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Based on a forthcoming joint paper with  
F. Eser, P. Karadi, L. Moretti, C. Osbat

# The Phillips Curve at the ECB

50<sup>th</sup> Anniversary Conference of the Money, Macro & Finance Research Group

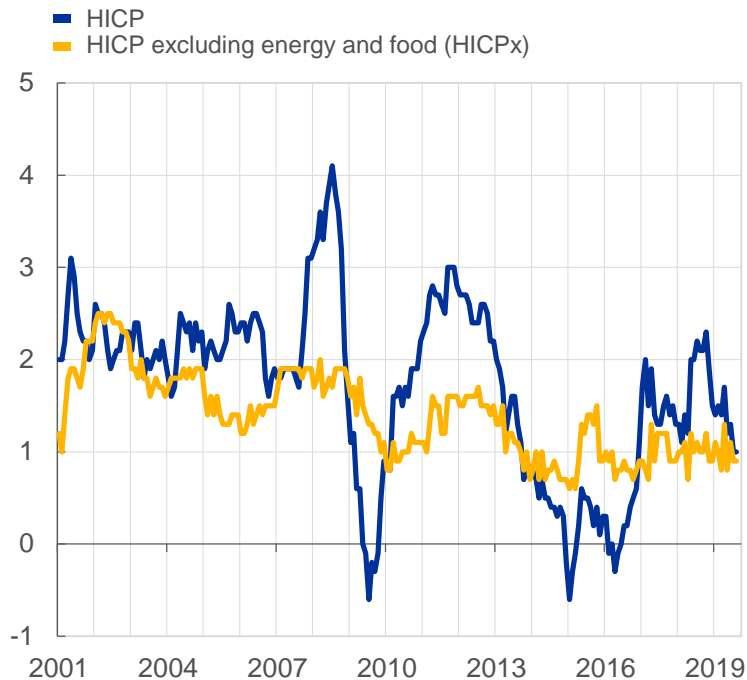
London School of Economics

4 September 2019

- 1 The ECB's policy context**
- 2 The structural Phillips Curve
- 3 Identifying the slope of the structural Phillips Curve
- 4 Reduced-form evidence
- 5 Conclusion

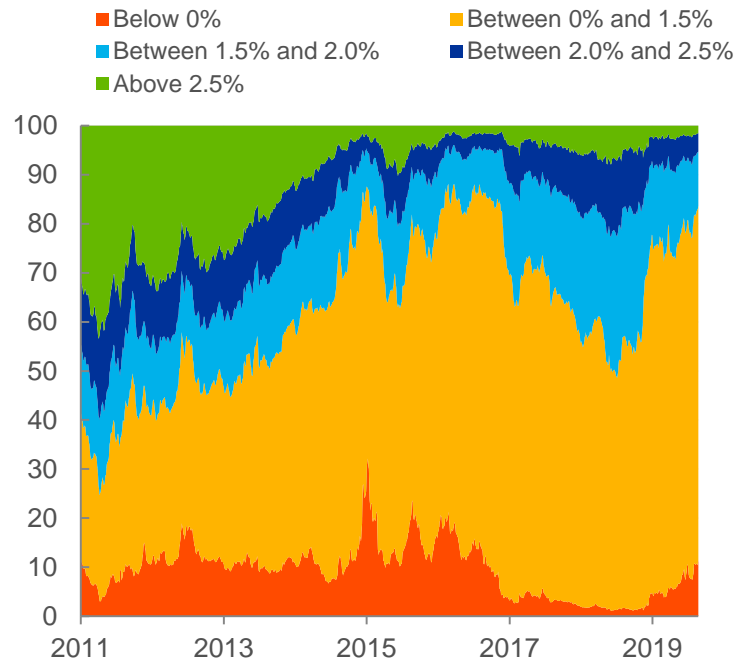
# Development of inflation and inflation expectations

## HICP and HICP excluding energy and food (percentage per annum)



Sources: Eurostat and ECB calculations.  
Notes: Based on monthly observations.  
Latest observation: August 2019 (flash estimate).

## Option-implied distribution of average inflation over the next five years (percentage)



Sources: Bloomberg, Thomson Reuters and ECB calculations.  
Notes: Probabilities implied by five-year zero-coupon inflation options, smoothed over five business days. Risk-neutral probabilities may differ significantly from physical, or true, probabilities.  
Latest observation: 30 August 2019.

# The ECB's package of measures

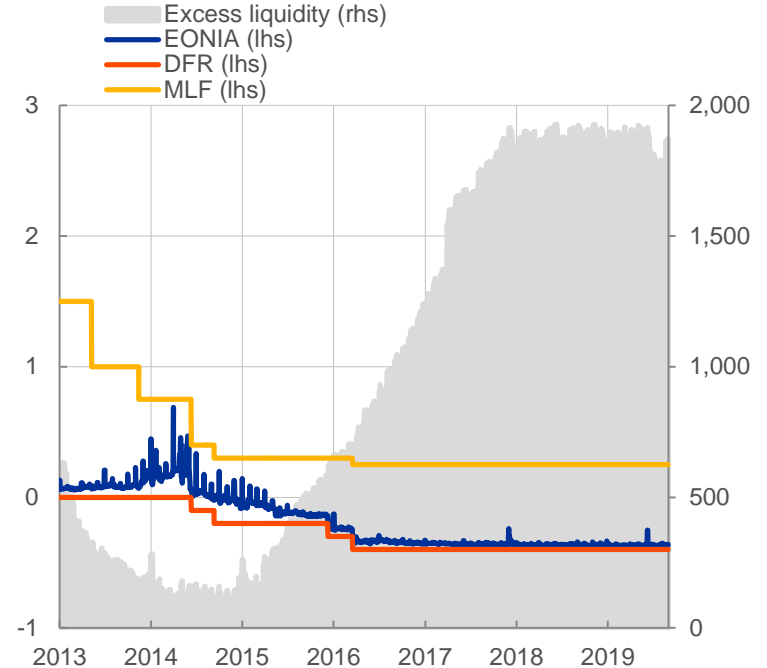
## A package of mutually reinforcing monetary policy measures

- 1) Pushing the policy rate into negative territory
- 2) Forward guidance on the future policy path
- 3) APP
- 4) TLTROs

The measures work as a package, with significant complementarities across the different instruments.

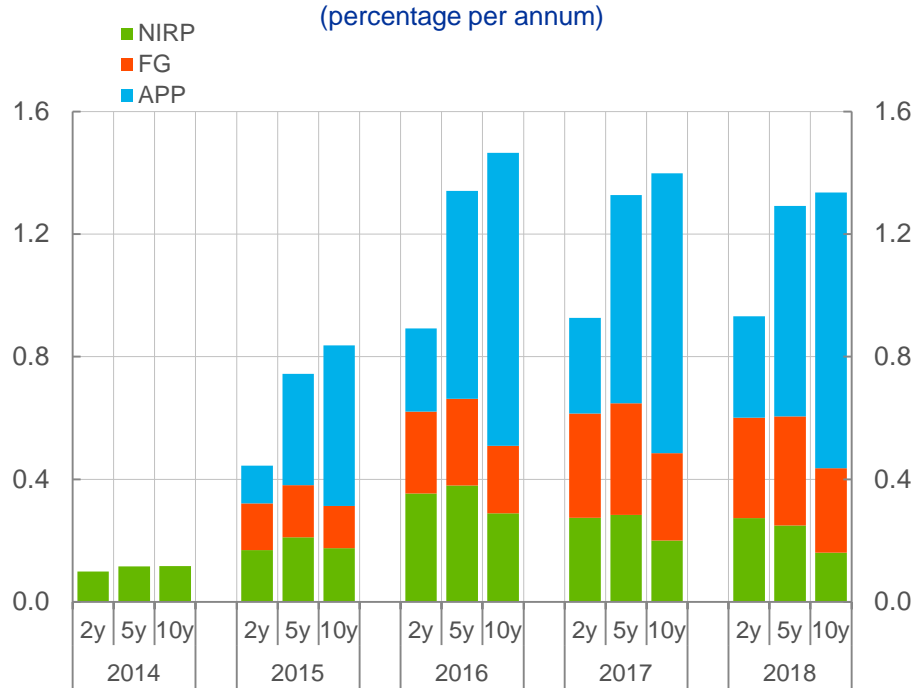
## EONIA, key ECB interest rates and excess liquidity

(lhs: percentage per annum; rhs: €bn)



Sources: Bloomberg, Thomson Reuters and ECB calculations.  
Latest observation: 30 August 2019.

## Upward pressures on euro area sovereign bond yields in absence of ECB's non-standard measures 2014-18



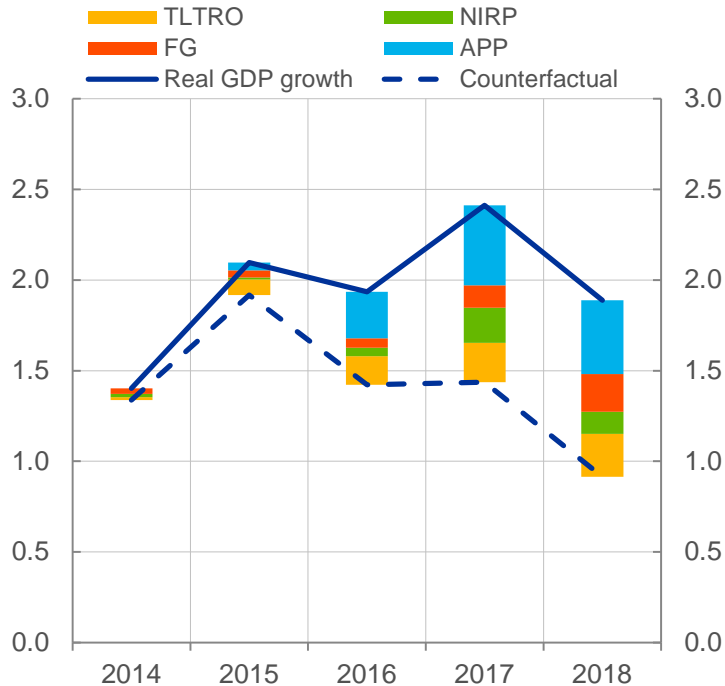
Source: Rostagno, Altavilla, Carboni, Lemke, Motto, Saint-Guilhem, Yiangou (2019), forthcoming.

Notes: NIRP = negative interest rate policy; FG = forward guidance; APP = asset purchase programme. The chart shows the impact of ECB non-standard measures on the GDP-weighted aggregate of euro area sovereign bond yields. The APP impact is due to Eser, Lemke, Nyholm, Radde, and Vladu (2019). The impact of NIRP and forward guidance is derived from counterfactual analysis of OIS forwards based on the option-implied densities.

# Contribution of ECB non-standard measures to growth and inflation 2014-18

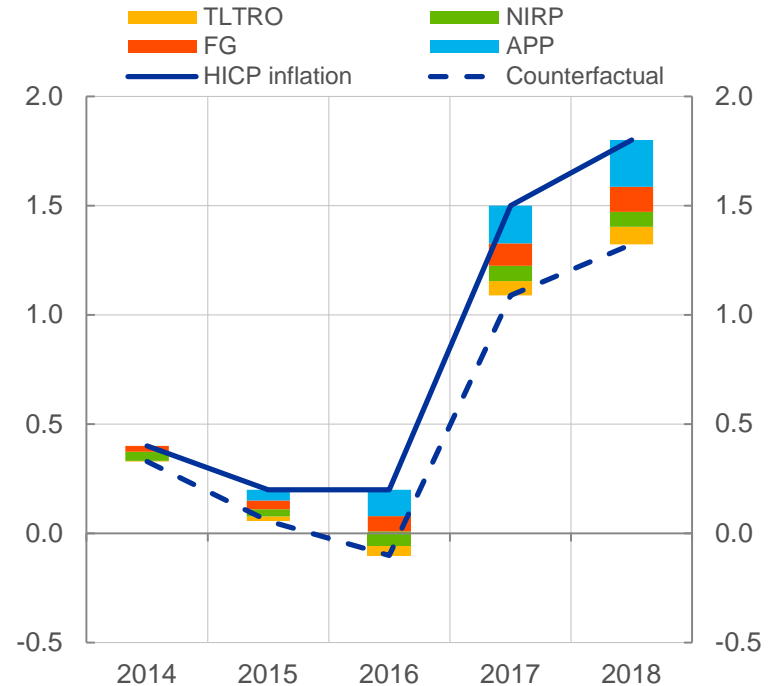
## Contribution of ECB non-standard measures to real GDP growth 2014-18

(percentage per annum)



## Contribution of ECB non-standard measures to HICP inflation 2014-18

(percentage per annum)



Source: Rostagno, Altavilla, Carboni, Lemke, Motto, Saint-Guilhem, Yiangou (2019), forthcoming.

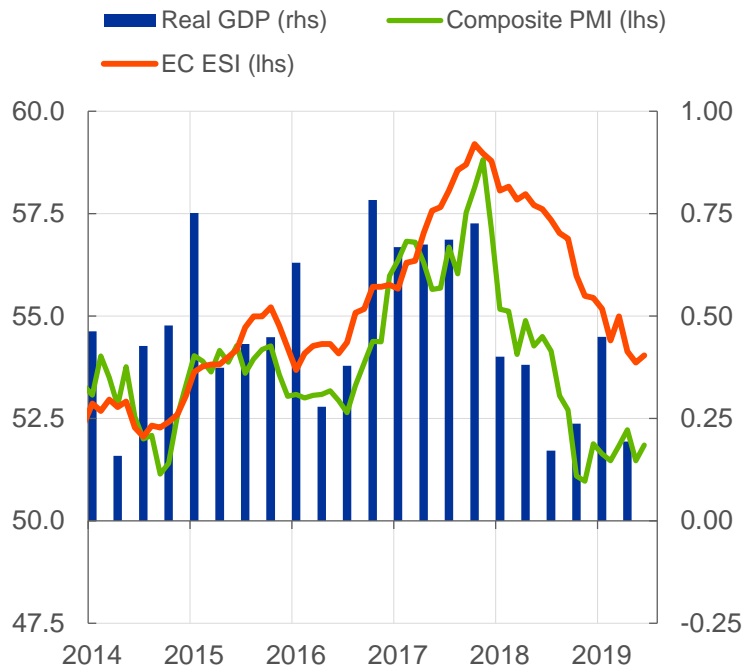
Notes: The chart shows the impact of ECB non-standard measures on macro variables based on a macroeconomic model with financial variables conditioning on the yield curve impact shown on the previous slide.

Source: Rostagno, Altavilla, Carboni, Lemke, Motto, Saint-Guilhem, Yiangou (2019), forthcoming.

Notes: The chart shows the impact of ECB non-standard measures on macro variables based on a macroeconomic model with financial variables conditioning on the yield curve impact shown on the previous slide.

## Real GDP and short-term indicators

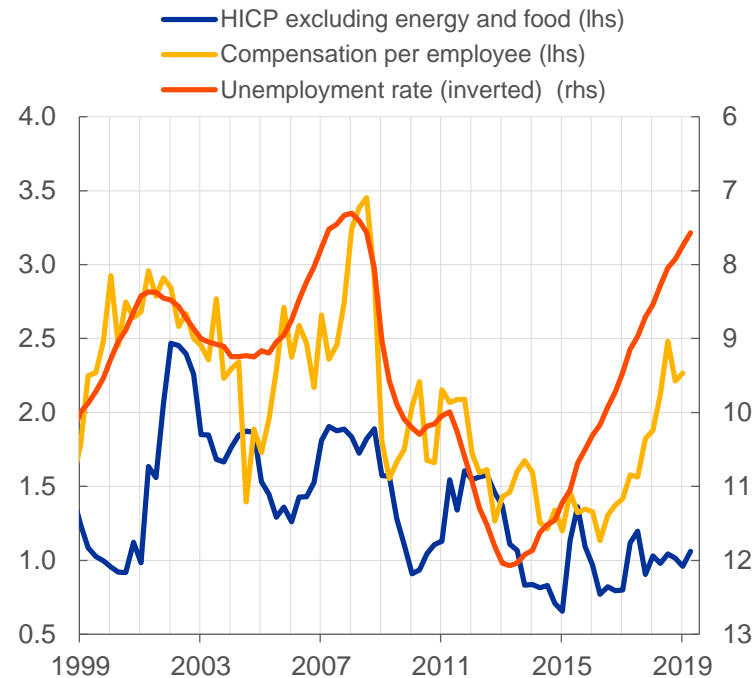
(lhs: index, rhs: quarter-on-quarter percentage changes)



Sources: Markit, Eurostat, European Commission and ECB calculations.  
 Latest observations: 2019Q2 for real GDP, August 2019 for PMI and ESI.

## Unemployment rate, wages and core HICP

(lhs: percentage per annum, rhs: percentage inverted)



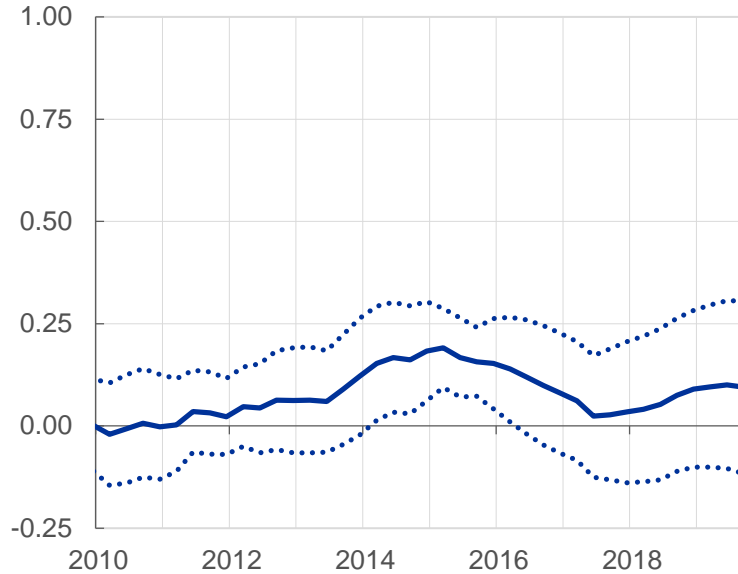
Sources: Eurostat and ECB calculations.  
 Latest observation: 2019Q1 for compensation per employee and 2019Q2 for the rest.

# The pass-through of short-term to long-term inflation expectations

## Pass-through of short-term (1y) to long-term (5y) SPF inflation expectations

(coefficients and confidence bands)

- ..... 84th percentile
- Time-varying parameter estimates - median
- ..... 16th percentile

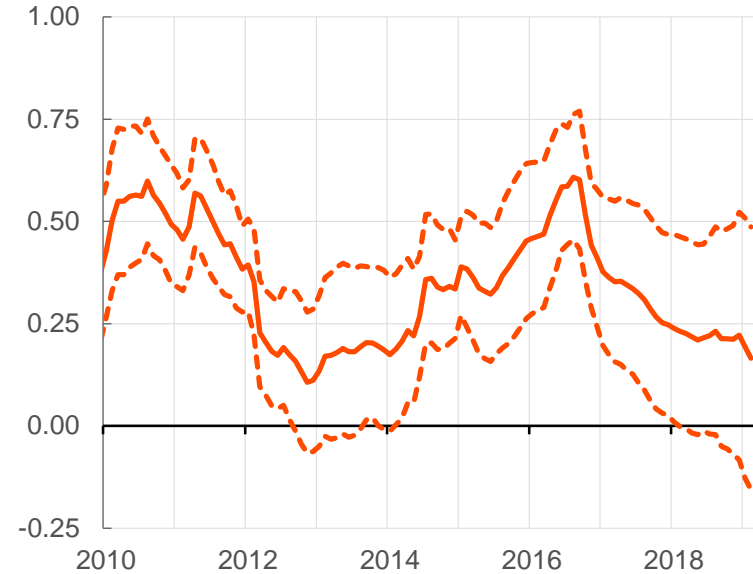


Sources: ECB, ECB Survey of Professional Forecasters (SPF), ECB calculations.  
Latest observations: 2019Q3.

## Pass-through of 1y1y to 5y5y market-based inflation expectations

(coefficients and confidence bands)

- - - 84th percentile
- Time-varying parameter estimate - median
- - - 16th percentile



Sources: ECB, ECB calculations.  
Latest observation: August 2019.



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## Comparison of selected parameter estimates across ECB models

Coefficients	Notation	NAWM II	ECB-Base	Reduced-form
Slope	$\hat{\kappa}$	0.008	0.12	0.08
Forward term	$\hat{\beta}$	0.998	0.63	0.16
Indexation term	$\hat{\gamma}$	0.230	0.39	0.51
Maximum multiplier	$\frac{\hat{\kappa}}{(1 - \hat{\beta})}$	4.000	0.33	0.02
Sample		1985Q1- 2014Q4	2000Q1- 2017Q4	1995Q1- 2019Q2
Type of model		Structural	Semi-structural	Reduced-form

Sources: ECB calculations.

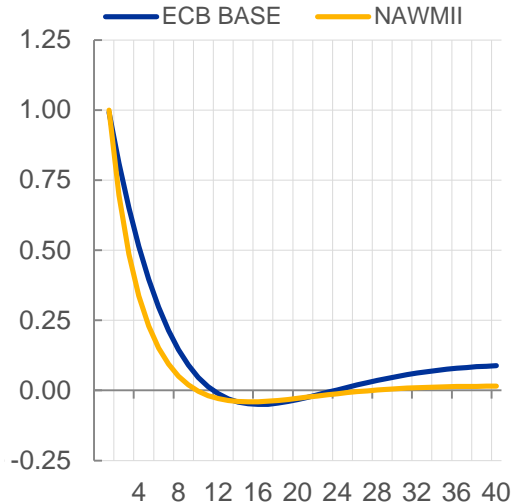
Notes: Estimated Phillips-Curve parameters of a structural open-economy DSGE model (New Area-Wide Model II), a semi-structural model (ECB-BASE) and an average of a suite of reduced-form estimations. The reduced-form estimation uses the HICPx index as a dependent variable, the internal output-gap estimate of the ECB as a slack measure and various inflation expectations. The results for NAWM II and ECB-BASE report a maximum output-gap multiplier, which obtains as the change in the output gap becomes permanent.

- reduced-form approaches tend to yield lower estimates of the PC slope
- the slope coefficients  $\kappa$  cannot be assessed independently of the estimated coefficient of the forward-looking term  $\beta$ : higher  $\beta$ , future output gap matters more for today's inflation → lower  $\kappa$  (see NAWM II vs. ECB-BASE)

# Phillips Curve slope estimates in light of the response to a monetary policy shock

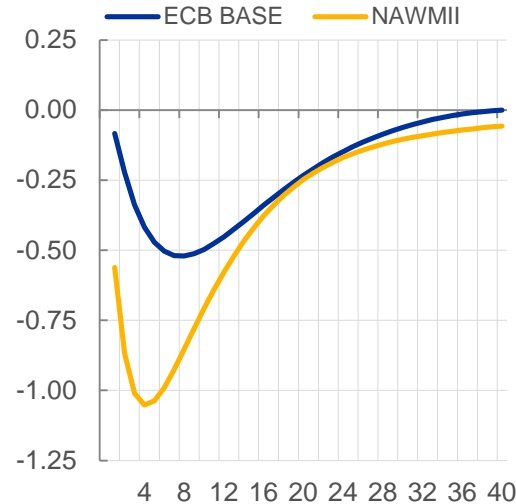
## Short-term nominal interest rate

(x-axis: quarters, y-axis: pp)



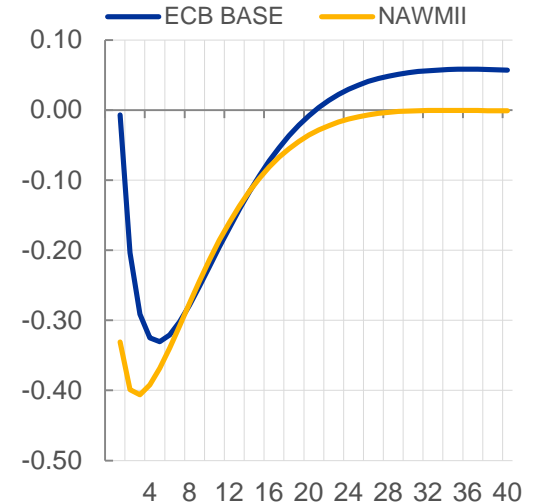
## Real output

(x-axis: quarters, y-axis: percentage deviation of GDP from steady state)



## GDP deflator inflation rate

(x-axis: quarters, y-axis: pp)



Sources: ECB calculations.

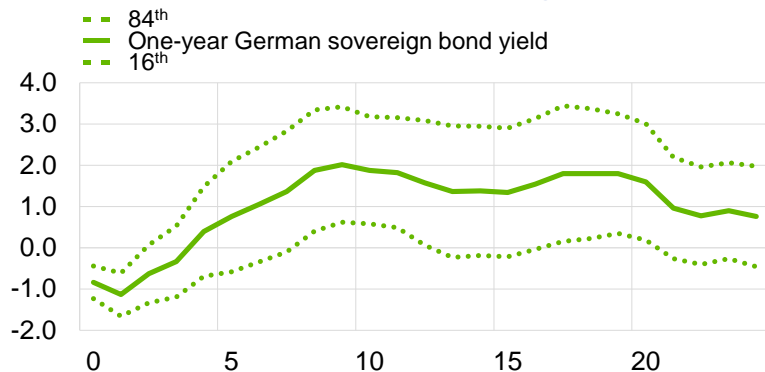
Notes: The graphs show the impulse responses to a one percentage point monetary policy shock in the structural New Area-Wide Model II (NAWM II) and the semi-structural ECB-BASE model.

- the slope coefficients  $\kappa$  cannot be assessed independently of the estimated coefficient of the forward looking term  $\beta$ : higher  $\beta$ , future output gap matters more for today's inflation  $\rightarrow$  lower  $\kappa$  (see NAWM II vs. ECB-BASE)
- this effect is visible in the impulse response to a monetary policy shock being larger in the NAWM II than in ECB-BASE despite the fact that NAWMII has a lower PC slope-coefficient

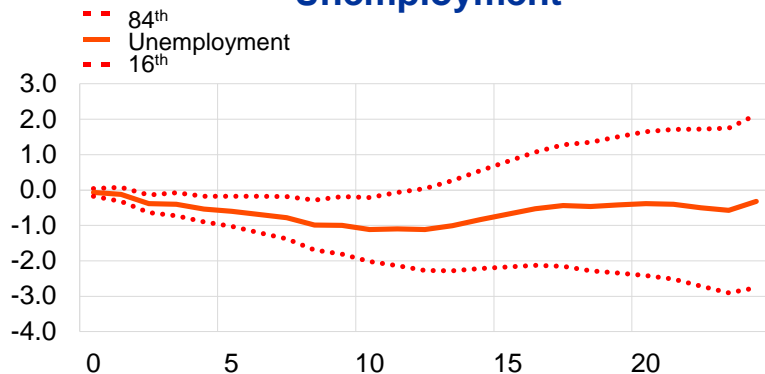
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# Identifying the Phillips Curve slope using external instruments

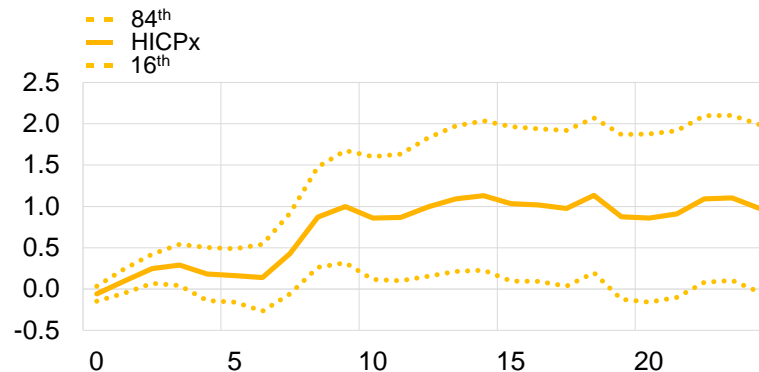
## One-year German sovereign bond yield



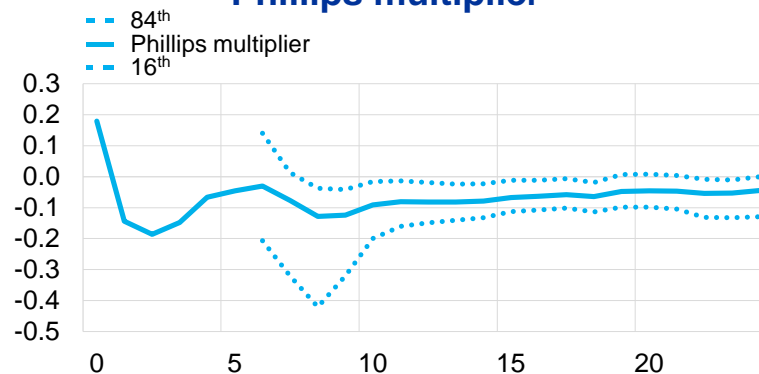
## Unemployment



## Core consumer price index



## Phillips multiplier



Sources: ECB calculations.

Notes: The figures plot the impulse responses of the one-year German sovereign bond yield, of the harmonized index of consumer prices excluding energy and food, and of the unemployment rate. The Phillips multiplier represents the coefficient  $\kappa_h$  in the regression  $\sum_{i=0}^h \pi_{t+i} = \kappa_h \sum_{i=0}^h u_{t+i} + \Gamma_h \Phi(L)X_t + e_{t,h}$  where the cumulative unemployment is instrumented by a proxy of a monetary policy shock. The Phillips multiplier is not well defined, and therefore is estimated with wide confidence bands at short horizons (bands up to 6 month are excluded from the figure). At horizons between 7 and 18 months, the Phillips multiplier is estimated to be negative with a coefficient between -0.05 and -0.1. The methodology follows Barnichon-Mesters (2019).

# Identifying the Phillips Curve slope using cross-country variation

## Parameter estimates from panel regressions

Regression	(1)	(2)	(3)	(4)	(5)
	Euro area	Pooled	Country FE	Time FE	Country, Time
<b>Output gap</b>	0.012	0.011	0.013	0.01	0.012
	(0.032)	(0.01)	(0.007)	(0.036)	(0.02)
<b>Constant</b>	0.068	0.049	0.058	0.173	0.191
	(0.012)	(0.000)	(0.001)	(0.001)	(0.001)
<b>HICP<math>x_{t-1}</math></b>	0.806	0.886	0.865	0.883	0.857
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
<b>Observations</b>	81	1296	1296	1296	1296
<b>R<sup>2</sup></b>	0.74	0.85	0.85	0.87	0.87
<b>Country FE</b>	No	No	Yes	No	Yes
<b>Time FE</b>	No	No	No	Yes	Yes

Sources: ECB calculations.

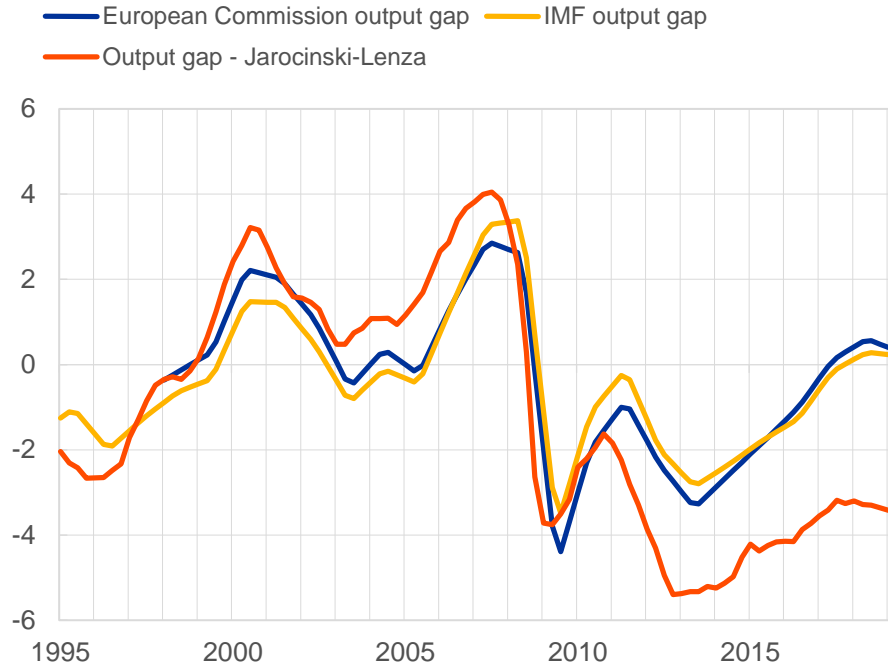
Notes: (1): OLS and (2) to (5) fixed-effects panel estimation using annual HICPx inflation and output gap, 1998-2018. For (1) heteroskedasticity-robust standard errors; for (2) to (5) robust standard errors are clustered at country level. P-values in parentheses. The countries included are: Austria, Belgium, Cyprus, Germany, Spain, Finland, France, Greece, Ireland, Italy, Luxembourg, Latvia, Malta, Netherlands, Portugal and Slovakia.



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## Comparison between official and alternative slack measures

(percentage)



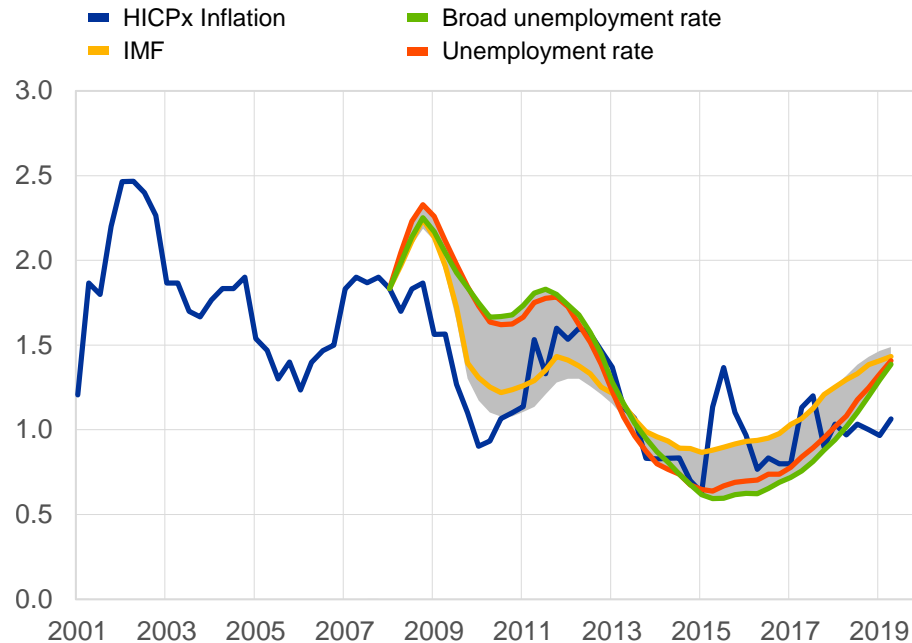
Sources: Eurostat, European Commission, IMF, ECB calculations based on Jarocinski and Lenza (2018).

Notes: the IMF and the EC output gap are depicted based on quarterly linear interpolation on annual data.

Latest observation: 2019Q2.

## Conditional forecasts of HICP<sub>x</sub> inflation for alternative indicators of economic conditions

(percentage per annum)



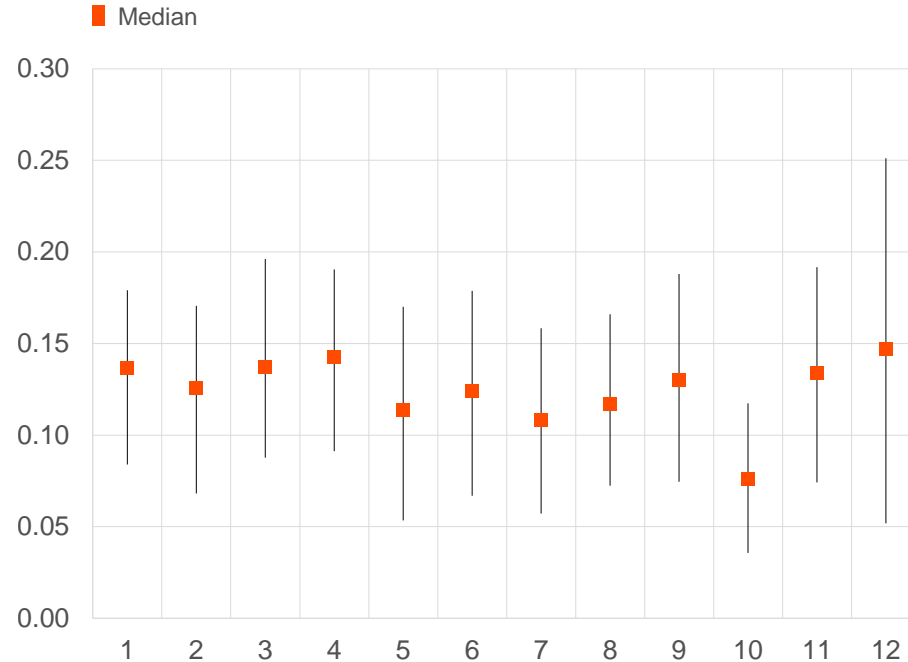
Sources: Eurostat, IMF, OECD, European Commission, ECB calculations.

Notes: the range was obtained using alternative indicators of slack: unemployment rate, unemployment gap (the difference between unemployment and NAIRU), broad unemployment rate (U6), output gaps estimated by the OECD, IMF and European Commission.

Latest observation: 2019Q2.

## Estimated Phillips Curve slope across all specifications

(regression coefficients of HICP<sub>x</sub> inflation on standardised slack measures)

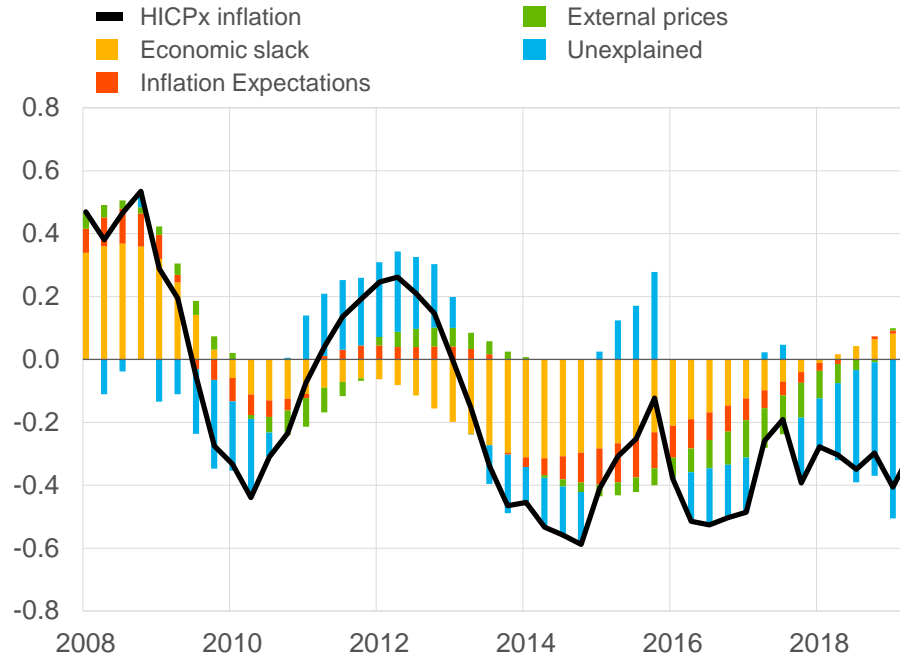


Sources: European Commission, Eurostat, IMF, OECD and ECB calculations.

Notes: We consider the following measures of slack: (1) output gap model-based estimate; (2) output gap IMF; (3) output gap European Commission; (4) output gap OECD; (5) unemployment rate; (6) unemployment gap model-based estimate; (7) unemployment gap IMF; (8) unemployment gap European Commission; (9) unemployment gap OECD; (10) short-term unemployment rate; (11) broad unemployment rate; (12) Jarocinski-Lenza output gap. The unemployment rates/gaps have been inverted. All measures of slack/tightness are standardised for the coefficients to be comparable across specifications. The vertical bars show the range of coefficients across all specifications including a particular measure of economic slack/tightness or activity.

## Thick modelling: Phillips Curve-based decomposition of core inflation

(percentage per annum and pp contributions;  
all values in terms of deviations from their averages since 1999)

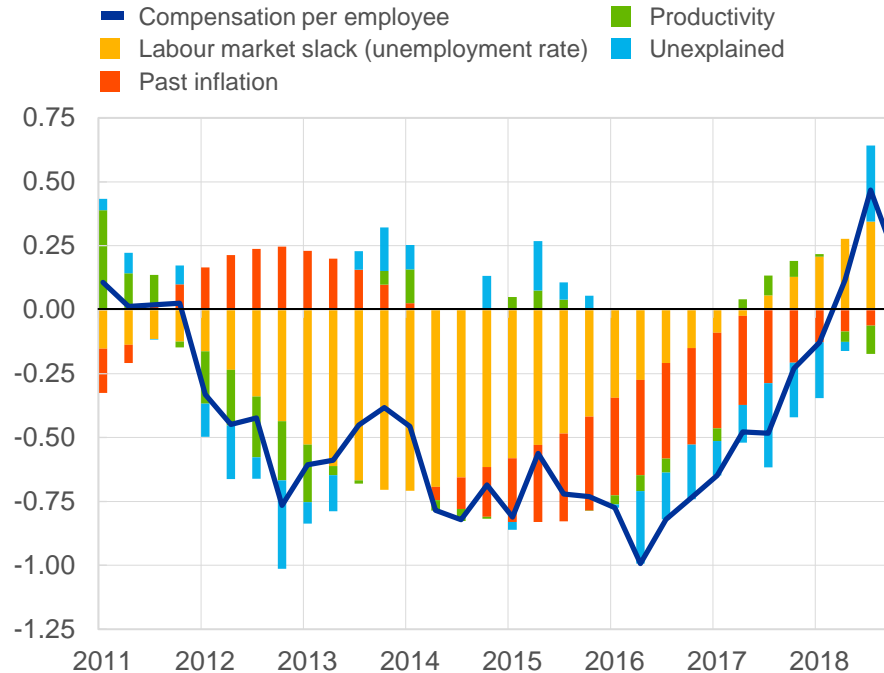


Sources: ECB calculations.

Notes: The bars show average contributions across 600 models with different permutations of external price, economic slack and expectations measures. Contributions are derived as in Yellen, J. L., "Inflation Dynamics and Monetary Policy", speech at the Philip Gamble Memorial Lecture, University of Massachusetts, Amherst, 24 September 2015.  
Latest observation: 2019Q2.

## Phillips Curve-based decomposition of wage growth into its main drivers

(deviations from mean in year-on-year growth terms and pp contributions)

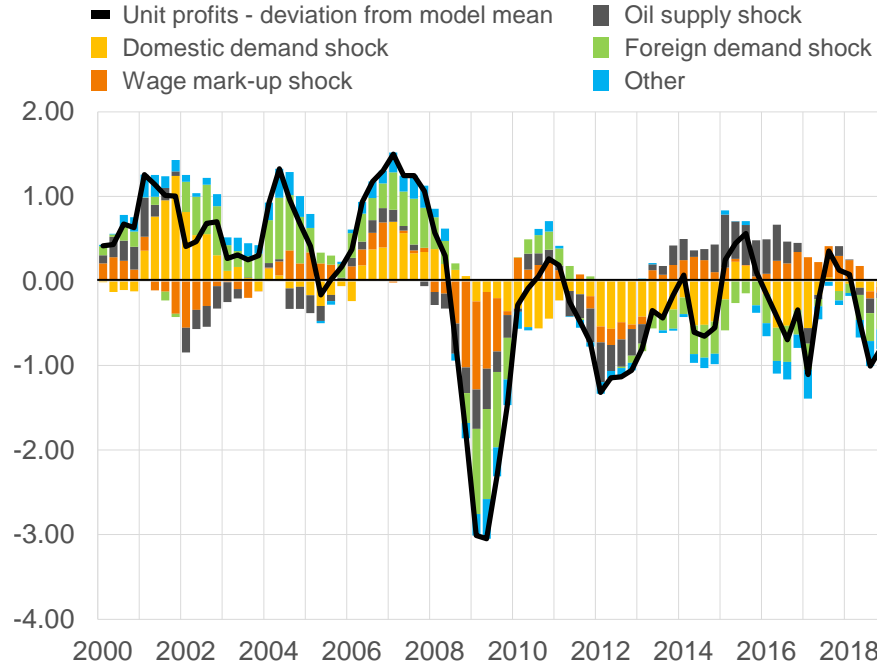


Source: Nickel, Bobeica, Koester, Lis, Porqueddu (2019) "Understanding low wage growth in the euro area and European countries".

Notes: Sample: 1995Q1-2018Q4. The 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).  
Latest observation: 2018Q4.

## BVAR-based structural decomposition of unit profits

(deviations from mean in year-on-year growth terms and pp contributions)



Source: ECB calculations.  
Latest observation: 2018Q4.

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- The structural Phillips Curve is a useful framework
- Slack in the economy, inflation expectations and markups are key determinants of inflation
- Using cross-country variation or external instruments are promising routes to identify the Phillips Curve slope
- Reduced-form empirical relation between slack and inflation provides a helpful contribution to the suite of forecasting models that we use at the ECB