SD negative |
| 1 | **0.60** | **0.58** | **0.71** | -0.02 |
| 2 | **0.63** | **0.64** | **0.84** | -0.10 |
| 5 | **0.62** | **0.63** | **0.64** | 0.20 |

Notes: Statistically significant results at 1% level in bold. Local projection method: linear = 1%, SD = change in public wages in absolute value ≥ 1 standard deviation; SD positive: change in public wages ≥+1 standard deviation; SD negative: change in public wages ≤-1 standard deviation. Variables are specified in growth rates.

# 4 Cross-checking tools for wage growth forecasts[102]

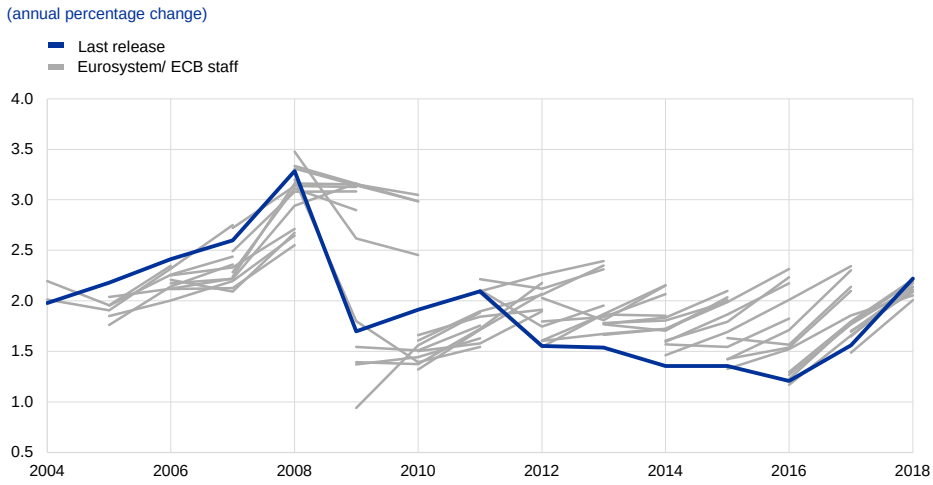
The recent period of low wage growth posed a challenge both to policymakers and economists and forecasters alike. During the low wage period 2013-17 (and in fact already starting in 2012) wage growth was overpredicted not only by the projections of the ECB and the Eurosystem, but also by other international institutions and professional forecasters (see also Chart 2 in the introduction). While the previous parts have looked into the drivers of low wage growth in the euro area, this section analyses the question whether in the future wage Phillips curves could serve as a cross-checking tool for wage forecasts in the euro area. To this end, this section conducts a comprehensive real-time evaluation of forecast errors for the euro area and also draws some conclusions for future wage forecasts.

## 4.1 Designing a real-time forecasting evaluation exercise

**During the period of low wage growth in the euro area, projections of Eurosystem/ECB staff have recorded substantial negative forecast errors for compensation per employee growth for basically all projection horizons (see Chart 29).** This raises the question whether additional tools – also based on the models discussed in this paper – could have helped to improve Eurosystem/ECB staff wage forecasts in real time.

**Chart 29**

Annual Eurosystem/ECB staff projections of total compensation per employee growth in the euro area




Notes: Eurostat and Eurosystem and ECB staff projections.

[102] Includes contributions from Adrian Page (ECB).

**In order to evaluate the forecast performance of possible cross-checking tools for the Eurosystem/ECB staff projections, the results of a real-time evaluation exercise for compensation per employee growth are shown in this section.** The focus is on compensation per employee as this is the main wage variable of Eurosystem/ECB staff forecasts. Using real-time vintages for most variables allows the same information available at the time of the projection exercises to be replicated as much as possible.[103] Furthermore, the focus of the exercise is on conditional forecasts, in order to evaluate what Phillips curve models would have predicted for wage growth based on the outlook for the real economy as included in the relevant Eurosystem/ECB staff forecast vintages.[104]

**In this exercise the forecasting performance of Phillips curve specifications from a thick modelling framework (as discussed in Section 2) is assessed in real time.** 240 Phillips curve specifications are evaluated and they are the result of the combination of the following choices on (i) the number of lags of the dependent variable (one or two), (ii) ten possible slack variables (including "no slack" to also test single equations without slack measures), (iii) six different inflation expectation variables (including headline and underlying inflation, backward-looking and forward-looking[105] and no-inflation measure), and (iv) with or without a productivity growth measure. For all other evaluated models only a single specification was considered.

## 4.2 Evaluation of forecasting performance of wage Phillips curves in real time

**For the real-time forecast evaluation exercise, the forecast error is defined as the difference between the latest available data and the projection.** Like all variables derived from national accounts, compensation per employee is subject to frequent and often quite substantial revisions, which complicates forecasting in real time but also has an effect on forecast errors ex post. Taking the latest available data series as a reference point allows for the forecast errors for the longest possible sample to be evaluated, and ensures consistency across projections and model-based forecasts. The analyses are based on real-time vintages available from December 2004 onwards.

**Forecasting performance is evaluated assessing also whether differences in performance between Phillips curves and Eurosystem/ECB staff projections are significant or not.** Relative forecast performance is based on the main (standard)

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[103] Phillips curve models include real-time vintages of the unemployment gap from the IMF, the European Commission and the OECD. Moreover, pseudo real-time vintages were produced for the slack measures derived from the dynamic factor model discussed earlier in this paper (see box on UCM/BCS model), and the unemployment gap, average hours worked per person gap and labour participation rate gaps derived from the UCM. The vintages in these cases used the latest vintage of the input data but parameters were re-estimated in each additional quarter of an expanding window.

[104] The results discussed here were part of a much broader forecast evaluation exercise which includes not only Eurosystem/ECB staff projections and Phillips curves but also a wide range of internal models currently used for a cross-check.

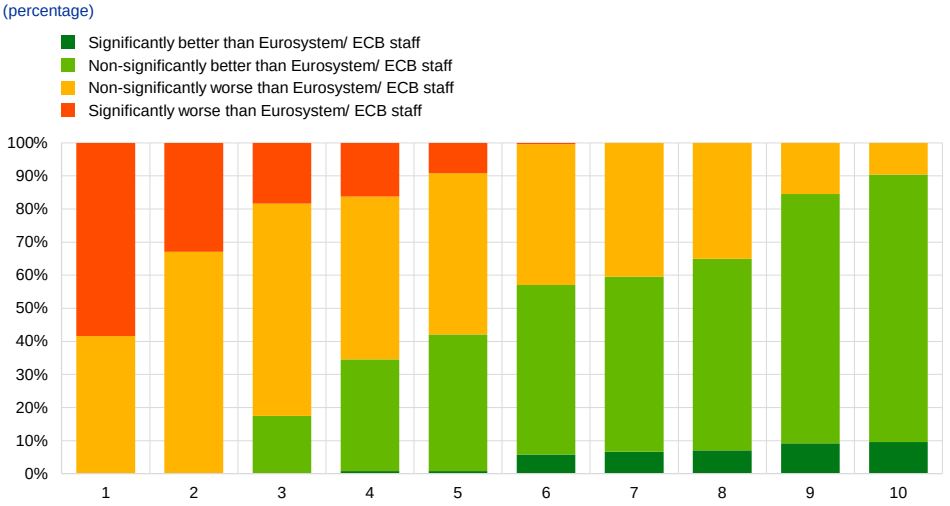
[105] Forward looking inflation expectations are proxied via the Eurosystem/ECB staff HICP projections.

criterion: the relative RMSE. In addition, the significance of differences in forecast performance is assessed with a Diebold-Mariano two-sided test.[106]

**The evaluation finds that the Eurosystem/ ECB staff wage projections are very hard to beat in the short-term, but that the performance of Phillips curve specifications tends to improve over an extension of the forecast horizon.** As illustrated in Chart 30 there is not a single Phillips Curve specification that can beat the Eurosystem/ECB staff wage growth forecasts for one or two quarters ahead. However, with an extension of the forecast horizon the share of Phillips curve specifications with a better performance than the Eurosystem/ECB staff projections increases. From the 6th quarter ahead – which represents in effect a calendar one-year ahead forecast from the moment the forecast is made owing to the time lags in the availability of data on compensation per employee – the Diebold-Mariano tests also assigns significantly better forecasting performance to some Phillips curve specifications. This share of specifications with a significantly better forecasting performance increases from around 5% (12 of the 240 Phillips Curve specifications) at a one-year ahead horizon to around 10% (24 specifications) tor a forecast horizon of two years (ten quarters).

**Chart 30**

Share of Phillips Curve specifications with a significant or non-significant (according to the Diebold Mariano test) better or worse forecasting performance




Notes: ECB calculation based on Eurosystem and ECB staff projections. Percentages refer to the full set of 240 Phillips curve models.

[106] The relative RMSE gives a first indication that a model has a better or worse forecasting performance compared with the Eurosystem/ECB staff projections, but a formal statistical test is needed to evaluate whether this difference is significant: the Diebold-Mariano test. The Diebold-Mariano test is conducted by testing for the significance of the constant in an OLS regression of the difference between the squared forecast errors of two models on a constant using heteroscedasticity and autocorrelation consistent standard errors. The interpretation of this two-sided t-test is that the rejection of the null implies that the forecasting performance of the tested model is statistically different from the Eurosystem/ECB staff projection, whereas failure to reject the null points to an equal forecasting performance. The forecasting performance of a model with a relative RMSE compared to the Eurosystem/ECB staff projection larger (smaller) than one is significantly worse (better) than the Eurosystem/ECB staff projection if the p-value of the DM test is below a chosen threshold, as for example 10%. If the p-value is above the chosen threshold, then the two models have statistically the same forecasting performance and it cannot be concluded that a model has a significantly better or worse forecasting performance compared to the Eurosystem/ECB staff projections.

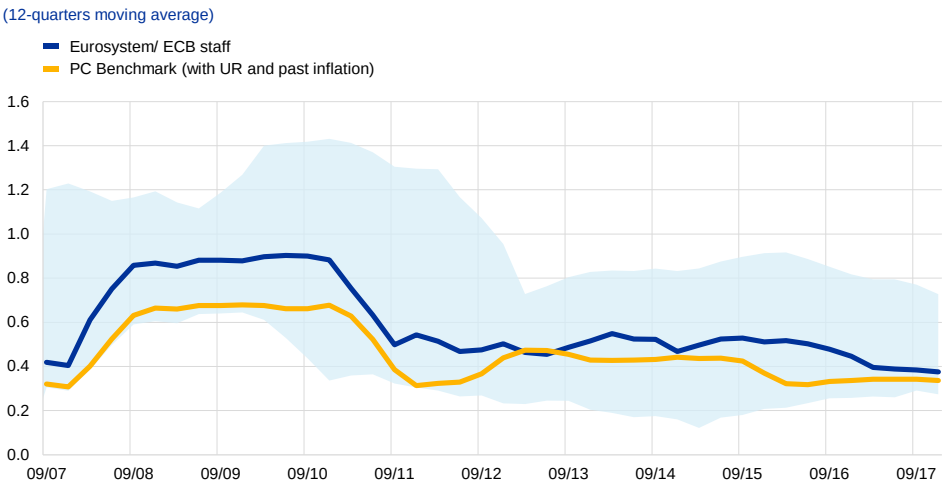
**The exercise identifies a range of Phillips curve specifications that seem well suited as cross-checking tools for medium-term wage growth forecast in real time.** As discussed these specifications are identified based on their RMSE relative to the Eurosystem/ECB staff projection and the Diebold Mariano test.

**The group of Phillips curve specifications performing well in the medium-term is dominated by relatively straightforward specifications.** Most of these specifications include the unemployment rate as slack measure, past inflation and a productivity measure. The fact that models including the unemployment rate as slack measure in particular perform well is probably linked to the fact that output or employment gaps are very difficult to measure and predict in real time. Among the well-performing specifications, a benchmark Phillips curve specification was selected, which performs especially well in terms of relative RMSE and with respect to bias and directional accuracy.[107] This specification includes compensation per employee with one lag, lagged unemployment rate, productivity growth and four-quarter average of year-on-year HICP inflation (see equation 1 in Section 2 for the benchmark specification).

**The identified Phillips curve specifications would have worked well as cross-checks not only during the low wage period.** Forecasting performance changes over time. In order to illustrate this, Chart 31 shows the RMSE calculated for one-year-ahead forecasts for different models using a 12-quarter-moving-average. As shown in the chart the RMSE of the Eurosystem/ECB staff projections remains inside the Phillips Curve range for most of the time. The chart also illustrates that the benchmark PC specification would have also been a valuable cross-checking tool for wage forecasts beyond the low wage period. The benchmark specification has nearly always had a lower RMSE compared to the Eurosystem/ECB staff projections when looking at the 12-quarters moving average

**Chart 31**

RMSEs for one-year ahead forecasts



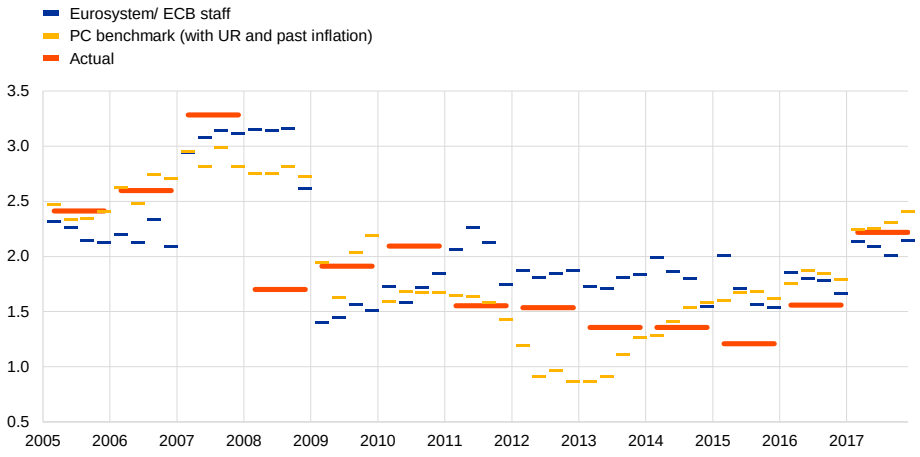

Sources: ECB calculations based on Eurosystem and ECB staff projections.
Notes: The shaded area shows the range across all 240 Phillips curve specifications.

[107] Results for tests of bias and directional accuracy are not explicitly shown here.

**During the first part of the low wage period forecasts of the benchmark Phillips curve and the Eurosystem/ECB staff projections differed substantially, while they were more aligned in the later part.** Chart 32 shows forecasts for the next year at different forecast vintages[108]. This means that values shown for the first quarter of 2012 relate for example to the March 2012 exercise forecast for 2013 – the first year of the "low wage period", which was characterised by sluggish wage growth despite an improving labour market. For the medium-term (forecast of wage growth between the current and the next year) a benchmark Phillips-curve specification would have under-predicted wage growth in the first phase of the low-wage period in 2013/14 (see Chart 32) and slightly overestimated wage growth in the later part (2015-17), while the Eurosystem/ECB staff projections over-predicted wage growth basically for the whole low-wage period. This supports the view that a relatively straightforward benchmark wage Phillips curve (and some other well-performing specifications) could have acted as an important cross-check and counterweight to the Eurosystem/ECB staff wage projections over the low-wage period – and especially in its first two years. More recently both medium term Eurosystem/ECB staff and Phillips curve forecasts have been largely in line with wage growth outcomes in the euro area.

**Chart 32**

Comparison of one-year ahead forecasts from benchmark Phillips curves and Eurosystem/ECB staff at different vintages




Sources: ECB calculations based on Eurosystem and ECB staff projections.
Notes: Values on the x-axis refer to vintages of projection rounds. Each observation reflects the forecast for annual wage growth between the current and the next year at one of the quarterly projections vintages. As an example the forecast shown for December 2011 refers to expected annual wage growth in 2012.

[108] While the previous charts of this section refer to the performance of projections for a fixed forecast horizon (as an example for six steps ahead with respect to the last available observation), the projections shown in chart 4 refers to a fixed calendar year and the forecast horizon depends on the projection exercise. For example, the forecast of wage growth for 2013 in the first quarter of 2012 requires projections of annual wage growth from the first quarter of 2013 to the last quarter of 2013, corresponding from six to nine steps ahead compared to the latest available observation of the third quarter of 2011. In the December 2012 exercise the information set of the forecaster includes data up to the second quarter of 2012, which means that projections of annual wage growth from three to six steps ahead are required for forecasting wage growth in 2013.

## Box 8

### The pass-through of labour costs to prices in the euro area and the large euro area countries

**Prepared by E. Bobeica and E. Hahn (ECB)**

**Increases in labour costs are considered to be an important driver of price increases in the euro area because they are an important component of companies' cost structures.** The assumption that changes in wages lead to changes in prices represents the cost-push view of the inflationary process whereby wage increases in excess of productivity are seen as putting upward pressure on prices. According to this view, wages are an important exogenous variable determining the future direction of inflation. While these wage-based explanations of inflation dynamics continue to hold a prominent position in the policy debate, the academic literature – which generally focuses on US data – has drawn more mixed conclusions on the link between labour costs and inflation, in particular at shorter horizons. First, in the empirical literature it remains unclear whether labour costs tend to precede or follow prices (see for instance Knotek and Zaman (2014) and Bidder (2015)). Second, studies suggest that the relationship between labour cost inflation and price inflation may have weakened over time, potentially owing to an improved anchoring of inflation expectations in the United States, as the credibility of the monetary policy would play a larger role for price-setting than cost pressures (see Peneva and Rudd (2017)). Against this background, this box synthesises recent empirical findings on the strength of the pass-through of labour costs to prices in the euro area.

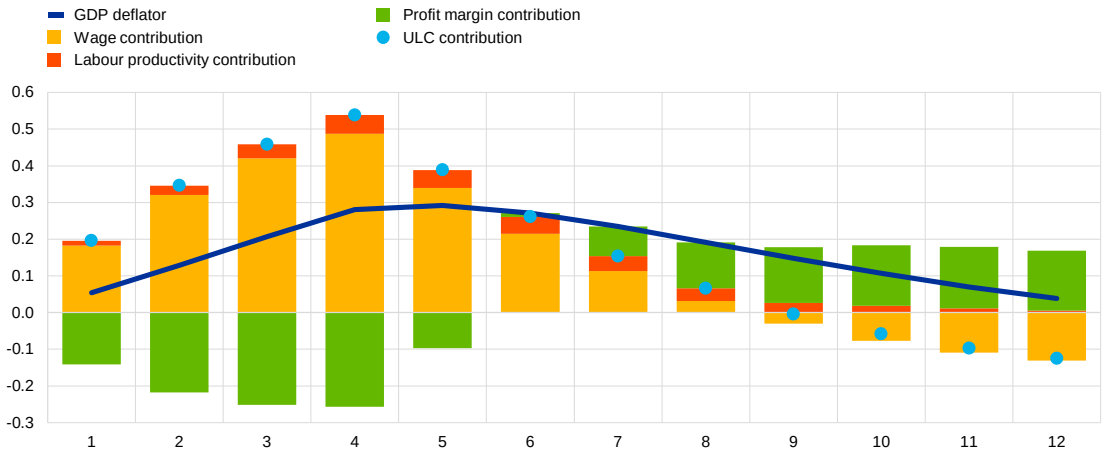
**Results based on both a fully-fledged structural model and lower scale reduced-form models document a clear link between labour costs and price inflation in the euro area, but this link appears to be shock and state-dependent.** In the ECB New Area-Wide Model,[109] the pass-through of labour costs to inflation depends on the nature of the shock hitting the economy (see Gumiel and Hahn, 2018). A typical adverse supply shock in the labour market like the wage mark-up shock lifts both wages and unit labour costs but dampens profit margins in the short run. Chart A shows the impact of the supply shock in the labour market on the GDP deflator, a measure of underlying inflation, and its components. The supply shock lifts compensation per employee and thereby increases companies' costs and prices. This leads to a reduction of demand, output and employment. The decline in employment is typically smaller than that in GDP, implying a decrease in labour productivity. This decrease adds to the accumulating price pressures from wages and implies an increase in unit labour costs beyond that of wages. Companies facing a downward-sloping demand curve and price-setting rigidities will only partly and gradually pass on the cost increases to prices, with profit margins acting as a buffer. The observable patterns of responses to the supply shock therefore show an increase in both wages and unit labour costs, whose impact on price pressures is partly buffered by decreasing profit margins.

[109] See Christoffel et al. (2008).

**Chart A**

Stylised pass-through of a wage increase to the GDP deflator following a supply shock in the New Area-Wide Model

(year-on-year percentage change; percentage point contributions)



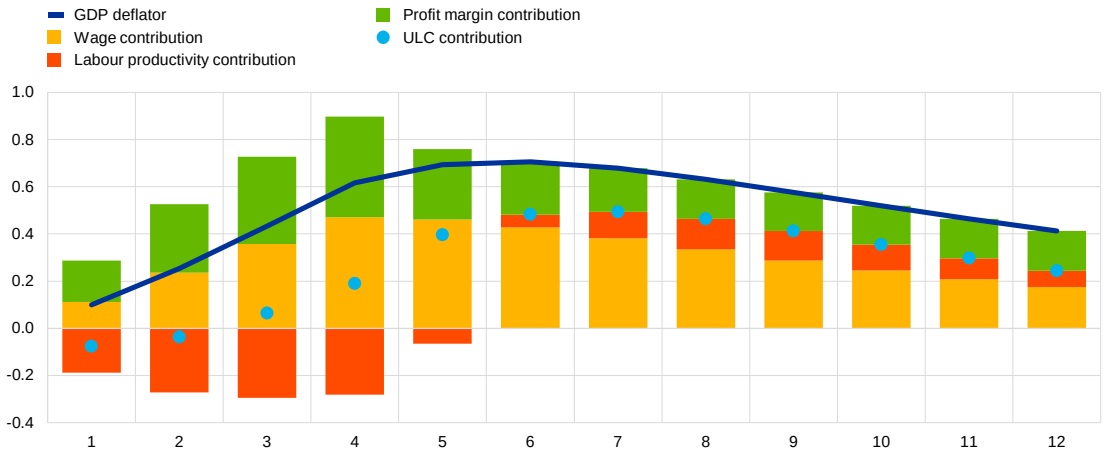

Sources: Eurostat and ECB calculations.
Notes: The x-axis indicates the quarters following the shock. The supply shock refers to a wage mark-up shock in the New Area-Wide Model. The magnitude of the shock is normalised to a cumulated increase in compensation per employee of 1% over the first year following the shock. It is assumed that indirect taxes net of subsidies respond proportionally to real GDP in such a way that this component does not contribute to changes in the GDP deflator.

**The pass-through is stronger for demand than for supply shocks.** For a demand shock the response pattern of wages and unit labour costs is qualitatively and quantitatively different from that for the supply shock. Chart B shows the impact of a typical demand shock in the New Area-Wide Model, namely the impact of the domestic risk premium shock, on the GDP deflator and its components. The favourable demand shock leads to an increase in production and a higher demand for capital and labour inputs, increasing both wages and employment. Again, the impact on employment is smaller than that on GDP, leading in the case of a positive demand shock to a pick-up in labour productivity with a dampening impact on unit labour costs. Given the favourable demand prospects, companies can pass on the cost increase to prices so that the productivity gains and their downward impact on unit labour costs are absorbed by the companies via their profit margins. In the case of the demand shock, therefore, wages pick up but unit labour costs are initially dampened and rise only with some delay. This is different from the responses in the case of a supply shock, where the wage increases amplified by the productivity losses lead to an immediate increase in unit labour costs (at the cost of profit margins). For the demand shock, the upward price pressures are initially only correctly signalled by compensation per employee, while unit labour cost developments respond only with a delay and even provide contradictory signals in the first few quarters following the shock. Besides these qualitative differences in the pass-through of the two types of shocks on prices, Chart A and Chart B also highlight that the impact on prices of a demand shock that lifts compensation per employee growth by a certain magnitude appears to be larger than the impact of a supply shock that entails the same impact on compensation per employee growth. Similar results to those of the ECB New Area-Wide Model have been obtained from a BVAR model for the wage-price pass-through in the euro area (see Hahn, 2018).

**Chart B**

Stylised pass-through of a wage increase to the GDP deflator following a demand shock in the New Area-Wide Model

(years-on-years percentage change; percentage point contributions)



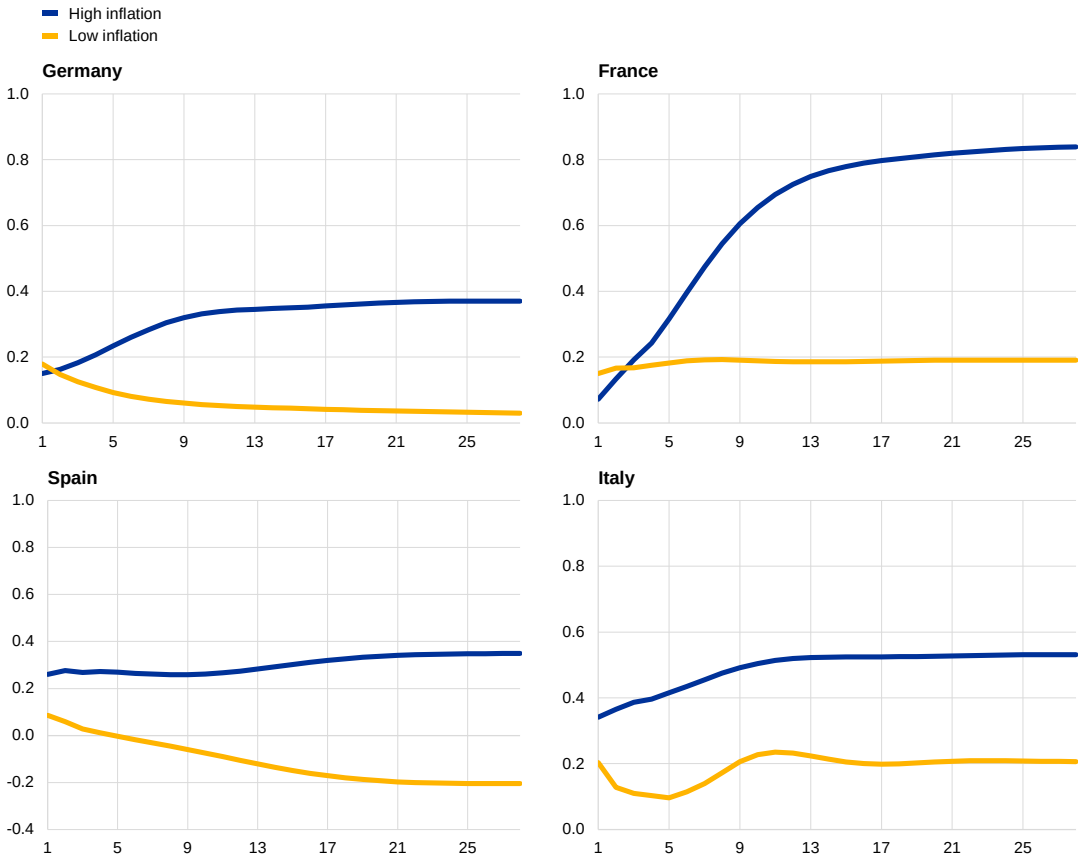

Sources: Eurostat and ECB calculations.
Notes: The x-axis indicates the quarters following the shock. The demand shock refers to a domestic risk premium shock in the New Area-Wide Model. The magnitude of the shock is normalised to a cumulated increase in compensation per employee of 1% over the first year following the shock. It is assumed that indirect taxes net of subsidies respond proportionally to real GDP in such a way that this component does not contribute to the changes in the GDP deflator.

**The pass-through from labour costs to prices is stronger in a high inflation regime.** Another important dimension to investigate at the current juncture is whether the low inflation regime had an impact on the strength of the link between labour costs and price inflation. The level of inflation is a key variable which determines the degree of nominal rigidities prevailing in the economy at a certain point and the pass-through from labour costs to price inflation reflects precisely these underlying nominal rigidities. Such a question is easily answered by more flexible, smaller scale reduced-form models. Bobeica, Ciccarelli and Vansteenkiste (2019) estimate a VAR model for the biggest euro area members including the real value added, the unit labour cost and the GDP deflator (variables in log differences, the last two are also adjusted for a common trend à la Knotek and Zaman (2014), also for stationarity rationales; hence, the focus of this analysis is on cyclical developments). The results suggest that the pass-through is systematically lower if it is estimated over samples when the inflation rate is lower than the historical average and this is a robust result across the biggest euro area countries. A low pass-through can be associated with a low inflation environment either because low inflation and low expected inflation persistence cause a low pass-through as firms adjust their prices less frequently (Taylor (2000)), or because low levels of price inflation could be expected to reduce the pass-through owing to downward wage rigidities (Daly and Hobijn (2014)). These results confirm that increases in labour costs should be passed on to prices. Coming from a period of low inflation, however, this pass-through could potentially be more moderate than after a period of elevated inflation rates.

## Chart C

The pass-through from labour cost to price inflation under low versus high price inflation

(years-on-years percentage change; percentage point contributions)




Notes: the pass-through is computed mimicking the fiscal literature (see e.g. Mountford-Uhlig, 2009) as the ratio of the cumulative responses of price and labour cost inflation to a shock in ULC growth; with such standardisation, the multipliers are comparable across countries. Estimation period: from 1985 to Q1 2018. The high/low inflation regime estimations were performed by splitting the sample accordingly.

# 5 Summary and conclusion

**This Occasional Paper presents a comprehensive analysis of the drivers of low wage growth in the euro area and the related substantial and persistent negative forecast errors in the period 2013-17.** The analysis takes a holistic view and looks at a wide range of cyclical, structural and institutional aspects. It is not restricted to the euro area but also takes the country dimension into account. It asks why wage growth was so low and underpredicted in the euro area and what can be done about it.

**Overall, this Occasional Paper makes – based on the work of the WEG – a threefold contribution: (i) it provides country-specific analyses based on a consistent methodology, (ii) it integrates analyses of cyclical, structural and institutional drivers, and (iii) it develops ready-to-use tools for cross-checking Eurosystem/ECB staff wage growth forecasts based on a comprehensive real-time forecasting evaluation exercise.**

**The main conclusions of this Occasional Paper are as follows:**

1. **Traditional drivers of wage growth as captured by a standard Phillips curve explain much of the weakness in wage growth over the euro area recovery.** A combination of slack in the labour market, low inflation readings and subdued productivity growth has been holding back wage growth in the euro area.

2. **The country dimension is key to understand the drivers of wage growth in the euro area.** Across countries there is a strong heterogeneity in the relative importance of the drivers that are deemed relevant to explain wage growth, which can best be illustrated based on a consistent methodology. A message valid across the board is that over the analysed period, the traditional cyclical drivers didn't paint the entire picture.

3. **Aspects of the weakness in wage growth are probably also related to additional factors not captured by a standard Phillips curve set-up:** (i) the impact of compositional effects, (ii) the possible non-linear reaction of wage growth to cyclical improvements whereby wage-cyclical sensitivity is lower when the economy grows below potential, (iii) structural shocks hitting the economy, and (iv) the decline in trend wage growth, reflecting secular movements in inflation and productivity growth. But they are also related to institutional factors such as changes in wage bargaining structures and labour market regulations or structural factors, including demographic change, digitalisation, the process of globalisation and migration.

4. **Based on a rich battery of models, a real-time forecast evaluation exercise identifies tools which could serve as cross-checks to Eurosystem/ECB staff wage growth projections.** The well-performing specifications identified are all relatively straightforward – with most of them relying on the unemployment rate as slack measure.

5. **A sound understanding of wage drivers and accurate wage forecasts is key in the pursuit of the ultimate monetary policy goal – price stability – as wages are a fundamental determinant of inflation.** This continues to be supported by recent analyses suggesting that in the euro area labour costs are passed through to prices in a noticeable manner.

6. **Looking forward, the results presented in this Occasional Paper can be seen as a motivation for investigating several issues further.** These include attempts to better integrate analyses of different driving forces into a more holistic framework, which might help to quantify the relative role of different factors more accurately. Also, the importance of non-linearities in the wage Phillips curve deserves further in-depth analyses. It also seems worthwhile to further investigate the pass-through of wages to prices and its determinants in more detail.

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# Appendix

**Table A.1**

Literature review on the impact of unconventional measures of slack on wage growth

| Study | Method | Sample | Finding |
|---|---|---|---|
| | **Broader measures of unemployment (e.g. underemployment and U6 rate) are informative for wage growth** | | |
| **Smith (2014)** | Estimate state-year panel relationship between wage inflation and labour market slack | US: 1985-2013 | LTUR and STUR exhibit similar negative wage pressure on wage inflation. OLF wanting jobs and PTER individuals also apply downward pressure on wage inflation |
| **Aaronson & Jordan (2014)** | Estimate state-year panel relationship between wage inflation and measures of labour market slack | US: 1982-2013 | 1 pp increase in the PTER and MTUR rates are associated with changes of respectively -0.4 and -0.5 pp in real wage growth. No effect of the VSTUR |
| **IMF WEO (2017a)** | Estimate wage Phillips curves augmented with broader measures of unemployment | AE: 2000-2016 | Involuntary part-time employment share is negatively associated to wage growth |
| **Blanchflower & Posen (2014)** | Estimate panel state-year wage curve with inactivity rate measures | US: 1980-2013. | Negative correlation of the state wage level with the unemployment rate and the non-participation rate with the UR effect being 3 times larger |
| **Bell & Blanchflower (2018)** | Identify determinants of the desire for additional working hours and their quantity with probit and regression models | UK: 2002-2017. | Underemployment significantly explains, yet not sufficiently, the 2% wage norm |
| **European Commission (2017)** | Estimate augmented Philipps curves with broader measures of labour underutilisation | EA: 2000-2016. | Underemployed workers hold back the wage growth but to lesser extent than unemployed |
| | **Other labour market slack indicators (e.g. job mobility and intensive margins) matter as well** | | |
| **Faberman, &Justiniano (2015)** | Estimate the correlation and test the granger causality of job switching and wage growth | US: 1991-2014 | Strong relationship between job switching and nominal wage growth. Significant predictive power of job switching for wage growth |
| **Moscarini & Vinay (2017)** | Estimate covariance over time of wage growth with job mobility measures | US : 1996-2013 | Positive covariance over time between wage growth and job-to-job transition rates but more strongly than with the unemployment-employment exit rate |
| **Danninger (2016)** | Estimate county-level relationship between wage and unemployment | US: 2000-2015 | Offset of average wage growth through the entry of low wage earners and the reduction of job mobility |
| **Daly & Hobijn (2016)** | Disentangle intensive and extensive margins contributions to the variance and the cyclicality of real median wage growth | US: 1980-2015. | In downturns, the countercyclical extensive margins offset the procyclicality of intensive margin, main driver of wage growth. Unemployment margin appears uninformative |
| **Bulligan et. al. (2019)** | Estimate wage Philipps curve specifications augmented with supply-side and demand-side labour market slack indicators | EA: 2000-2017. | The intensive margin is informative to assess the degree of labour market slack (deviations from its trend help explain wage developments) and changes slope and fit of the Philipps curves |
| | LTUR = long-term unemployment rate / STUR = short-term unemployment rate/ OLF = out of the labour force / PTERR = part time for economic reasons rate / VSTUR = very short-term unemployment rate | | |

# Glossary

## Description of less standard terms

| Variable Name | Description | Source |
|---|---|---|
| **Average Hours Worked** | Average hours worked per person employed, calculated as the ratio between total hours worked and total employment. | Eurostat |
| **Broad Unemployment Rate** | The ratio of unemployed, underemployed part-time workers, those who are seeking work but are not available and those who are available but are not seeking work (this latter group includes discouraged workers) to the extended labour force (i.e. the labour force plus those available, but not seeking work and those seeking work, but not available). Underemployed are part-time workers who would like to work higher hours. | Eurostat – EU-LFS, ECB staff calculations |
| **Broad UR Gap** | The difference between the broad unemployment rate and its trend as estimated by the Unobserved Component Model (UCM) in a specification where the unemployment rate is replaced by the broad unemployment rate. | Eurostat – EU-LFS, ECB staff calculations |
| **Compensation per Employee in the Private Sector** | The sum total of the compensation of employees working in the private sector divided by the total number of employees in the private sector. The private sector is composed of industry excluding construction, construction and market services. | Eurostat, ECB Staff calculations |
| **Compensation per Hour** | The sum total of the compensation of employees divided by the total number of hours of employees. | Eurostat, ECB Staff calculations |
| **Compensation per Hour in the Private Sector** | The sum total of the compensation of employees working in the private sector divided by the total number of hours of employees working in the private sector. | Eurostat, ECB staff calculations |
| **Consensus Inflation Expectations** | Survey-based measure of consumer price expectations. | Consensus Economics |
| **DG ECFIN Consumer Survey Balance of Responses of Inflation Expectations** | Consumer survey – price trends over next 12 months. | European Commission |
| **Dynamic Factor Model (DFM) Composite Indicator** | Common component of a large number of de-trended labour market indicators. The trends have been estimated with the help of a low-pass filter. | ECB staff calculations |
| **European Commission (EC) Unemployment Gap** | The difference between the headline unemployment rate and its trend, estimated by the European Commission. | European Commission |
| **IMF Unemployment Gap** | The difference between the headline unemployment rate and its trend, estimated by the IMF. | IMF |
| **Job-to-Job Transition Flows** | Percentage of active population moving from one job to another from one year to the next for persons with tertiary education (ISCED) and/or employed in science and technology. | Eurostat – EU-LFS, ECB staff calculations |
| **Labour Shortage** | Balance indicators; measured by the European Commission's Business and Consumer Surveys for the main economic sectors; answers to the question on labour as a factor limiting production. Aggregate of main sectors. | European Commission, ECB staff calculations |
| **Model-Based Unemployment Gap** | The difference between the headline unemployment rate and a model-based estimate of its trend. | Eurostat, ECB staff calculations |
| **Narrow Broad UR** | The ratio of unemployed, underemployed part-time workers and those who are available but are not seeking work to the extended labour force. | Eurostat – EU-LFS, ECB staff calculations |
| **Negotiated Wages** | Indicator of negotiated wage rates. | ECB, ECB staff calculations |
| **OECD Unemployment Gap** | The difference between the headline unemployment rate and its trend, estimated by the OECD. | OECD |
| **Short Term Unemployment Rate** | The ratio of the number of persons who have been unemployed for less than 12 months to the labour force. | Eurostat – EU-LFS, ECB staff calculations |
| **Survey of Professional Forecasters (SPF) Inflation Expectations** | Survey based measure of HICP inflation expectations. | ECB SPF |

| Variable Name | Description | Source |
|---|---|---|
| **The Rate of Unemployed and Underemployed** | The ratio of unemployed and underemployed part-time workers to the labour force. | Eurostat – EU-LFS, ECB staff calculations |
| **Underemployment Rate** | The ratio of underemployed part-time workers to the labour force. | Eurostat – EU-LFS, ECB staff calculations |
| **Unobserved Component Model (UCM) Intensive Margin Gap** | Percentage deviation of hours worked per employed persons from its trend as estimated by the UCM. | Eurostat, ECB staff calculations |
| **UCM Narrow Broad UR** | The difference between the narrow broad unemployment rate and its trend as estimated by the UCM in a specification where the unemployment rate is replaced by the narrow broad unemployment rate. | Eurostat – EU-LFS, ECB staff calculations |
| **UCM Participation Rate Gap** | The difference between the headline labour force participation rate and its trend as estimated by the UCM. | Eurostat – EU-LFS, ECB staff calculations |
| **UCM Unemployment Gap** | The difference between the headline unemployment rate and its trend as estimated by the UCM. | Eurostat, ECB staff calculations |
| **Wages and Salaries in the Private Sector** | Wages and salaries per employee in the private sector. | Eurostat, ECB staff calculations |
| **Wages and Salaries in the Total Economy** | Wages and salaries per employee in the total economy. | Eurostat, ECB staff calculations |

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