EUROPEAN CENTRAL BANK

EUROSYSTEM

Occasional Paper Series

Work stream on employment

Employment and the conduct of monetary policy in the euro area

No 275 / September 2021

Acknowledgements

This report has been jointly produced by the Eurosystem work stream on employment comprising staff from the European Central Bank (ECB) and the national central banks (NCBs) of those countries that have adopted the euro. The report fed into the Governing Council's deliberations on the monetary policy strategy review 2020-21.

Co-leads of the workstream

Claus Brand
European Central Bank
email: claus.brand@ecb.europa.eu

Günter Coenen
European Central Bank
email: gunter.coenen@ecb.europa.eu

Reamonn Lydon
Central Bank of Ireland
email: reamonn.lydon@centralbank.ie

Meri Obstbaum
Suomen Pankki – Finlands Bank
email: meri.obstbaum@bof.fi

David Sondermann
European Central Bank
email: david.sondermann@ecb.europa.eu

Contributors

Viktors Ajevskis
Latvijas Banka

Siria Angino
European Central Bank

Henrique Basso
Banco de España

Gert Bijnens
Nationale Bank Van België/Banque Nationale De Belgique

Elena Bobeica
European Central Bank

Katalin Bodnár
European Central Bank

Vasco Botelho
European Central Bank

Andrea Colc(a)4.8 (go)]TJ ET Q q 51.36796.36 240.96 19.2 r

Felix Hammermann
European Central Bank

Nils Hernborg
European Central Bank

Matthias Hertweck
Deutsche Bundesbank

John Hutchinson
European Central Bank

Pascal Jacquinot
European Central Bank

Andrew Kanutin
European Central Bank

Alex Karsay
Národná banka Slovenska

Gasper Ploj
Banka Slovenije

Marios Polemidiotis
Central Bank of Cyprus

Maximilian Propst
European Central Bank

Pedro Luis Rebelo Neves
European Central Bank

Annukka Ristiniemi
European Central Bank

Manuel Bernado Rodrigues Pereira
Banco de Portugal

Arthur Saint-Guilhem
European Central Bank

Ana Seco Justo
European Central Bank

Domingos Seward
Banco de Portugal

Jirka Slacalek
European Central Bank

Andrej Sokol
European Central Bank

Michel Soudan
European Central Bank

Bela Szörfi
European Central Bank

Dominik Thaler
Banco de España

Juuso Vanhala
Suomen Pankki – Finlands Bank

Anders Warne
European Central Bank

Anastasia Zhutova
Banque de France

This report is part of a set of papers within the ECB's Occasional Paper Series, related to the ECB's Strategy review 2020-21. This set includes the following papers:

Set of Occasional Papers related to the ECB's Strategy review 2020-21

No 263, "The implications of globalisation for the ECB monetary policy strategy".
No 264, "Inflation expectations and their role in Eurosystem forecasting".
No 265, "Inflation measurement and its assessment in the ECB's monetary policy strategy review".
No 266, "Digitalisation: channels, impacts and implications for monetary policy in the euro area".
No 267, "Review of macroeconomic modelling in the Eurosystem: current practices and scope for improvement".
No 268, "Key factors behind productivity trends in EU countries".
No 269, "The ECB's price stability framework: past experience, and current and future challenges".
No 270, "Non-bank financial intermediation in the euro area: implications for monetary policy transmission and key vulnerabilities".
No 271, "Climate change and monetary policy in the euro area".
No 272, "The role of financial stability considerations in monetary policy and the interaction with macroprudential policy in the euro area".
No 273, "Monetary-fiscal policy interactions in the euro area".
No 274, "Clear, consistent and engaging: ECB monetary policy communication in a changing world".
No 275, "Employment and the conduct of monetary policy in the euro area".
No 276, "The mandate of the ECB: Legal considerations in the ECB's monetary policy strategy review".
No 277, "Evolution of the ECB's analytical framework".
No 278, "Assessing the efficacy, efficiency and potential side effects of the ECB's monetary policy instruments since 2014".
No 279, "The need for an inflation buffer in the ECB's price stability objective – the role of nominal rigidities and inflation differentials".
No 280, "Understanding low inflation in the euro area from 2013 to 2019: cyclical and structural drivers".

Contents

Abstract

This report discusses the role of the European Union's full employment objective in the conduct of the ECB's monetary policy. It first reviews a range of indicators of full employment, highlights the heterogeneity of labour market outcomes within different groups in the population and across countries, and documents the flatness of the Phillips curve in the euro area. In this context, it is stressed that labour market structures and trend labour market outcomes are primarily determined by national economic policies. The report then recalls that, in many circumstances, inflation and employment move together and pursuing price stability is conducive to supporting employment. However, in response to economic shocks that give rise to a temporary trade-off between employment and inflation stabilisation, the ECB's medium-term orientation in pursuing price stability is shown to provide flexibility to contribute to the achievement of the EU's full employment objective. Regarding the conduct of monetary policy in a low interest rate environment, model-based simulations suggest that history-dependent policy approaches − which have been proposed to overcome lasting shortfalls of inflation due to the effective lower bound on nominal interest rates by a more persistent policy response to disinflationary shocks − can help to bring employment closer to full employment, even though their effectiveness depends on the strength of the postulated expectations channels. Finally, the importance of employment income and wealth inequality in the transmission of monetary policy strengthens the case for more persistent or forceful easing policies (in pursuit of price stability) when interest rates are constrained by their lower bound.

JEL Codes: E24, E52.

Keywords: Employment, monetary policy, heterogeneity.

1 Introduction

This report identifies conditions under which monetary policy can contribute to the European Union's objective of full employment without prejudice to maintaining price stability. First and foremost, in many circumstances there is positive complementarity in that, by pursuing price stability, monetary policy already supports the objective of full employment. However, in response to economic shocks that give rise to a trade-off between employment and inflation stabilisation, the ECB's medium-term orientation in pursuing price stability (as embedded in the ECB's monetary policy strategy adopted in 1998 and reconfirmed in 2003) affords flexibility to contribute to the achievement of the EU's full employment objective. The report does not explore the relationship with other secondary objectives stipulated by the Treaty, or the interaction with national policies. Its findings relate to three main areas.

First, while national policies predominantly determine labour market outcomes, monetary policy can support full employment, without prejudice to maintaining price stability. Full employment can be approximated through a set of indicators and models, but the range of values from various approaches indicates significant uncertainty about the prevailing degree of labour market slack. While indicators approximating labour market slack remain relevant for euro area wage growth and inflation, the price Phillips curve is rather flat. Accordingly, changes in slack indicators tend to imply only small changes in inflation. Evidence on non-linearities in Phillips curves suggests that this might particularly be the case in low inflation regimes. Aggregate labour market data also hide significant inequality in income and wealth, as well as in opportunities, across various socio-demographic groups, but also across countries. Disadvantaged groups are hit harder by recessions and are particularly prone to hysteresis effects, which, among other factors, could stem from a protracted demand shock that is not addressed adequately or promptly by policymakers, e.g. if misperceived as a supply shock. Importantly, though, aggregate labour market outcomes and inequality in income, wealth and opportunities are primarily structural in nature with national policymakers primarily responsible for addressing them.

Second, by exploiting the flexibility of the ECB's medium-term orientation and, possibly, by accounting for a history-dependent element, monetary policy generally has scope to support full employment in the presence of trade-offs between inflation and employment stabilisation, but different sources of uncertainty pose limitations. In view of the empirical evidence of a flat price Phillips curve, short-term inflation stabilisation would result in heightened employment fluctuations, whereas policies aimed at getting close to full employment are likely, at least in the shorter term, to exert a rather moderate influence on the build-up of inflationary pressures. On that basis, model simulations indicate that a medium-term policy horizon which caters for employment without compromising the primacy of price stability can achieve better outcomes for society's welfare. At the same time, the high degree of uncertainty surrounding measures of economic slack, which is compounded by uncertainty about fundamental economic relationships, notably the Phillips curve, calls for a data-driven and state-dependent approach to monetary policy to insure against the risk of making policy mistakes. Model simulations show that history-dependent policy approaches, which have been proposed to overcome lasting shortfalls of inflation due to the effective lower bound (ELB) in a low interest rate environment, can also diminish accompanying shortfalls of employment and, hence, help to bring employment closer to full employment. But they are subject to several caveats, especially the high uncertainty about the strength of the postulated expectations channels.

And third, taking employment income and wealth inequality across households into account can have implications for the effectiveness of monetary policy under different strategies. Consumption of poorer households (or households holding illiquid assets) is more responsive to adverse demand shocks pushing their income down, because they are unable to save in advance and cannot borrow to smooth their consumption. Their employment prospects also take longer to recover following downturns. Keeping monetary policy expansionary for longer can help poorer households' income to rise to higher levels in a more sustained manner and thereby avoid hysteresis. Creating more jobs for those households, which have a higher marginal propensity to consume out of their income, is a more effective way of stimulating consumption. Accordingly, monetary policy has more asymmetric and stronger effects on less wealthy or lower-income households and possibly also on aggregate output. Conversely, given these amplifying impacts of employment heterogeneity and inequality on the propagation of shocks, the ELB can aggravate economic downturns. Model settings with labour income or wealth inequality confirm that monetary policy's ability to attain its inflation objective, when constrained by the ELB, may be improved by more forceful or persistent easing strategies when inflation is too low. Considerations about the role of employment income and wealth inequality in pursuing price stability therefore strengthen the case for a lower for longer strategy, as already established in representative household settings. Notwithstanding the limits in exploring the general equilibrium effects of monetary policy in models with heterogeneous settings, empirical evidence, including for the euro area, points to the importance of considering employment heterogeneity and inequality in the conduct of monetary policy in pursuit of price stability. Success in delivering on the price stability mandate will also contribute to broad-based and inclusive employment growth.

2 Full employment concepts and the Phillips curve

2.1 Introduction

Chapters 2 and 3 outline key features of the euro area labour market, providing the basis for the monetary policy strategy discussion in Chapters 4 and 5. This chapter summarises concepts of full employment and how they link to wage and price inflation. Unemployment is one of the most salient issues faced by euro area citizens, with a negative impact on individuals and groups and with sizeable costs for the economy as a whole. Box 1 analyses the salience of unemployment in the euro area, analysing data from the Eurobarometer and drawing on the feedback received from the ECB Listens activities, both on the importance of unemployment and on its socio-demographic breakdown.

The term "full employment" refers to distinct employment benchmarks, both positive and normative.[1] Normatively, it refers to a situation where labour in an economy is being fully and efficiently utilised, where everyone who is able and willing to work can get a job at the prevailing wage and for the hours they prefer. In practice, assessing what level represents full employment is challenging. Discussions on full employment often focus on the unemployment rate. However, this does not imply zero unemployment when an economy has reached full employment. Some level of "frictional" unemployment − owing, for example, to the time needed for employers and employees to find productive matches − is expected.

Labour market outcomes are predominantly affected by national structural policies. Euro area countries' unemployment rates vary significantly, first and foremost reflecting labour market policies and characteristics, such as the unemployment benefits replacement rate, the degree of union density or the tax wedge. But other policies, such as product market policies, including opportunities for new firms to access markets, also affect employment growth. Estimates of structural unemployment rates that aim to distil the influence of national policies and characteristics vary significantly across euro area countries.

A second notion of full employment is the long-run level of unemployment, i.e. the level of unemployment to which the economy returns after shocks have subsided. This long-run level does not necessarily correspond to the normative notion of full employment, as there may be structural factors that give rise to scarring effects or longer-term mismatch. Addressing this type of unemployment is best achieved by national policies. However, long-run unemployment provides a useful

---

[1] Terms used to designate (un)employment benchmarks, such as "natural", "structural", or "equilibrium", are abundant and often used indistinctively to refer to different concepts (Rogerson, 1997). Among the three concepts distinguished here, the distinction between the long-run level of employment and the level of employment consistent with on-target inflation is similar to the one made by Crump et al. (2020).

benchmark for monetary policy, especially for the structural conditions of the labour market.

In addition, full employment is linked to a third notion, the level of unemployment consistent with the absence of inflationary pressures, captured by the non-accelerating inflation rate of unemployment (NAIRU). While the NAIRU is not a normative concept and therefore does not in general correspond to a full-employment objective, it can guide monetary policy, helping to assess future price developments and achievement of the price stability objective.

With a view to determining the "distance" to full employment, the position of the labour market is not captured by the unemployment rate alone; it is more broadly gauged by a wider range of labour-market indicators. Underemployment, the potential for discouraged workers, large observed flows from inactivity to employment and precarious contracts are all relevant factors in assessing the state of the labour market.

The second part of this chapter discusses the role of labour market slack[2] for wage growth and inflation. A meaningful and stable wage/price Phillips curve relationship is one of the cornerstones of modern macroeconomics, embedded in the macroeconomic frameworks used by central banks. For European System of Central Banks (ESCB) projections, Phillips curves are used both in-sample, to provide a *narrative* for inflation and wage developments, and out-of-sample, for example, to cross-check the Broad Macroeconomic Projection Exercise (BMPE) inflation projections.

To gauge the role of slack in driving wage growth and inflation (the slopes of the two Phillips curves), it is important to account for factors that might change those relationships over time. For the euro area, slack matters for both wage growth and inflation, although most estimates point to a rather flat price Phillips curve. Empirical analysis also highlights the need to account for both cyclical and secular factors that can affect this relationship.

Cyclical factors include other important determinants of nominal variables, such as productivity or inflation expectations. For example, productivity growth was an important driver of wage growth over most of the period following the global financial crisis, and similarly, the behaviour of survey inflation expectations helps account for inflation dynamics.

Secular factors could be behind the downward drift of various measures of inflation in recent years. More secular forces, such as demographics, migration, globalisation and digitalisation, especially when coupled with monetary policy constrained by the zero lower bound, may also help explain the gradual downward drift of inflation since 2013, largely coinciding with what is known as the "missing inflation" period.

---

[2] In broad conceptual terms, labour market slack is understood as the labour market's distance from full employment, or the underutilisation of labour market resources.

The pass-through from wage growth to inflation is not one-for-one. Imperfect pass-through from wages to prices, possibly due to the particular nature of the shocks that hit the euro area economy over recent years, might go some way towards reconciling the disconnect between an apparently intact wage Phillips curve and a flatter price Phillips curve that struggles to account for the recent inflation weakness.

Both Phillips curves are surrounded by numerous uncertainties, including how slack variables are measured, time variation in key parameters, and whether it is appropriate to assume a linear relationship. Changing slopes could also point to state dependence in the Phillips curve relationships, for example a situation in which the amount of slack in the economy in turn influences the responsiveness of nominal variables to slack.

However, considering a broader range of labour market slack measures does not lead to very different estimates of the slope of either Phillips curve. With very few exceptions, slope estimates are very similar to those implied by more standard measures. This suggests that measurement of labour market slack is not a key source of uncertainty for either Phillips curve (in line with earlier results for the wage Phillips curve).

In non-linear specifications, there is tentative evidence of state dependence in both Phillips curves, but with very high margins of uncertainty. In many cases, uncertainty bands are so wide that it is impossible to detect any statistically significant change over time.

This chapter is organised as follows. Sections 2.2 to 2.4 look at indicators of full employment including long-run (un)employment, the NAIRU and the unemployment gap. Sections 2.5 and 2.6 review specifications for the wage and price Phillips curve, and discuss sources of uncertainly common to both.

Box 1
The importance of unemployment in citizens' priorities and perceptions

Unemployment is bad for welfare and has sizeable costs for the economy as a whole. This box aims to assess the importance given to employment and unemployment in euro area citizens' priorities and perceptions, using survey data from the Eurobarometer and the main insights gained from the ECB Listens activities. Employment is a key component of the production process in the economy, with around 60% of the total income generated each year in the euro area accruing to labour. Conversely, there are still 13 million unemployed workers in the euro area, representing 8% of the over 160 million workers who were in the labour force in the second quarter of 2020. Unemployment has a pervasive effect on the daily life of euro area citizens involving substantial private and social costs (Feldstein, 1978). The costs of unemployment are mostly borne by workers and lead to lower welfare and to the depreciation of workers' skills when long-lasting.

Unemployment is one of the most salient issues faced by euro area citizens according to survey data. This box uses microdata from the biannual Standard Eurobarometer to assess euro area citizens' perceptions of the salience of unemployment. The Eurobarometer asks each respondent to choose the two most important issues facing their own country and themselves at the time of the survey. Chart A (left panel) shows the average share of respondents mentioning unemployment as one of the two most important issues in the euro area between 2012 and 2020. Overall, 38% of euro area citizens consider unemployment to be one of the two most important issues facing themselves and/or their own country over the period. The perceived importance of unemployment is higher during downturns than in expansionary periods, reaching 48% at the peak of the sovereign debt crisis in 2012 and slowly declining to 27% at the end of 2019, just before the onset of the coronavirus (COVID-19) crisis. The perceived importance of unemployment is also related to the level of unemployment in each country. Countries that register lower unemployment rates also observe a lower perceived importance of unemployment. This is the case in Germany and the Netherlands, where the perceived salience of unemployment stood at 17% and 26%, respectively. By contrast, countries with relatively higher unemployment rates note instead a higher salience of unemployment, reaching levels of 55% in France, 57% in Italy, and 73% in Spain.

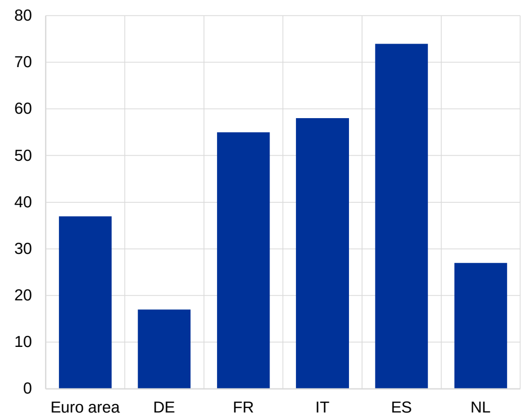
While the perceived importance of unemployment varies across socio-demographic groups, unemployment is a more salient issue among young and low-educated workers, and in households with a more fragile financial situation. Chart A (right panel) describes the breakdown on the salience of unemployment across different socio-demographic groups (gender, age, occupation, and education). Regarding gender, women are on average slightly more likely to consider unemployment to be an issue than men, and more so during downturns than in expansions. On the age and education breakdowns, young and low-educated citizens are more concerned with unemployment than their older and higher-educated counterparts, with 42% of young citizens and 46% of low-educated citizens indicating, on average, unemployment among the top two issues affecting themselves and/or their own country. Finally, socio-economic status seems to be important for citizens' perceptions of the salience of unemployment. The perceived importance of unemployment is more salient among individuals who face a more fragile financial situation and who have more difficulties in paying their bills. On the other hand, only 24% of managers seem to consider unemployment an important issue, which is likely due to their, on average, higher education, older age, better financial situation and lower risk of facing unemployment.

Chart A

The salience of unemployment in the euro area between 2012 and 2020 (left panel) and socio-demographic breakdown of the salience of unemployment (right panel)

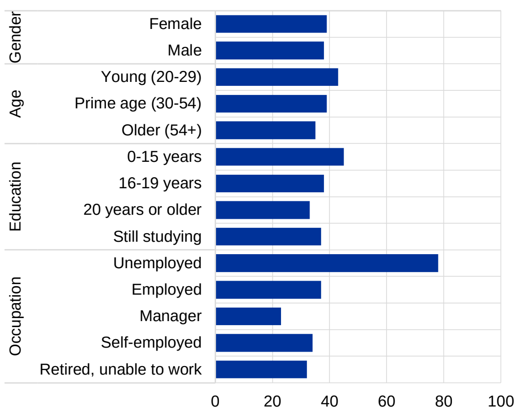
The salience of unemployment in the euro area between 2012 and 2020

(share of total respondents; percentages)



Socio-demographic breakdown of the salience of unemployment

(share of group-specific respondents; percentages)



Sources: Standard Eurobarometer.
Note: The question in the survey reads: "What do you think are the two most important issues [facing (OUR COUNTRY)/you are facing] at the moment?" and the respondent can pick from a range of issues. The euro area and country figures are stratified at country level and the euro area figure is also weighted by country population.

The feedback received from the ECB Listens activities confirms the findings from the Eurobarometer, both on the importance of unemployment and on its socio-demographic breakdown. In the context of the Strategy Review, civil society organisations and the general public were invited to express their views on a range of issues via the ECB Listens Portal, at the ECB Listens event, and at national central banks' listening events. Unemployment and job precariousness were often mentioned as significant sources of distress. In fact, on the ECB Listens Portal, around one quarter of respondents mentioned employment issues when asked what economic concerns they were facing. Women are more concerned about employment than men, as are people in southern EU Member States, who traditionally face higher unemployment rates. Younger people were specifically concerned about deteriorating employment conditions and lower chances of finding suitable employment, while older cohorts also recognised the complexity of the job market faced by young generations. Older cohorts are also concerned about their own employment prospects and highlighted their difficulty in finding a new job at their age.

Overall, unemployment remains an important issue for euro area citizens. This is especially the case for young, low-educated, and unemployed workers, although women and older workers also expressed concerns about their own employability. Many approved of the ECB's support measures for the European economy during the pandemic crisis so far, stressing their importance and the continued need for them during the economic recovery.

2.2 Labour market indicators and full employment

The unemployment rate provides an important first indicator of full employment. The International Labour Organization (ILO) categorises the working age population into employed, unemployed (together forming the active population, or labour force), and inactive; the unemployment rate is the share of unemployed in the labour force.[3]

However, the unemployment rate is also limited in its ability to measure the distance of the economy to full employment. Some workers are better described as falling between two categories, rather than belonging in any one group. Outside of ILO unemployment, slack can also be captured by (i) employed persons willing to work more hours than they currently do (i.e. underemployed part-time workers); (ii) persons who are currently not actively seeking work, despite being available (i.e. "discouraged" workers); and (iii) persons who are actively seeking work, but are not immediately available (e.g. students before graduation, participants in qualification schemes). Workers in these three categories are important to account for alternative forms of labour underutilisation and to quantify the potential labour force. In the euro area, the "extended" unemployment rate that takes account of this potential slack is roughly double that in the narrow unemployment rate (see U6 in Chart 1, left panel).

To measure the gap to "full employment", the unemployment rate is complemented by other labour market indicators. Outside of unemployment, indicators such as the labour force participation rate or the employment/population ratio also tell us about the size of the *potential* labour force (Chart 2, right panel) in which changes can be separated into increases in the population and individual decisions about employment status. The labour force participation rate has increased steadily from 58.5% in 1997 to 64.5% in 2019, mainly reflecting the increased participation of women and older workers in the labour market.[4]

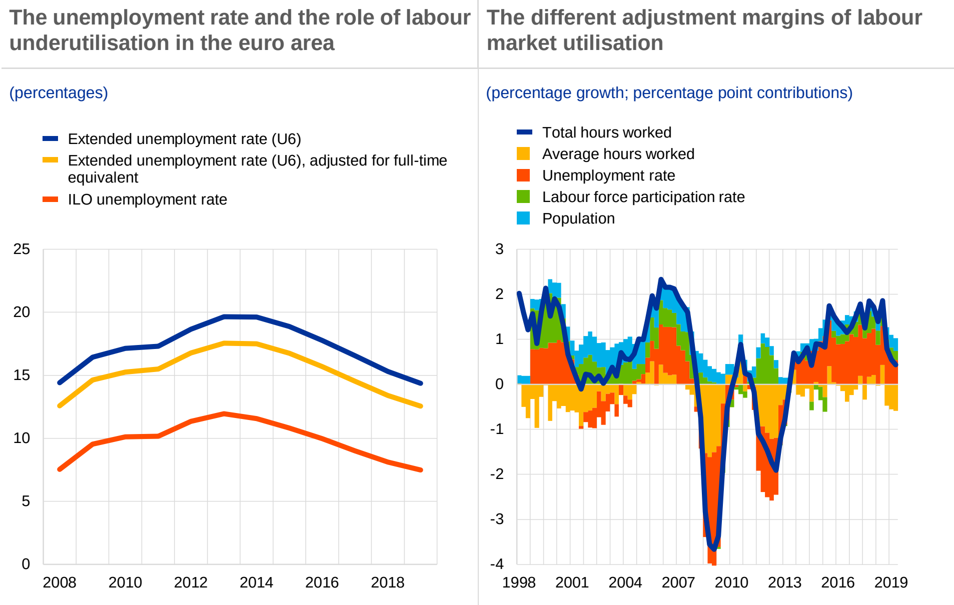
---

3 See the ILO Glossary of Statistical Terms for further details.

4 The employment/population ratio of persons aged between 15 and 74 years old also increased by 8.1 percentage points during the same period, from 51.8% in 1997 to 59.9% in 2019. The employment/population rate is however more cyclical than the labour force participation rate, having declined during both the global financial and sovereign debt crises, while the labour force participation rate decreased during the former but increased during the latter. The differences in the cyclicality of these indicators reflect, for example, increases in the number of discouraged workers during the global financial and sovereign debt crises and in the labour force participation of workers who were previously inactive (such as women and older workers). These factors create a discrepancy between the declines in employment during a recession and the corresponding observed increases in unemployment following these declines.

Chart 1

The unemployment rate and the role of labour underutilisation in the euro area (left panel) and the different adjustment margins of labour market utilisation (right panel)



Sources: Eurostat, EU Labour force survey, and ESCB staff calculations.
Note: The latest observation is for 2019.

Part-time and temporary employment can bring the economy closer to full employment by allowing more people to participate in the labour market, but less so if it is involuntary. Part-time employment represents a significant 20% of employment in the euro area, three quarters of which is "voluntary". This voluntary choice for part-time work has been increasing over time, from 14.4% of total employment in 2006 to 16.6% in 2019 (see Chart 2, left panel). Involuntary part-time employment can signal underused labour resources not captured by unemployment. The rate of involuntary part-time employment is countercyclical, tracking movements in the unemployment rate of the euro area.[5]

Temporary employment can also be voluntary and involuntary.[6] The share of temporary employees tends to decrease during recessions and increase during recoveries (see Chart 2, right panel).

Labour demand also adjusts through the intensive margin of labour (hours worked). Average hours worked have been on a steady decline in the euro area over the last decades, and also appear to be procyclical, falling by more than their average decline during recessions.[7] The importance of this adjustment at the intensive margin

5 Similar patterns in involuntary part-time employment can be found in the United States, see Valletta et al. (2020).

6 Out of all workers on a temporary contract, the share of voluntary temporary workers stood at 38.9% in 2018 in the euro area, a decrease of 1.4 percentage points from levels of 40.3% in 2006.

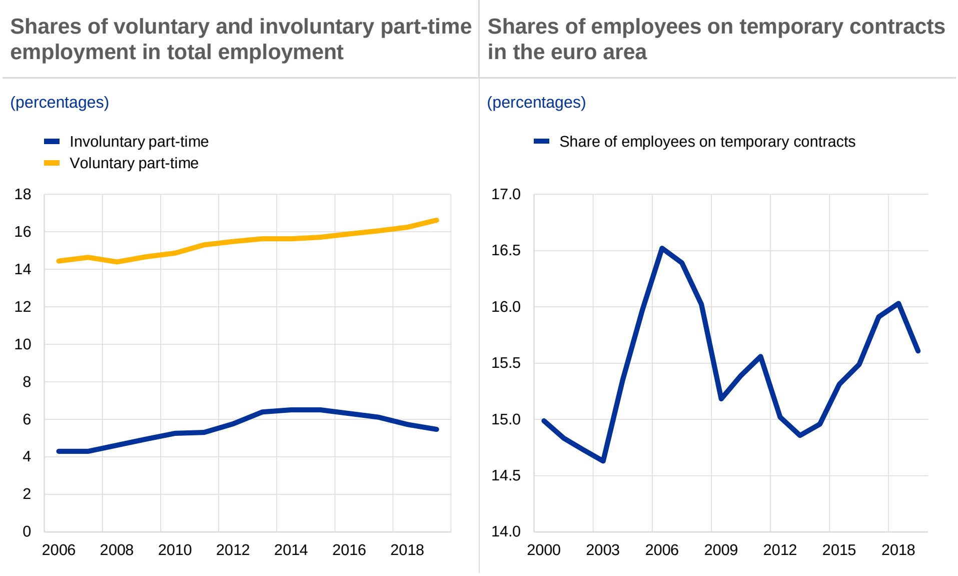
7 The steady decline in the average hours worked in the euro area is associated with the rise in part-time employment and the rising share of market and public services. See Chapter 3 for further details.

was particularly significant in 2020, due to the large deployment of job retention schemes (see Box 3, Chapter 3).[8]

The Beveridge curve reflects the negative relationship between job vacancies and unemployment (Chart 3, left panel). Movements *along* the curve reflect aggregate *cyclical* fluctuations, while inward/outward *shifts* in the curve reflect *structural* economic changes that contribute to lower/higher levels of long-term unemployment. The Beveridge curve provides a quick assessment of how rapidly and efficiently the labour market can match unemployed workers to the available job vacancies.[9] An alternative measure of job vacancies and labour market tightness is available from employer surveys, such as those shown in Chart 3, right panel.

Chart 2

Shares of voluntary and involuntary part-time employment in total employment (left panel) and shares of employees on temporary contracts in the euro area (right panel)



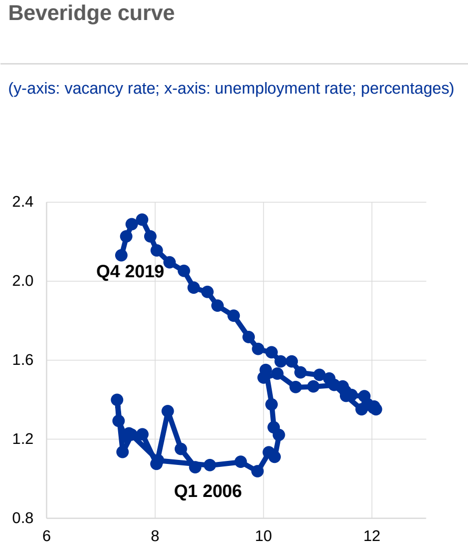
Sources: Eurostat and EU Labour Force Survey.
Note: The latest observation is for 2019.

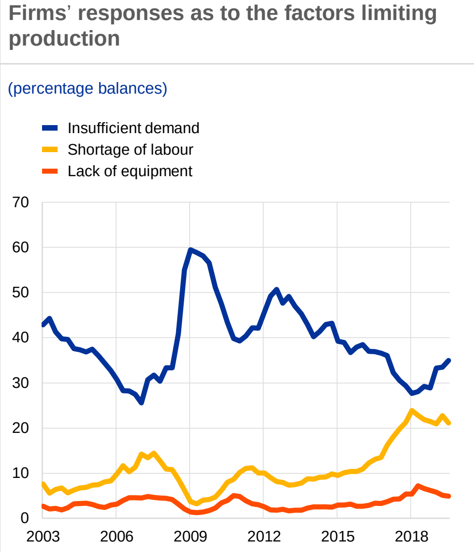
[8] Job retention schemes have been used in previous recessions, but to a different extent. For further details, see the OECD Employment Outlook (2010) and Brey and Hertweck (2016).

[9] See Consolo and Dias da Silva (2019) and Bonthuis et al. (2016).

Chart 3

Beveridge curve (left panel) and firms' responses as to the factors limiting production (right panel)





Sources: Left panel: Eurostat and EU Labour Force Survey; right panel: European Commission Business and Consumer surveys.
Notes: Left panel: The latest observation is for 2019; Right panel: The latest observation is for the fourth quarter of 2019. Sectors included are industry, services and construction.

2.3 Structural determinants of the level of full employment

The long-run level of employment depends considerably on the long-run level of unemployment, which varies substantially across euro area countries. The European Commission's structural unemployment anchor estimates the portion of the unemployment rate explained by country-specific structural characteristics,[10] including both labour market policies and other, non-policy, factors that characterise the underlying structure of the economy, such as productivity growth or the share of persons working in the construction sector. The level of long-run unemployment differs widely across countries, ranging from 4% in Austria to almost 16% in Spain (see Chart 4).

Country-specific labour market institutions and policies determine the level of unemployment outside of business cycle fluctuations.[11] Countries' structural unemployment anchors are found to depend on labour market characteristics such as the unemployment benefits replacement rate, the degree of union density and the tax wedge between a worker's net earnings and his cost to his employer.[12] Across countries, the unemployment rate is positively correlated with the degree of

10 This structural unemployment anchor is assumed to be the level to which the non-accelerating wage inflation rate of unemployment (NAWRU) returns in the medium run in a model used to estimate it. Section 4 discusses estimation methods of the NAIRU and NAWRU. See Orlandi (2012) and Hristov et al (2017) for further details. The European Commission uses an estimate of the NAWRU instead of the unemployment rate. Results are similar when using the unemployment rate, as shown in Orlandi (2012).

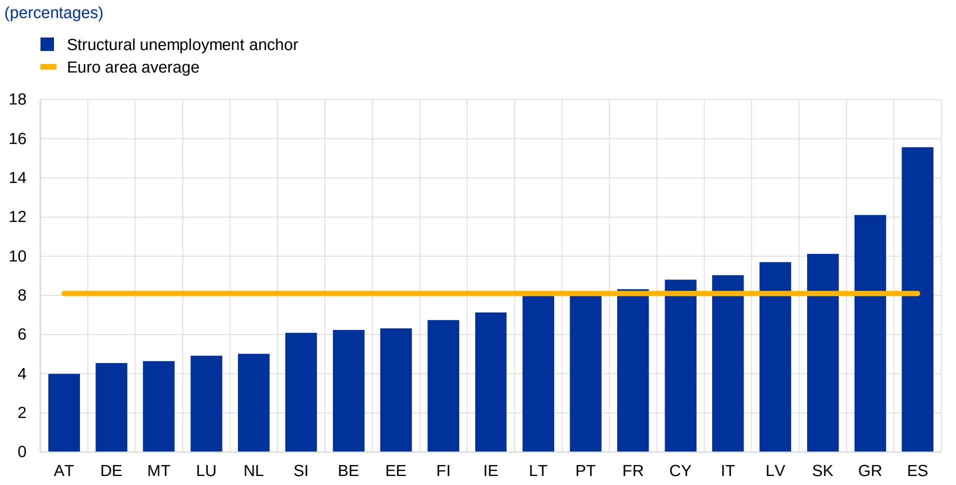
11 See Blanchard and Wolfers (2000).

12 See Orlandi (2012). Bassanini and Duval (2006) find similar results.

employment protection, the unemployment replacement rate, the duration of unemployment benefit, as well as with the labour tax rate and the degree of union density. Use of active labour market policies to help people find work or training and coordinated wage bargaining is negatively correlated with unemployment.[13] [14]

Chart 4

Structural unemployment anchor in euro area countries



Source: European Commission.
Notes: The structural unemployment anchors in this chart are based on estimates for 2019.

2.4 Inferring labour market slack or tightness from a price stability perspective

From a price stability perspective, the concept of full employment can be linked to measures of the natural rate of unemployment. The natural rate of unemployment indicates the level of unemployment that results from real economic forces and is largely determined by structural factors. By contrast, short-run deviations from the natural rate are affected by cyclical fluctuations in the economy (changes in aggregate demand, e.g. due to cyclical variation or shocks) which can be influenced by monetary policy and are linked to developments in inflation.[15] This link implies a potential trade-off between inflation and unemployment. For price stability, we need to use concepts that directly link unemployment and inflation. Prime examples are the concepts of a non-accelerating inflation rate of unemployment (NAIRU), or the non-accelerating wage inflation rate of unemployment (NAWRU), when talking about wage changes.[16] The NAIRU is unobservable and difficult to identify, as the relationship between inflation and unemployment is regularly shifted by supply shocks

13 See, among others, Orlandi (2012), Anderton and Di Lupidio (2019) and Piton and Rycx (2019).

14 In search and matching models, the impact of a higher degree of employment protection is typically ambiguous; see e.g. Jung and Kuhn (2014).

15 See Friedman (1968, 1976) and Pries (2008).

16 In this paper we understand the NAIRU to encompass the concept of the NAWRU. We only explicitly mention the difference between these concepts when there are differences in the modelling approach that may lead to some heterogeneity in the estimates for the natural rate of unemployment.

and by long-run developments (e.g. demographic change). Estimates are prone to measurement uncertainty, due to the different methodologies and assumptions used for estimating the NAIRU, to model and parameter uncertainty, and to data revision issues.[17]

The Eurosystem NAIRU can be estimated as an aggregation of country NAIRU estimates or by using aggregated data for the single euro area economy. The (broad) macroeconomic projection exercises ((B)MPE) employ a bottom-up approach (aggregated country-specific estimates), thereby explicitly allowing for differences in economic structure at the country level. However, approaches for estimating the NAIRU differ across countries. Multivariate filters, in combination with reduced form relationships from the Phillips curve or Okun's law are commonly used. Some countries also estimate structural unemployment rates from fully-fledged macroeconomic models.

The (B)MPE NAIRU can be cross-checked against estimates for the euro area NAIRU. The ECB uses a multivariate unobserved components model (UCM) built using a production function approach (Tóth, 2021) to estimate a euro area NAIRU.[18] An alternative UCM for the euro area, which incorporates a dynamic factor model to capture movements in a large number of real variables, is Jarociński and Lenza (2018).[19]

Estimates of the level and cyclicality of the NAIRU can depend on the methodology used. Chart 5, left panel, presents the range of estimates for the euro area NAIRU, both as an aggregation of country-level estimates and direct estimates. The range includes the Eurosystem estimate, the NAIRU from the UCM and dynamic factor models. Comparisons from statistical filters – Hodrick-Prescott (HP) filter or the Christiano-Fitzgerald (CF) bandpass filter – are also shown,[20] as well as the NAIRU estimates of international organisations. The currently available estimates differ notably in the period after the global financial crisis. However, all estimates point to a strong decline of the euro area NAIRU in the years 2017-19.

Different NAIRU estimates mean different unemployment gap estimates. Chart 5, right panel, shows the range of the difference between the actual unemployment rate and the different NAIRUs ("unemployment gap"). A positive gap is generally interpreted as more "slack", and lower wage and price pressures. Most gaps, including those of international institutions (European Commission, International Monetary Fund (IMF) and Organisation for Economic Co-operation and Development (OECD)) tell a similar cyclical story, differing in amplitude.

---

17 See Estrella and Mishkin (1999).

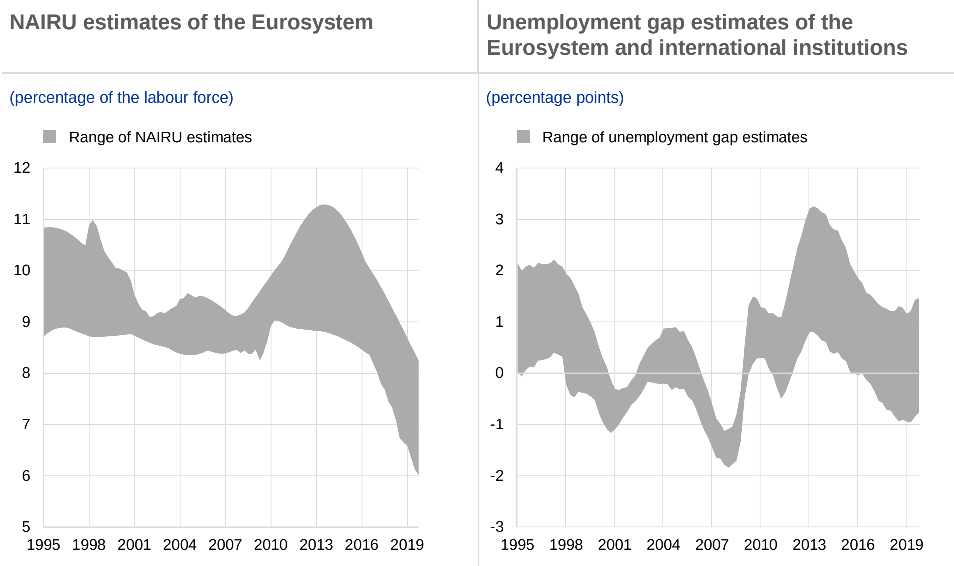
18 This unobserved components model is used in each forecast iteration to cross-check the projected NAIRU (and other trend variables) coming from the (B)MPE projections, with the NAIRU from Tóth (2021) being regularly reported in the quarterly (B)MPE report as the main cross-checking device for the (B)MPE NAIRU.

19 In this paper we report the NAIRU that would arise from model (4) in Jarociński and Lenza (2018), as this model obtained the best performance on the prediction for euro area core inflation.

20 Refer to Hodrick and Prescott (1997) for the HP filter and to Christiano and Fitzgerald (2003) for the CF filter. The NAIRU resulting from either filter can be interpreted as the trend unemployment rate, see Banbura and Bobeica (2020).

Chart 5

NAIRU estimates of the Eurosystem (left panel) and unemployment gap estimates of the Eurosystem and international institutions (right panel)



Sources: Eurosystem, European Commission, IMF, OECD, Eurostat and ECB Staff calculations.
Notes: The latest observation is for the fourth quarter of 2019. Left panel: The range includes the following estimates: Eurosystem (2019, December BMPE) the aggregation of the country-specific NAIRUs for the euro area countries; UCM (Tóth, 2021); Jarociński and Lenza (2018); HP filter NAIRU, estimated as the trend component using a smoothing parameter of 1600; CF filter NAIRU, estimated filtering out all time frequencies (or cycles) shorter than 15 years, as in Bańbura and Bobeica (2020), and estimates by the European Commission, IMF and the OECD. Right panel: The range includes the following estimates: Eurosystem (2019 December BMPE), UCM (Tóth, 2021), Jarociński and Lenza (2018), HP filter, CF filter as in Bańbura and Bobeica (2020), and estimates by the European Commission, IMF and the OECD.

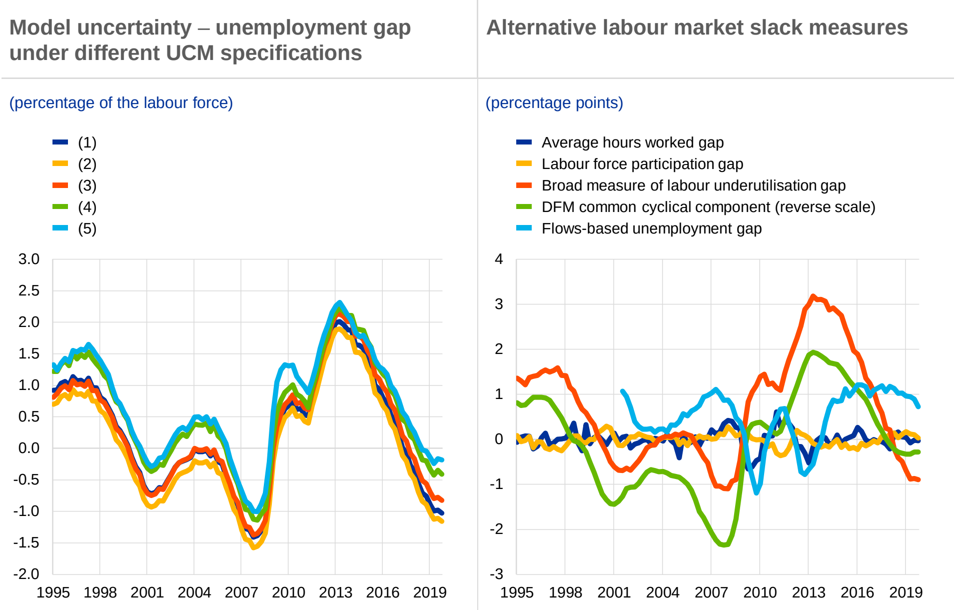
NAIRU estimates can depend on model specification, which means the unemployment gap is also subject to model uncertainty. To illustrate, Chart 6, left panel, shows the UCM with five different model variations, depending on how capacity utilisation, Phillips curves, and real quantities through reduced form relationships like Okun's law are incorporated.[21] A common assumption in all of the above models, including the UCM, is that the unemployment gap averages zero over time. In other words, there can be both positive (slack) *and* negative gaps (tight). An alternative view, Friedman's (1964) "plucking theory", is that unemployment fluctuates mostly *above* its natural level. This means symmetric approaches would *systematically* underestimate the level of slack. Box 2 summarises the empirical evidence and what plucking might mean for policy.[22]

21 Capacity utilisation enters the UCM by providing meaningful information on the cyclical developments in total factor productivity, consistent with Basu et al. (2006), Fernald (2012), Comin et al. (2018), or Huo et al. (2020).

22 On top of model uncertainty, the precision with which parameters of the time series processes in each model can be estimated (model parameter uncertainty), different definitions for the variables used in each model, and revisions to past observable data (Orphanides and van Norden, 2002) can all contribute to the uncertainty surrounding the estimates of the NAIRU and the unemployment gap at any given point in time.

Chart 6

Model uncertainty – unemployment gap under different UCM specifications (left panel) and alternative labour market slack measures (right panel)



Sources: Left panel: 2019 December BMPE and Tóth (2021); right panel: Eurostat.
Notes: The latest observation is for the fourth quarter of 2019. Left panel: The models above have the following features: (1) no wage and price Phillips curves, no role for capacity utilisation, and no long-term unemployment rate; (2) includes role for capacity utilisation; (3) includes role for capacity utilisation and price Phillips curve; (4) includes role for capacity utilisation and both price and wage Phillips curve, and the long-term unemployment rate. Model (4) is the benchmark unobserved components model used in this paper. Right panel: The average hours worked, labour force participation and the broad measure of labour utilisation gaps were estimated with an unobserved components model; the flows-based unemployment gap was obtained following Shimer (2012) and Elsby et al. (2013); and the dynamic factor model (DFM) common cyclical component was obtained following Tóth (2018).

Box 2

Friedman's plucking theory and its implications for assessing employment slack

Estimates of output gaps often embed the assumption that gaps are zero, or close to zero, on average. This applies to filters, as well as to many unobserved component (UCM) models. This is justified if unemployment fluctuates symmetrically around the NAIRU, and/or around the long-run level of unemployment, so that the NAIRU/long-run unemployment roughly equals average actual unemployment over a long time period.

An alternative view, which Milton Friedman (1964, 1993) called the "plucking model", is that full employment is better seen as a ceiling below which employment falls during contractions and recovers to during expansions. This implies employment gaps are negative on average, not zero. The plucking model does not preclude labour market overheating but implies that estimates of employment gaps that impose a zero or close to zero average employment gap are biased towards underestimating slack (Aiyar and Voigts, 2019).

There is evidence in favour of the plucking model for the United States. US unemployment fluctuations are consistent with the plucking model view (Dupraz, Nakamura and Steinsson, 2019) in that economic contractions are followed by expansions of a similar amplitude, and the amplitude of contractions is not related to the previous expansion.

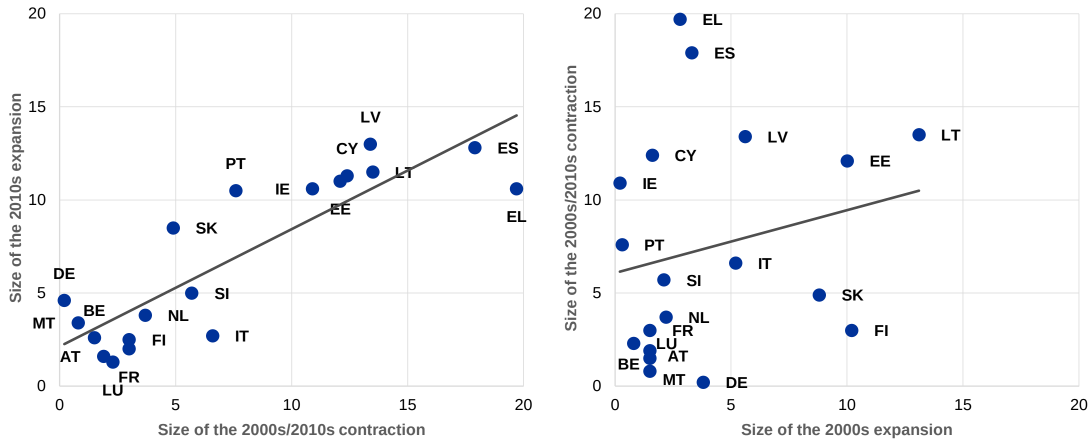
The Federal Reserve System's shift to assessing "shortfalls of employment from its maximum level" instead of "deviations from its maximum level" is consistent with putting more weight on the plucking model view. In presenting the outcomes of the Federal Reserve's strategic review, Powell (2020) explained the change in terminology as "clarifying that, going forward, employment can run at or above real-time estimates of its maximum level without causing concern".

Evidence for or against the plucking model is harder to obtain for the euro area. Based on GDP growth data, Hartley (2021) finds support for the plucking model across countries. For employment, shorter unemployment series limit a time-series investigation like that for the United States, but Chart A provides cross-country evidence for the euro area based on the last business cycle. The left panel shows that the size of the contraction in a country in the late 2000s/early 2010s is a good predictor of the size of the subsequent recovery (R2=0.75), while, on the right panel, the size of the expansion in a country in the early 2000s has little predictive power for the size of the subsequent contraction (R2=0.05). Bearing in mind the significant data limitations shown in this Chart, the overall results could be seen as consistent with Friedman's plucking theory.

Chart A

The plucking model in the euro area: a cross-section look

(percentage points; percentage point change in unemployment)



Source: AMECO.
Notes: Business cycles expansions and contractions are identified through turning points in the annual unemployment rate (the Bry Boschan method), except that the 2008 subprime crisis and 2010 European sovereign debt crisis are treated as a unique contraction in all countries, to allow comparability across countries. The sizes of contractions and expansions are measured as the percentage point change in unemployment.

Margins of adjustment beyond unemployment can also be captured by broader slack measures. Other measures of labour market slack can take alternative margins of labour input adjustment into account, such as cyclical variations in the labour force participation rate or in average hours worked.[23] Changes in the "broad" measure of labour underutilisation – which captures movements in the dynamics of marginally attached and underemployed part-time workers – and the flow steady state unemployment rate – which incorporates changes in job finding and separations rates,

[23] See Nickel et al. (2019) for a more detailed review on the alternative slack measures used by the Eurosystem and Burnside et al. (1993) and Burnside and Eichenbaum (1996) for a detailed description of labour and, more generally, factor hoarding and its interaction with business cycles. Changes in average hours worked and in labour force participation have been particularly substantial during the COVID-19 crisis, highlighting the importance of alternative slack measures in assessing the adjustment of the euro area labour market.

alongside unemployment duration -- can be used as alternative indicators to the NAIRU-based unemployment gap. Chart 6, right panel, shows these alternative slack measures for the euro area to 2019. The cyclical components of average hours worked and labour force participation fluctuate mildly over the business cycle in comparison to the cyclical variation in the unemployment gap.[24] The gap in the broad measure of labour underutilisation shares the same features as the unemployment gap. Finally, the flows-based unemployment gap offers a different perspective on labour market slack in the context of future and expected changes in the unemployment rate, with the unemployment rate being expected to decline in expansions and to increase in recessions.[25]

2.5 The Phillips curve

The Phillips curve relates observed nominal wage growth or inflation to the cyclical stance of the economy. We refer to Work stream on inflation measurement (2021) (for the price Phillips curve) and to Nickel et al. (2019) (for the wage Phillips curve) for background material. Drawing on those findings, the next section looks at the latest evidence, and specifically the uncertainties related to Phillips curve estimates and the implications for monetary policy.

2.5.1 The wage Phillips curve

Nickel et al. (2019) developed a benchmark specification based on Galí (2010),[26] where annualised quarterly compensation per employee/hour, π_t^w, is regressed on a constant c, its own lag π_{t-1}^w, the lagged unemployment rate y_{t-1}, annualised quarterly productivity growth per employee/hour $prod_t$, and a measure of inflation expectations π_t^e:

$$\pi_t^w = c + \rho \cdot \pi_{t-1}^w + \beta \cdot y_{t-1} + \gamma \cdot prod_t + \pi_t^e + \varepsilon_t$$

Subdued wage growth in recent years when unemployment was low led some observers to question the relevance of the wage Phillips curve for policy.

---

24 The cyclical variation in labour force participation and average hours worked increases exponentially during the COVID-19 crisis, with workers passing from both employment and unemployment into inactivity and with firms reducing average hours worked, also through job retention schemes and the existing support from fiscal policy. See Anderton et al. (2020) and Box 3 for more details on the impact of the COVID-19 crisis on the euro area labour market.

25 The flows-based unemployment gap provides an alternative interpretation of labour market slack by assessing whether the unemployment rate still has some scope to decline given the structural conditions of the economy, rather than the relationship between the unemployment rate and developments in inflation. The unemployment rate is expected to keep declining when the flows-based unemployment gap is positive, and to increase when the flows-based unemployment gap is negative. See Juvonen and Obstbaum (2017) or Crump et al. (2019) for more details on alternative ways of measuring the natural rate of unemployment via labour market flows, and D'Amuri et al (2021) on applying such flows in the context of a Phillips curve.

26 The set-up follows a standard wage Phillips curve augmented with productivity growth. See the Nickel et al. (2019) for further details.

However, as shown by Nickel et al. (2019), much of the relatively subdued headline wage growth can be attributed to slack, relatively weak productivity growth, and the impact of the prolonged period of low inflation on expectations (Chart 7, left panel). Nonetheless, some "missing" model-based wage growth remains, suggesting that other factors not captured by standard wage Phillips curves, such as hidden slack, compositional effects[27], or structural factors (e.g. migration or globalisation), could also play a role.[28] In addition, state dependence and model uncertainty might have complicated the identification of the effects, as discussed in the next section. However, it should also be noted that following the global financial crisis, the dispersion of wage growth across euro area countries has remained fairly stable, and lower than in the pre-crisis period,[29] including over the whole "missing" wage growth period. So at least as far as the left-side variable is concerned, cross-country heterogeneity is unlikely to have played a more prominent role than over the rest of the sample.

---

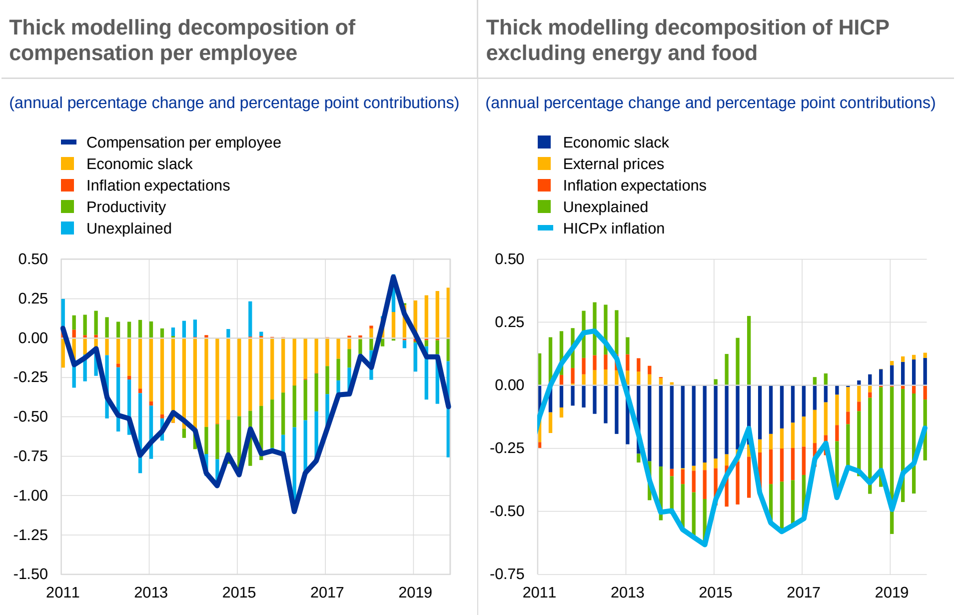
[27] Net of compositional effects, wage growth in the euro area between the years 2007 and 2015 also seems somewhat more in line with the cycle. Compositional effects on wage growth are changes in wage growth due to changes in the composition of the workforce. Early during the great financial crisis, younger and less educated/skilled workers in the euro area lost their jobs first, thereby increasing the share of older and highly-educated employees, dampening the reaction of wages to the business cycle. According to Nickel et al (2019), compositional effects contributed between 1 and 1.5 percentage points to wage growth between the years 2008-12 (exception: 2009). The effect has been declining steadily since then, with a positive effect of just above 0.25 percentage points in 2015. On the other hand, when cyclical conditions started improving from 2012 onwards, compositional effects began to reverse, and their contribution to wage growth became more muted.

[28] See Nickel et al. (2019) report, Chart 3, p. 13.

[29] According to both compensation per employee and compensation per hour measures.

Chart 7

Thick modelling decomposition of compensation per employee (left panel) and thick modelling decomposition of HICP excluding energy and food (right panel)



Sources: Eurostat and ECB calculations.
Notes: The latest observation is for the fourth quarter of 2019. All values in terms of deviations from their averages since 1999. The bars show average contributions across all the models included in the thick modelling exercise (see Bobeica and Sokol, 2019 for details). Left panel: The slack measures included are: unemployment rate, unemployment gap and BMPE output gap. Right panel: The slack measures included (11 in number) are as in Eser et al. (2020). The HICP excluding energy and food (HICPX) series used is the one officially published by Eurostat, and therefore displays a kink in 2015 due to a methodological change (see Deutsche Bundesbank, 2019a).

2.5.2 The price Phillips curve

A common empirical specification of the price Phillips curve, which also underlies a range of ECB and ESCB applications[30] is the following:

$$\pi_t = c + \gamma \cdot \pi_{t-1} + \alpha \cdot \pi_t^e + \beta \cdot x_{t-1} + \gamma \cdot Z_{t-l} + \varepsilon_t$$

where π_t is inflation, π_t^e is a measure of inflation expectations, x_t is a measure of economic activity or “slack” and Z_{t-l} captures external price shocks. The model is an empirical version of a hybrid New Keynesian Phillips curve, where inflation is driven by forward-looking inflation expectations (proxied here by survey measures), past inflation is allowed to play a role as well (to capture backward-looking expectations and other sources of persistence in price setting) and firms’ marginal costs are proxied by measures of slack or economic activity. External variables capture supply-side shocks.

30 Typically, these applications, which include the LIFT report (Ciccarelli and Osbat, 2017) and cross-checking tools routinely used within the (B)MPE and other processes, also follow a “thick modelling” approach, see Section 4.

The price Phillips curve in the euro area is alive, but quite flat[31]**.** Persistently below-average Harmonised Index of Consumer Prices (HICP) inflation could be accounted for by a drift in the Phillips curve relationship, a mismeasurement of slack, or a change in the Phillips curve slope (i.e. presence of non-linearities). Explanations put forward for a drift include a de-anchoring of inflation expectations, global factors, or a dampened pass-through of wage inflation to price inflation. In addition, standard measures of slack could fail to adequately capture all relevant margins in the labour market, or other factors relevant to correctly gauging domestic price pressures. Finally, the slope itself could have changed in recent years due to structural factors, as predicted by some theoretical models with non-linearities in wage and price adjustment.[32]

2.6 Measurement, non-linearity and missing pass-through from wages to prices

There are many Phillips curves, reflecting both choice of variables and functional form.[33] We choose a generic specification and estimate different versions of it, changing how we measure each variable – an approach referred to as "thick modelling", which also underlies the decompositions in Chart 7.

The circularity of Phillips curve uncertainty. The way in which all relevant variables, including slack, are measured has a direct bearing on model fit, and thus on modelling choices such as functional form (e.g. linear or non-linear, etc). As an example, the only slack measure that tracks HICPX inflation data after 2013 within a linear framework is the Jarociński-Lenza (JL) one. Estimating a linear Phillips curve with JL slack can achieve the same objective as fitting a non-linear specification where, e.g., the intercept and other parameters change over time.

Other factors, not captured in "traditional" Phillips curves, can help explain wage and price changes. One example is the impact of migration – which is not captured in domestic unemployment – on labour supply. The apparent flattening of the wage Phillips curve in Germany has been, in part, attributed to the migration-induced expansion of the labour supply.[34] Changes in workers' age composition may also have an impact on both slack and wage growth. Weaker bargaining power arising from a deep and long-lasting recession following the global financial crisis, combined with various labour market reforms in some countries, could also have shifted the relationship between slack and nominal variables, as could have the incidence of temporary contracts (Ramskogler, 2021).[35]

---

31 The relative flatness of the price Phillips curve is confirmed when estimating it using country-level data, as suggested by McLeay and Tenreyro (2019) to address the potentially confounding role of monetary policy – see Eser et al. (2020). Incidentally, the wage Phillips curve also retains a similar slope when estimated using country-level data, see Box 2 in Nickel et al. (2020).

32 Costain et al. (2019), Lindé and Trabandt (2019).

33 See ECB (2014) or Bobeica and Sokol (2019).

34 See Deutsche Bundesbank (2018) and Nickel et al. (2019).

35 See, for example, Lombardi, Riggi and Viviano (2020) and Conti, Guglielminetti and Riggi (2019).

Empirical evidence suggests that different slack measures yield similar Phillips curve slope coefficients. Within a linear framework, both wage and price Phillips curves are estimated for each of the slack measures discussed in Chapters 2 to 4. With very few exceptions, the measures all imply similar slopes for both Phillips curves. The estimated wage Phillips curve is generally steeper.

In a non-linear specification, there is tentative evidence of time-variation in the slope parameters. Subject to taking the time variation at face value, the coefficients appear to positively co-move with the labour market slack measures considered, providing some evidence of state dependence. In other words, expansionary policies are less likely to lead to wage or price inflation when there are large amounts of slack, only becoming increasingly inflationary as slack is absorbed. These results are consistent with a number of papers which similarly find evidence of various forms of non-linearity in both Phillips curves, although some care should be exercised as estimation samples and techniques can vary, as can the robustness of each individual finding.[36]

When the pass-through of wages to prices is imperfect, the observed slope of the price Phillips curve is likely to be flatter. Labour costs are only one component of variable costs faced by firms. Therefore, in aggregate, complete pass-through of wage changes to price changes is unlikely, and wage Phillips curves will typically be steeper than price ones. But other economic mechanisms can further cloud the pass-through of wages to prices, leading to an even flatter observed relationship between slack and inflation than might otherwise be the case, as we discuss below.

2.6.1 Different measures of slack and the Phillips curve[37]

In the aftermath of the global financial and sovereign crises, low wage growth in the euro area prompted a re-examination of wider measures of slack beyond unemployment. Between 2013 and 2017, the unemployment rate and gap declined steadily, wage growth was subdued, and inflation was also low. As a way to reconcile these developments, it was suggested that measures of slack that account for adjustment margins other than unemployment might be more suitable for the behaviour of nominal variables.

However, most estimates, regardless of method, assumptions and margin considered, still pointed to declining slack in labour markets during the recovery, and some degree of tightness by 2018.[38] Although average hours

[36] For example, Forbes et al. (2020) find evidence of concavity in the price Phillips curve in a panel of advanced and emerging market economies over the period 1996-2017; Bussetti et al. (2021) find a steeper coefficient on slack for higher quantiles of the euro area core inflation distribution in expectile regressions over the partially overlapping 1989-2016 sample; Byrne and Zekaite (2020) find evidence of a flatter wage Phillips curve for higher levels of euro area unemployment. See also Box B in Bobeica and Sokol (2019).

[37] This subsection draws on the slack measures discussed in earlier sections. It should be pointed out, however, that slack might not be the only relevant source of measurement uncertainty. For example, Rosolia (2015) shows that the specific wage measure considered has important consequences for the estimated responsiveness of Italian wage rates to labour market conditions.

[38] See Chapters 2 to 4.

worked were persistently lower, and the labour force participation rate persistently higher than before the global financial crisis, these developments were mainly driven by trend developments, and thus the relevant gaps were quite small over the entire period preceding the COVID-19 shock.[39] The broad unemployment rate gap (U6 gap) was larger than the standard unemployment gap, but it normally has a somewhat larger amplitude, which does not necessarily translate into different wage dynamics. The only exception, pointing to a different degree of slack, was the unemployment gap of Jarociński and Lenza (JL), which can have a different interpretation from the other measures, as it is, first and foremost, derived from the *assumption* of a stable price Phillips curve relationship over the estimation sample.

The note investigates the impact of the uncertainty surrounding the measurement of labour market slack on both Phillips curves by means of a standard thick modelling exercise. The analysis keeps to the linear specifications outlined in the previous sections and estimates many versions looping over the right-side variables. i.e. hundreds of estimated Phillips curves.[40]

Remarkably, most measures[41] imply very similar slopes, suggesting that measurement of slack is not a key source of uncertainty for Phillips curves. For wages (Chart 8, left panel), all measures but the flow-based one yield median Phillips curve slopes of around 0.4, indicating that, all things being equal, a one standard deviation increase in labour market slack would translate into a 0.4 percentage point drag on quarterly wage growth. For inflation, the slope coefficients are typically around 0.1, with a few specifications suggesting an even flatter Phillips curve. Not even the unemployment gap implied by the Jarociński-Lenza approach yields a noticeably different slope compared to the other measures.[42]

39 Nevertheless, Bulligan, Guglielminetti and Viviano, 2020 find that the intensive margin of labour utilisation could play a role in the wage Phillips curve, which in their analysis becomes flatter for lower levels of hours per worker. At the country level, D'Amuri et al. (2021) find that price dynamics in Italy are not only strongly influenced by the unemployment gap but also by the labour force participation gap.

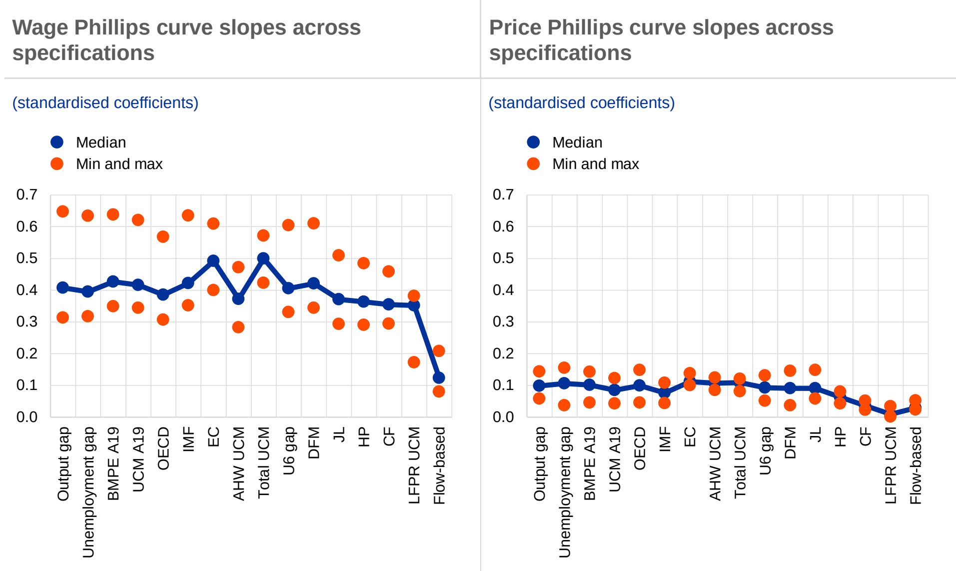
40 For the price Phillips curve, we have ten measures of survey-based inflation expectations (10x16 = 160 specifications). For the wage Phillips curve, we use, in addition to the survey-based measures, realised HICP and HICPX inflation (12x16 = 192 specifications).

41 Bobeica and Sokol (2019) and Eser et al. (2020) also include additional measures of slack such as the headline unemployment rate and real GDP growth. Once standardised, these two measures also tend to yield similar slopes to the ones shown in Charts 15 and 16.

42 This result is interesting in light of the results in Eser et al. (2020), where the full Jarocinski-Lenza output gap measure yields a somewhat steeper price Phillips curve than more traditional measures.

Chart 8

Wage Phillips curve slopes across specifications (left panel) and Price Phillips curve slopes across specifications (right panel)



Sources: Eurostat and ECB calculations.
Note: The latest observation is for the fourth quarter of 2019.

2.6.2 A changing slope?

A flattening or a steepening of both Phillips curves' slopes could have occurred as well. Theoretical models that allow for non-linearities in nominal adjustment imply that the Phillips curve itself should be non-linear. For the price Phillips curve, some of the arguments rely on declining trend inflation as a trigger and are therefore linked to secular forces.[43] If downward adjustments of prices and wages are "stickier" than upward adjustments, then the Phillips curve will become flatter as inflation declines. Models where nominal adjustments are more likely when they are more valuable also imply that the Phillips curve will be flatter at low trend inflation rates. Other mechanisms rather rely on the slope being related to the state of the cycle, for example through threshold effects or other devices.[44]

For wages, the econometric evidence is mixed. Bulligan and Viviano (2017) find instability of the euro area wage Phillips curve parameters after the global financial crisis, mainly link it to a flattening in Germany,[45] and also observe substantial cross-country heterogeneity.[46] Nickel et al. (2019) also indicate that the wage Phillips curve might be convex, i.e. it steepens when economic slack is low and is flatter in a downturn, consistent with the existence of downward nominal rigidities which imply

---

43 Lombardi, Riggi and Viviano (2020) show that the long-standing drop in workers' bargaining power has weakened the relationship between inflation and a standard output gap.

44 See Box 2 in Bobeica and Sokol (2019) for a short review.

45 According to Deutsche Bundesbank (2018) estimates, the apparent flattening of the wage Phillips curve can be attributed to labour market-oriented immigration (see earlier comments).

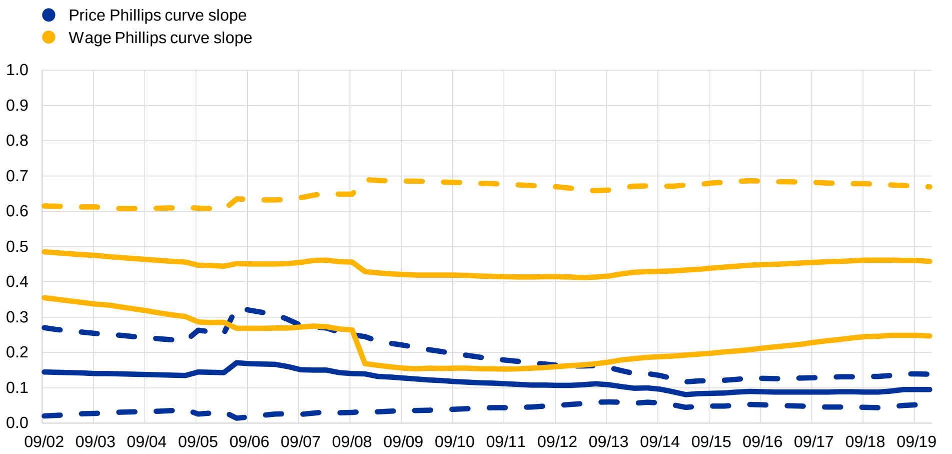
46 For Italy, see also Conti and Gigante (2018), who estimate a price Phillips curve.

that changes to wages will be less frequent during periods of weak economic activity and low inflation than otherwise (Laxton et al., 1995).[47] Byrne and Zekaite (2020) show that the euro area wage Phillips curve is flat for unemployment rates above approximately 10%.

Chart 9

Time-varying wage and price Phillips curve slopes across specifications

(standardised coefficients)



Sources: Eurostat and ECB calculations.
Notes: The solid lines show average slopes calculated across all models, and the dashed lines plus/minus two standard deviations based on the distribution of the means calculated across all models sharing the same slack measure. The ranges therefore understate the actual uncertainty around the solid lines. The latest observation is for the fourth quarter of 2019.

Time-varying versions of the thick modelling wage Phillips curves do not provide strong evidence of changing slope. We estimate the same set of Phillips curves, based on all labour market slack measures previously discussed, but allowing all model coefficients to vary over time. Point estimates for individual slack measures occasionally point to mild signs of time variation. However, this washes out in the average across all models. Estimates are highly uncertain.

Time-varying estimates of the thick-modelling price Phillips curves do not show meaningful signs of a flattening (in the period we examine). We also estimate the thick-modelling price Phillips curve, this time allowing all model coefficients to vary over time (Chart 9). Even if only considering the dispersion across average slope coefficients for each slack measure, the slope coefficient, while greater than zero, doesn't appear to be meaningfully changing over time.

With the important caveat of statistical significance, the slope coefficients in both sets of estimates appear to positively co-move with the corresponding slack measures, consistent with state-dependent Phillips curves. Focusing on point estimates, we check the correlation of the average slope coefficient series for each slack measure with the corresponding slack measure (lagged by a quarter, in the same way as they enter both Phillips curves). For wages, such correlation ranges

[47] Nickel et al. (2019) first present evidence from time-varying parameter models and show that the estimated parameters are correlated with slack measures. Similar conclusions can be drawn from Markov-switching models. Adamopoulou and Villanueva (2020) show that wages close to the negotiated wage floor are not affected by current cyclical conditions.

between 0 and 0.8, with a median of 0.4; for prices, the range is 0.2 to 0.7, with a median of 0.5. The point estimates are thus consistent with both the wage and price Phillips curves being viewed as state-dependent, in line with some of the earlier findings.

While non-linear Phillips curve estimates are not very robust, they might nevertheless be indispensable to fit the data, and frame the debate, around the COVID-19 shock. One reason is that more traditional estimation methods, such as linear regressions, can break down due to the extreme nature of the COVID-19 shock, as documented in Lenza and Primiceri (2020) and other recent papers. Moreover, some of the mechanisms on which non-linear Phillips curves rely might be at play in the most recent periods: for example, regime-switching or threshold-based Phillips curve estimates have been shown to help fit the data during recession periods, especially more severe ones.

2.6.3 Imperfect pass-through of wages to prices

The transmission mechanism between wages and consumer prices includes numerous margins. First, firms may adjust their profit margins rather than product prices in response to wage shocks, either because they find it optimal to do so or because price rigidities leave them no other choice.[48] Second, the composition of the consumer basket and of gross value added may differ considerably – mainly, but not only, because a substantial share of the consumer basket in open economies is imported. In addition, gross value added contains large fractions of investment goods and goods for government consumption.[49] Third, changes in taxes/subsidies at the product level may drive an additional wedge between consumer and producer prices.

Profitability, competition and price transparency are integral to the transmission of economic conditions to prices. When wage and unit labour cost growth picked up strongly from mid-2017 onwards, the growth in firms' profit margins, which had already been lower than in the period before the global financial crisis, compressed further. At least in an accounting sense, the reduced profit margins restrained the increase in domestic price pressures. This suggests that firms may have been reluctant to pass through cost increases into prices.[50] One explanation could be cyclical, as they might have been uncertain about how sustained the demand prospects were. Another explanation is more secular and relates to the possibility of changes in goods market structure: specifically, digitalisation leading to increased price transparency and globalisation having strengthened international competition,

48 Andrés et al. (2021) have pointed out recently that firms with larger market shares find it optimal to dampen the response of their price changes by internalising the increase in marginal costs in order to preserve their strong position in the market, thus cushioning the shocks to their marginal costs through endogenous countercyclical mark-ups.

49 The price determination mechanism of these two types of aggregate goods is quite different from that of consumption goods. For instance, the share of tradable goods in investment goods is higher and prices of goods for government consumption are often publicly administered.

50 See Eser et al. (2020).

leading to stronger strategic complementarities in firms' pricing setting policies (Riggi and Santoro, 2015).[51]

Empirical results on the dynamic correlation between wage growth and price inflation are often mixed.[52] The inconclusive evidence can be attributed to (at least) two reasons. First, in the literature, wage variable is either defined as unit labour cost (ULC) or as compensation per employee (CPE). However, it can be shown that, in the long run when changes in firms' profit margins have been netted out, the reference point for the pass-through from ULC to domestic producer prices is equal to one.[53] This is consistent with the notion that wage increases in excess of labour productivity gains either compress firms' profit margins or put pressure on inflation. On the other hand, the reference point for the pass-through from CPE to domestic producer prices is equal to the labour share (which amounts to about 63% in the euro area). Pass-through in the long run, thus defined, is less than one because, in response to a rise in CPE, firms can substitute labour for other factors of production, also facilitated by increased automation, to increase the marginal revenue product of labour towards the higher level of CPE. In addition, the ULC specification implicitly imposes the constraint that the pass-through of labour costs (the numerator of ULC) to prices is identical (with the sign reversed) to the pass-through of labour productivity (the denominator of ULC) to prices – whereas the CPE specification offers more flexibility in this respect.

Another potential reason for the inconclusive evidence is that the pass-through of wages to prices depends on the nature of the underlying shock. Supply shocks originating in the labour market directly affect wages, but prices only indirectly through the slow-moving transmission mechanism described above. On the other hand, an improvement in demand conditions in the economy could directly boost pricing power, with wage inflation maybe even lagging price inflation (especially given the stickiness in wage dynamics). Consistent with this, recent work by ECB and Eurosystem staff pursued the hypothesis that wage-price "pass-through" is state dependent. These studies found that wage increases pass through to inflation faster and to a larger extent following a demand shock than a supply shock.[54] This suggests that while adverse demand shocks were dominating the behaviour of wages and HICPX, as would appear to be the case over the earlier part of the period 2013-19 when slack largely accounts for both weak wage growth and weak HICPX (see Figures 1 and 7), inflation-specific supply shocks (e.g. negative mark-up shocks in product markets) could have broken that co-movement from around 2017 onwards.

[51] Santoro and Viviano (2021) offer additional evidence on heterogeneous pass-through from labour costs to prices depending on firms' size and productivity, which is rationalised by a model featuring firm heterogeneity and strategic complementarities in price setting.

[52] See Eser et al. (2020) for a list of references. Another factor that needs to be taken into account is that HICPX might not be a good measure of domestic inflation. Diev et al (2019) offers an explanation of why the HICPX has remained low despite accelerating wages.

[53] On the wage-price relationship in economy theory, see the annex of Deutsche Bundesbank (2019b).

[54] Gumiel and Hahn (2018); Bobeica et al. (2019); Hahn (2019); Conti and Nobili (2019).

3 Labour market heterogeneity and hysteresis effects

3.1 Introduction

To comprehend the state of the labour market, labour market heterogeneity needs to be well understood. Within countries, differences across demographic groups and type of jobs complicate the assessment of the relevant labour market slack for wage formation and prices. Across countries, institutional differences affect the relationship between unemployment and wages, as well as the pass-through from wages to prices.

Even in the face of common shocks, the unemployment response across countries might differ due to a variety of factors, and some groups or types of jobs are more exposed to cyclical variation in employment and income. Across countries, a common shock can result in differing levels of unemployment for institutional reasons or owing to differences in sectoral composition or available (fiscal) policy space. In addition, the heterogeneous developments across groups and type of jobs, together with long-term unemployment, indicates that some workers would only be reemployed if there was a strong expansion.

The source of labour market shocks is important for understanding potential inflationary effects. Employment and inflation move in the same direction in response to demand-type shocks, the “divine coincidence” of monetary policy. In this case, stabilising inflation is equivalent to stabilising employment. Supply shocks can, in contrast, lead to trade-offs for monetary policy, with certain groups potentially more exposed to negative employment effects.

The evidence that temporary shocks can persist, contributing to hysteresis and structurally higher unemployment is a rationale for a prompt monetary policy response, without prejudice to maintaining price stability. Institutional factors and labour market rigidities (such as wage rigidities and asymmetries, search and matching frictions and skill heterogeneity) play a role. Hysteresis affects certain socio-economic groups differently, especially those more prone to unemployment in the first place. In terms of employment and wages, downturns affect various segments of the society differently, mainly youth, the elderly and low-skilled and low-educated workers.

Demand shocks can lead to significant hysteresis effects. Recent work has shed light on the role of endogenous economic growth and downward wage rigidity, among other factors, in explaining unemployment hysteresis and asymmetric effects on unemployment and output growth following an aggregate demand shock. Demand-driven hysteresis effects are even more pervasive in a low-growth and low-inflation environment. These results complement the work on hysteresis effects stemming from labour market institutions and human capital depreciation.

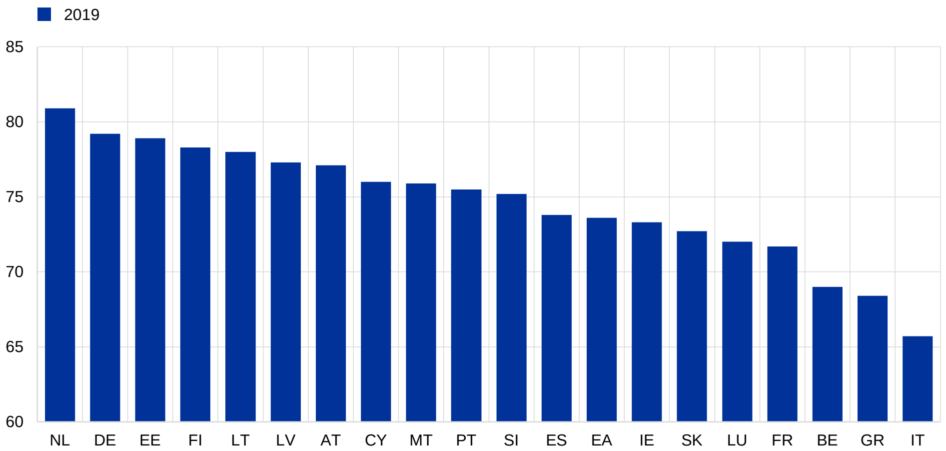
3.2 Dimensions of labour market heterogeneity

The euro area labour market is composed of 19 national labour markets, each operating under their own set of (labour market) institutions, giving rise to diverse labour market outcomes. In 2019, participation rates (age group 15-64) ranged between 65.7% and 80.9% (Chart 10); employment rates (age group 15-64) ranged between 56.5% and 78.2%; and the unemployment rate (age group 15-74) ranged between 3.1% and 17.3%.

The average participation rate of the working age population in the euro area was 73.6% in 2019, with large differences in age, gender, education and citizenship. Participation is lower for younger and older groups, females (despite trend increases in recent decades), less educated groups, and non-EU immigrants (Chart 11).

Chart 10
Participation rate

(percentage of population, age group 15-64, 2019)



Source: Eurostat.

Labour income risk varies across age, educational and skill groups and with the business cycle. A single representative income process is unlikely to account for the observed heterogeneity in income risk across workers.

Income inequality and income variability lead to differences in wealth and consumption patterns, contributing to heterogeneous effects of monetary and fiscal policy. The literature shows low cash-on-hand households, who also tend to face higher employment income risk, exhibit a higher propensity to consume out of their income than more affluent households,[55] with obvious implications for the heterogeneous and aggregate demand effects of policy.[56]

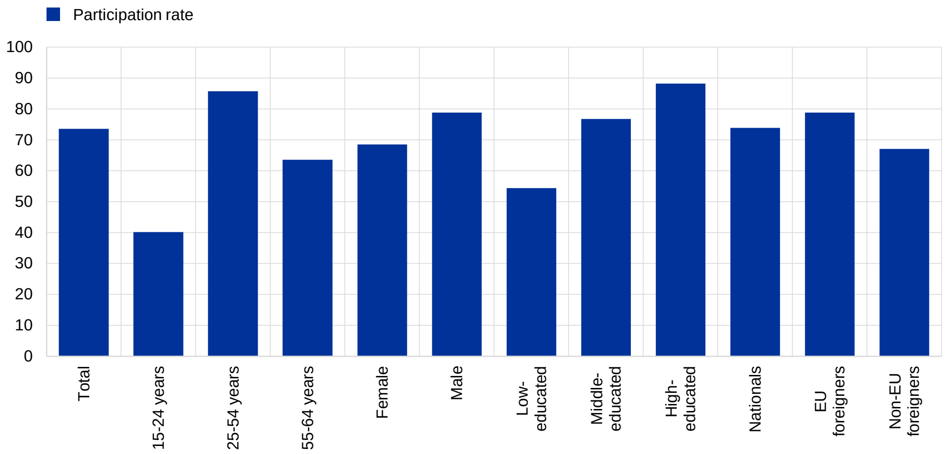
[55] See Broda and Parker (2014); Jappelli and Pistaferri (2014).

[56] See Ampudia et al. (2018); Kaplan et al. (2018); Kaplan and Violante (2014).

Chart 11

Labour market participation rate in the euro area by demographic group

(in percentages of the corresponding population aged between 15 and 64 years, 2019)



Sources: Eurostat.
Notes: Education levels are based on the International Standard Classification for Education (ISCED). A low level of education corresponds to ISCED levels 0 to 2, a medium level corresponds to ISCED levels 3 to 4, and a high level corresponds to ISCED level 5 or above.

3.3 What are the structural drivers behind heterogeneity?

3.3.1 Labour market policies and institutions

Labour market institutional set-ups vary across the euro area and affect labour market outcomes in a structural manner.[57] Differences in levels of participation, employment and unemployment across the euro area countries tend to be persistent over time, suggesting that they are caused by structural factors. Differences in institutions and overall institutional quality have been linked to differences in labour market performances. Facing an adverse common shock, a country with a weaker economic structure (in terms of labour and product market regulation as well as political institutions) may suffer on average double its output loss compared with an efficient country (with more flexible and adaptable institutions).[58] One illustrative example is the all-encompassing measure of “Labour market efficiency” (from the Global Competitiveness Institute), which shows a significant degree of heterogeneity across euro area countries (see Chart 12).[59]

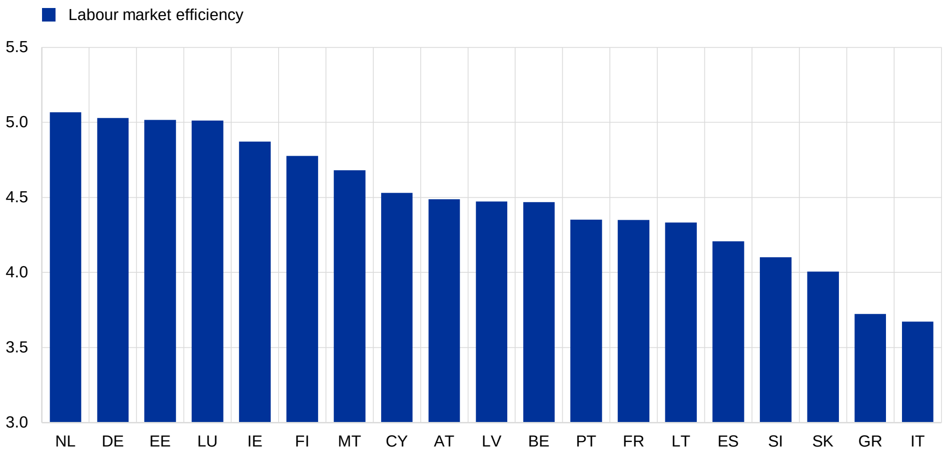
57 See Arpaia and Mourre (2009) for a summary of the literature.

58 See Sondermann (2016).

59 A similar message is given by the World Bank’s World Governance Indicators.

Chart 12
Labour market efficiency

(index, 2017)



Sources: Global Competitiveness Index, World Economic Forum.
Note: Higher index numbers denote higher efficiency.

Institutions can affect labour market performance and welfare. Examples include employment protection, unemployment benefit replacement rates, collective bargaining and minimum wage setting, taxation and active labour market policies.[60]

The euro area economies differ significantly in their minimum wage setting, in the level of tax wedges and in collective bargaining practices. These factors affect labour market resilience – that is, the capacity to limit fluctuations in the unemployment rate, and deliver low unemployment on average.[61]

Product market deregulation can help to reduce unemployment and increase employment.[62] Product market regulations vary across the euro area, as measured by the OECD indicators, affecting incentives for investors, firms and employees.[63] Wages can also be affected by product market regulations.[64] While it can depend on the type of regulations in question, the literature suggests that not all workers are affected equally.

60 Blanchard et al. (2014) suggest the following taxonomy, partly based on societal preferences: (1) an “Anglo-Saxon” model − based on low employment protection and low unemployment insurance − which leads to large flows, short unemployment duration, and low unemployment; (2) a “Nordic” model − based on a medium to high degree of employment protection, on generous but conditional unemployment insurance, and on strong active labour market policies − which allows for reallocation while maintaining low unemployment; (3) a “Continental” model − based on high employment protection, generous unemployment insurance, and limited active labour market policies − which leads to limited reallocation and high unemployment.

61 Jung and Kuhn (2014) evaluate the impact of different labour market institutions on employment volatility.

62 See Ebell and Haefke (2003); Blanchard and Giavazzi (2003); Cacciatore et al. (2012) for theoretical predictions, Amable et al. (2011); Bassanini and Duval (2006); De Serres et al. (2012); Griffith et al. (2007); Berger and Danninger (2007); Boeri et al. (2000); Fiori et al. (2007); Nicoletti et al. (2001); Nicoletti and Scarpetta (2005) for empirical findings.

63 See Biroli et al. (2010).

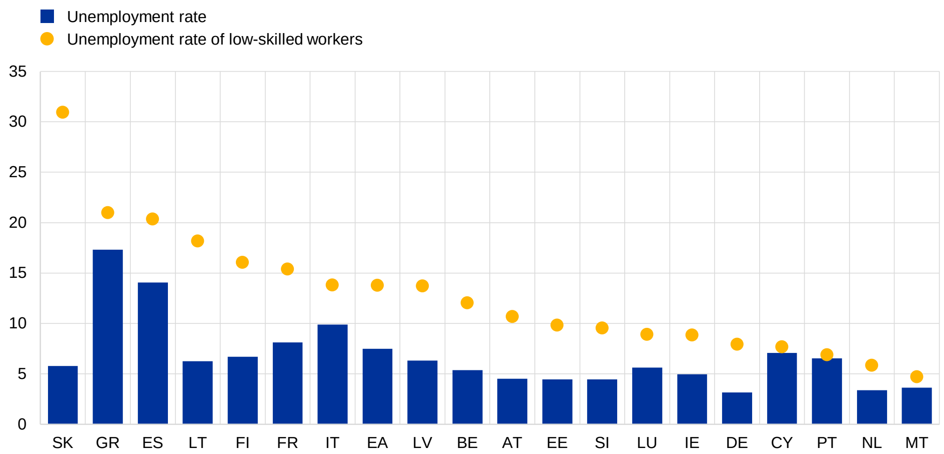
64 See Jean and Nicoletti (2004) Amable and Gatti (2001); Ebell and Harfke (2003); Blanchard and Giavazzi (2003).

Product and labour market (de)regulations have a heterogeneous impact on different categories of workers. Although men and women seem to be equally affected by product and labour market deregulations, workers are affected differently depending on their age and educational attainment. Looking at employment protection, young workers are almost twice as strongly affected by unemployment than older workers. However, there are large country differences in outcomes. Regarding product market deregulation, highly educated individuals are less affected than low and middle-educated workers.[65] A more flexible labour market can improve access to the labour market and to employment for immigrants as it does for any other outsiders. Studies comparing countries' performance show that immigrants' employment rates tend to be higher in countries where the labour market is more flexible compared with those where it is more rigid.

Chart 13

Unemployment rate and unemployment rate of low-skilled workers

(percentage, 2019)



Source: Eurostat.

In addition to labour market policies, education and training policies play a key role in individual and aggregate labour market outcomes. In the euro area, the employment rate of individuals with completed tertiary education is 84%, almost double that of individuals with low-secondary education or below (47%). Less educated groups also have higher unemployment rates, both on average (Chart 13) and during downturns, are more likely to be on temporary contracts and would like to supply more hours than are demanded (higher prevalence of involuntary part-time workers).[66]

65 See, for example, Piton and Rycx (2019); Bilgili et al. (2015); Angrist and Kugler (2003).

66 See Wolcott (2021).

3.4 Common drivers of heterogeneity

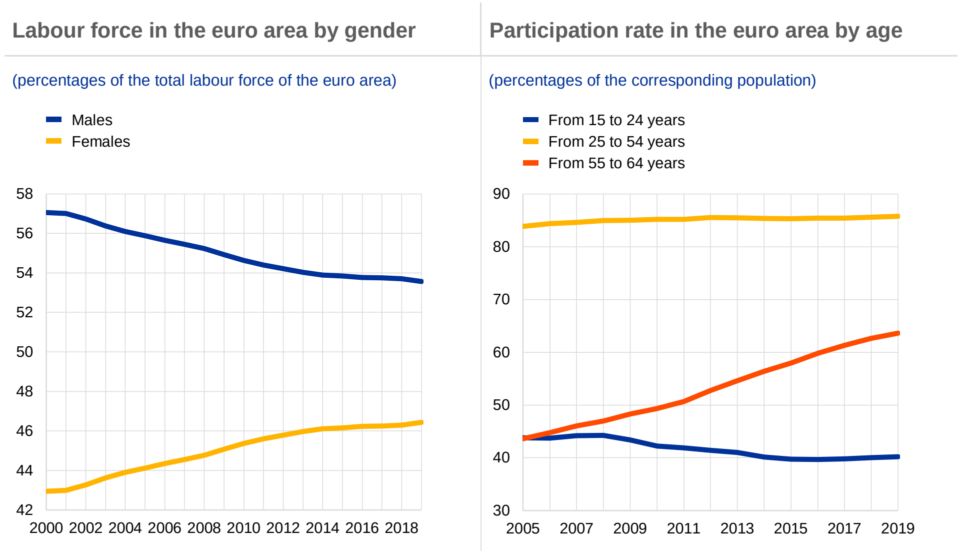
3.4.1 Gender and age

Female labour force participation has been on a long-term upward trend due to higher educational attainment, better work-life balance policies and the rise of services sectors (Chart 14, left panel). Policies supporting the work-life balance, such as income-related childcare allowances and childcare tax subsidies, changes in tax policy,[67] and the expansion of the services sector, which offers more part-time jobs, have coincided with the increase in female labour market participation.

The unemployment rate in the euro area is on average higher for women than for men. But, up until the pandemic, male unemployment tended to rise more in recessions, owing in part to the concentration of males in sectors more exposed to cyclical shocks, such as construction and industry (see Box 2 for the developments during the COVID-19 pandemic).[68]

Chart 14

Labour force in the euro area by gender (left panel) and Participation rate in the euro area by age (right panel)



Source: Eurostat.

The share of older workers (55+) in the working age population is rising, as is their participation rate (Chart 14, right panel). These changes are driven by a variety of factors, including an ageing population, increased level of education and pension reforms.[69] Youth employment and unemployment appear most sensitive to the cycle and shocks. With fewer financial buffers to rely on, the income and

67 See, for example, Bosch and van der Klaauw (2009) for the Netherlands, and Colonna and Marcassa (2015) and Carta and Rizzica (2018) for Italy.

68 Lydon and Simmons (2020).

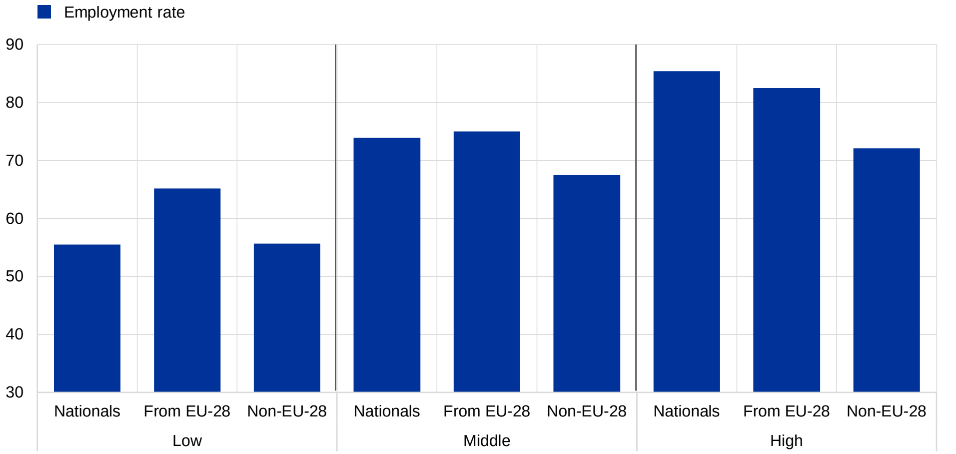
69 De Philippis (2017).

consumption of younger households is therefore more volatile, on average.[70] Moreover, a period of early-career unemployment has long-term effects on wages and employment prospects, known as “scarring effects”.[71] In addition, young workers are frequently on temporary contracts: 52% of employees aged between 15 and 24 had a temporary contract in the euro area in 2019, against 13% between 25 and 54 and 6.5% between 55 and 64.

Chart 15

Employment rates by nationality and education

(percentage of population aged between 20 and 64, 2019)



Source: Eurostat.

3.4.2 Immigration and workers’ origin

Immigrants, as a group, have strikingly different labour market experiences to other groups. Among euro area countries, the average gap in the employment rate between immigrants and natives was 7.7 percentage points. There are, however, two distinct “immigrant groups’”: European citizens, whose employment rate is equal to that of natives at 73.5%, and non-European citizens, with an employment rate of just 59.8%. As well as their lower employment rates, immigrants are more often employed in low-skilled jobs, under temporary contracts, for which they are largely over-qualified.[72] Lower access to employment and lower job quality also apply to the second-generation of immigrants (people born in host country but with at least one parent born abroad) even if the gap with respect to natives decreases.[73] Immigrant

70 See Patterson (2020), Alstadsaeter et al. (2020); Adams-Prassl et al. (2020); Blundell et al. (2020); Crossley et al. (2020); Brussevich et al. (2020).

71 See, for example, Gregg (2001); Gregg and Tominey (2005); Cockx and Picchio (2011); Scarpetta et al. (2010).

72 See, among others, High Council for Employment (2020) for evidence in Belgium. On mismatch, see Piracha and Vadean (2012).

73 For a documentation of these patterns, and potential explanations as to why, see Card (2005); Brinbaum (2018); Portes and Rumbaut (2001); Brinbaum and Guégnard (2013); Liebig and Widmaier (2009); Manning (2010); Piton and Rycx (2020).

workers are on average more mobile than natives and thus tend to have an important role in absorbing labour demand shocks.[74]

3.4.3 Digitalisation of the economy and job opportunities by level of education

Over the last two decades, the share of high-skilled occupations has increased from 35% to 43% of employment, almost completely at the expense of medium-skilled occupations (Chart 16). Drivers include skill-biased technological change and the complementarity between certain jobs and technological progress.[75] Technological progress could further increase job polarisation. Task-based analysis suggests that the jobs most likely to be replaced in the future by technology/machines are the most repetitive ones, not involving interaction with other people, and requiring little or no problem-solving skills or creativity.[76] Sectors with the highest potential for automation are transportation, hotels and accommodation, manufacturing and trade. Sectors expected to be least affected are education, information and communication, professional services and health.[77] For monetary policy, the key take-away is that labour markets could become *more* heterogenous in the future, with some workers more exposed to cyclical shocks, lower pay, precarious work and involuntary short-time work.

---

74 Basso, D'Amuri and Peri (2019) show that mobility of immigrants is especially important in the euro area, where natives are much less mobile than in the United States.

75 See Autor et al. (2003).

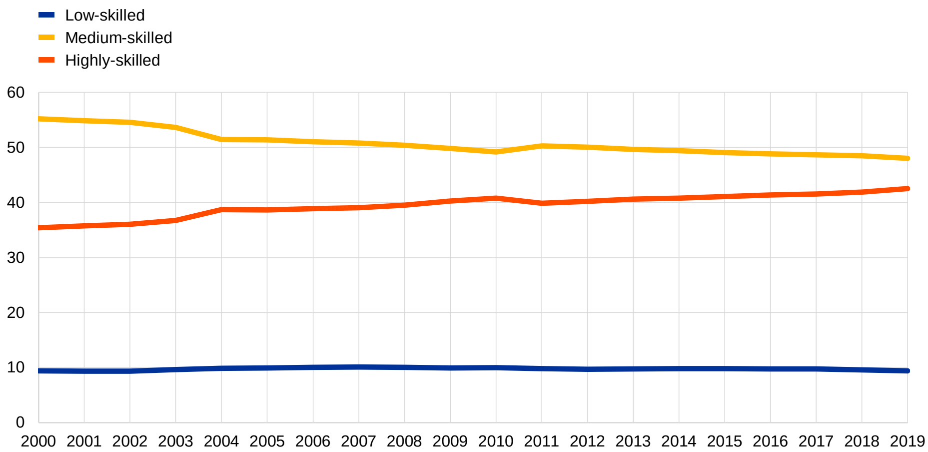
76 Goos and Manning (2007), Goos et al. (2009, 2014), De Sloover and Saks (2018) provide evidence of polarisation in Belgium but on a relatively modest scale compared with that in other advanced economies; see Bachmann et al. (2018) for evidence of polarisation in Germany. In addition, the authors find that exposure to jobs with more routine tasks is associated with a reduced likelihood of being in employment in both the short (after one year) and medium term (five years).

77 See McKinsey & Company (2017).

Chart 16

Evolution of employment by occupation in the euro area

(percentage of total employment)



Source: Eurostat.
Notes: Skill levels are defined on the basis of the International Standard Classification of Occupations (ISCO): low-skilled jobs correspond to elementary occupations such as domestic help, labourers, etc., medium-skilled occupations correspond to administrative staff, skilled industrial trades, etc., and highly skilled occupations comprise directors, management, intellectual and scientific occupations, etc.

3.5 Labour market heterogeneity and the business cycle

Workers are not equally affected by changes in aggregate demand. Some individuals benefit from strong recoveries, while others are particularly harmed by recessions.[78] In the euro area, the sensitivity of unemployment to GDP (often expressed by Okun's law) is higher for men, for less educated workers and for younger workers (Chart 17). Participation rates show a similar pattern (Chart 18).[79] [80] The period after the financial crisis seems to have increased the cyclical response of unemployment for men, young workers and workers with low levels of education (Table A1 in Annex). In addition, the elasticity during expansion periods is larger for women and workers with tertiary education (Table A2 in Annex).

---

78 Aaronson et al. (2019) show that, for the United States, employment of Blacks, Hispanics and those with a low level of education is more cyclically sensitive than the outcomes of whites and those with a higher level of education.

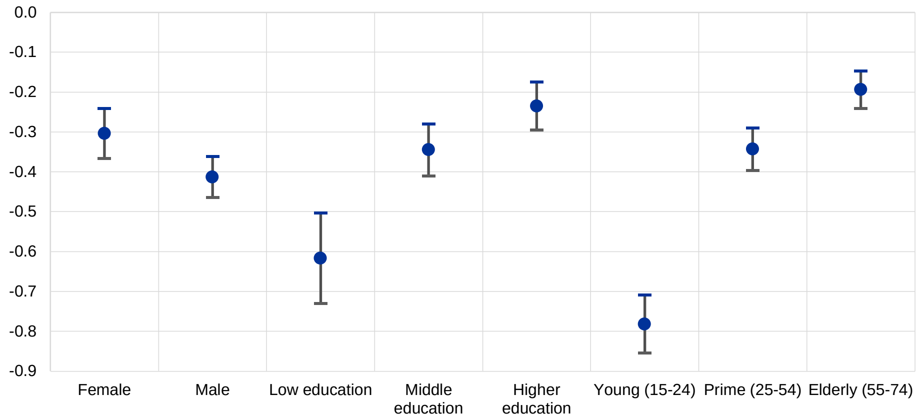
79 The estimate for women becomes positive and statistically significant when the regression controls for the unemployment rate of men, which can be read as suggestive evidence of the added-worker effect.

80 Anderton and Di Lupidio (2019) show employment/unemployment flows differ across age, gender and skills relative to the average Okun response, and that the Okun relationship may differ between large and small GDP shocks (i.e. non-linearities).

Chart 17

Elasticity of unemployment rate to GDP by demographic groups

(percentage points change in unemployment to a 1% increase in GDP)

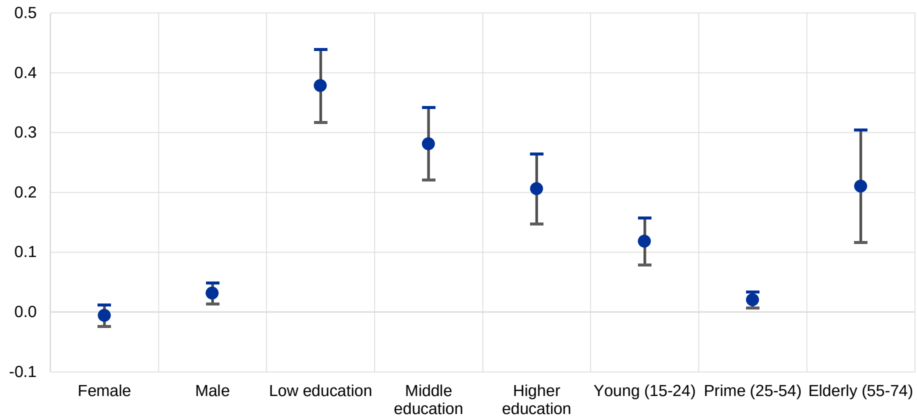


Source: Estimation based on Eurostat data.
Note: Estimations are for the period 1998-2019, except for education which starts in 2005.

Chart 18

Elasticity of the participation rate to GDP by demographic groups

(percentage points change in unemployment to a 1% increase in GDP)



Source: Estimations based on Eurostat data.

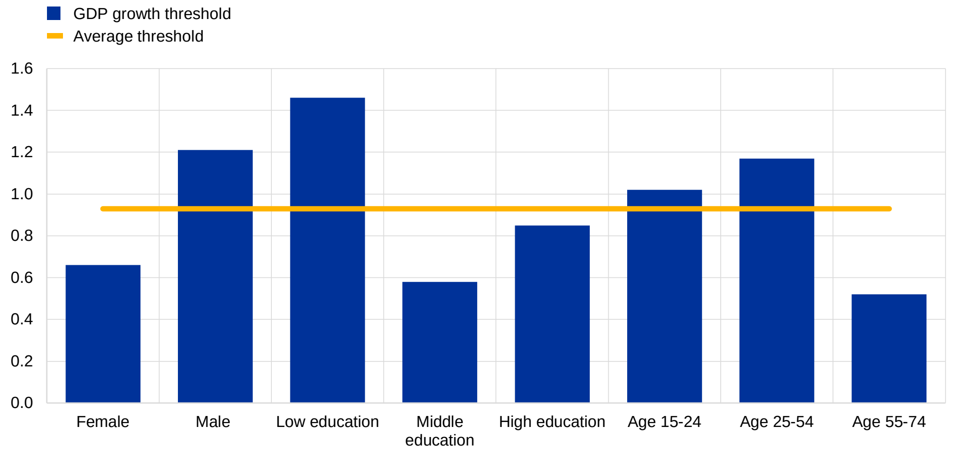
The GDP growth threshold to reduce unemployment is heterogeneous across groups: the level of GDP growth that older workers, women and workers with middle education require to see their unemployment decrease is lower than for other groups. These thresholds offer a gauge of GDP growth "required" by each group for its unemployment to start receding. Estimated thresholds for the whole sample show that there are clear differences among demographic groups (see Chart 19 and Table A3 in Annex). Women, middle-skilled and older workers require less growth to improve their employment situation, while male, low-skilled and younger workers tend to benefit later in a recovery.[81] [82]

Okun elasticities for the unemployment rate vary across countries.[83] For example, whereas in Spain a 1% change in GDP leads to a change in unemployment of about 0.8 percentage points, in Germany the same variation in GDP changes unemployment by only 0.2 percentage points (see Chart 20). Various factors can affect these elasticities, including the sectoral composition of the economy, the level of unemployment and labour market institutions, including, for example, the prevalence of short-time work.[84] Countries with a higher share of workers on temporary contracts tend to have higher elasticity of unemployment to GDP. Indeed, temporary contracts play an important role for the flows in the euro area labour market. About 60% of new hires and more than 40% of dismissals in the euro area occur via temporary contracts. The cross-country heterogeneity is very large. While in Spain almost 70% of dismissals occur via temporary contracts, in Germany that percentage is less than 20%.

Chart 19

Threshold estimations for the elasticity of unemployment to GDP

(percentage change in GDP that keeps unemployment stable)



Source: Estimations based on Eurostat data.

81 For further results on the elasticity between GDP and labour market variables see, for example, Burggraeve et al. (2015); Ball et al. (2017); Botelho and Dias da Silva (2019a).

82 The cyclical sensitivity is higher for men than for women, but the growth threshold is lower for women. This is because the threshold also depends on α_0 (α_0/α_1 - Equation 1, in Annex), which captures the average increase in unemployment over the estimation period. That increase for women was much lower than for men (less than half), likely related to the strong positive trends of female participation and employment.

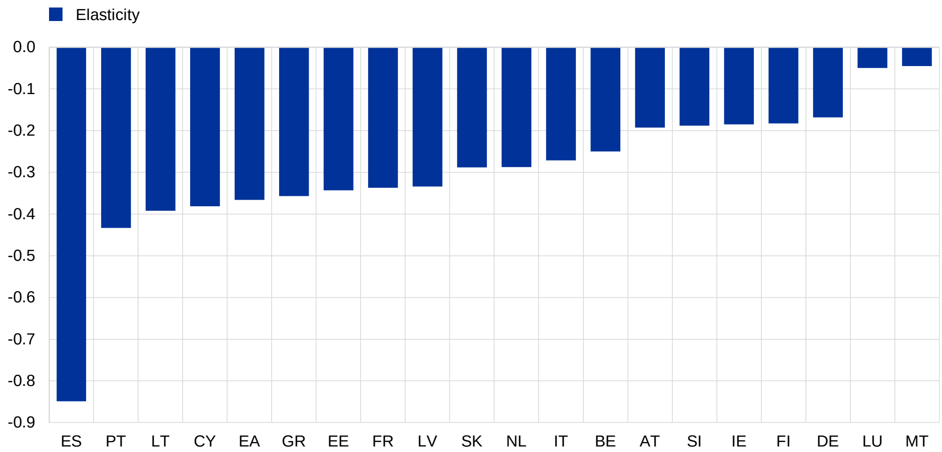
83 See Chapter 5, for an analysis of how heterogeneity in firms' financial conditions affects employment fluctuations. The authors show that firms' financing heterogeneity amplifies the impact of an output shock on employment and that reducing the credit market friction, via restoring a more homogenous monetary policy transmission to firms' financing conditions, reduces employment volatility.

84 See, for example, Bovini and Viviano (2018).

Chart 20

Elasticity of unemployment to GDP

(percentage points change in unemployment to a 1% increase in GDP)



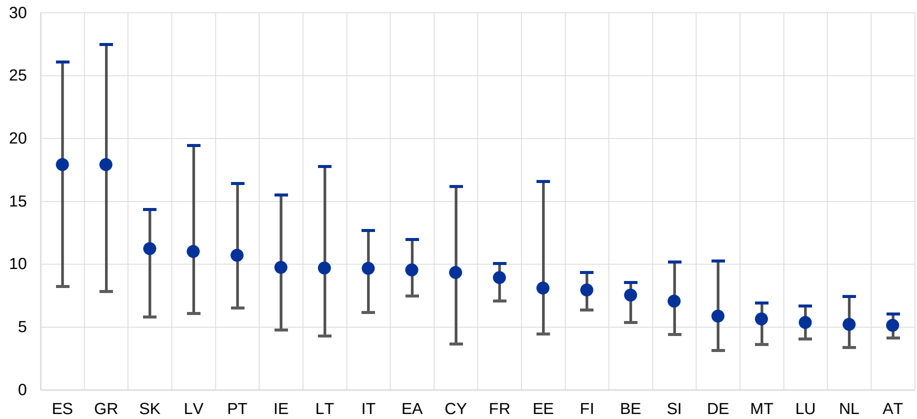
Source: Estimations based on Eurostat.

The amplitude of the changes in unemployment rate also vary substantially across euro area countries and tend to be higher for countries with higher average unemployment levels (Chart 21). This could be driven by the way in which labour market institutions interact with macroeconomic shocks.[85]

Chart 21

Range of the unemployment rate

(percentage of the labour force; period considered: 2005-19))



Source: Calculations based on Eurostat data.
Note: The chart shows the maximum, minimum and the average unemployment rate over the period 2005-19.

Average hours worked is an important margin of adjustment to shocks, differing substantially across countries, income and skill groups. Hours worked per week of employment are more cyclical in countries like Italy and Germany, which have well-established short-time work schemes in place, facilitating the use of hours

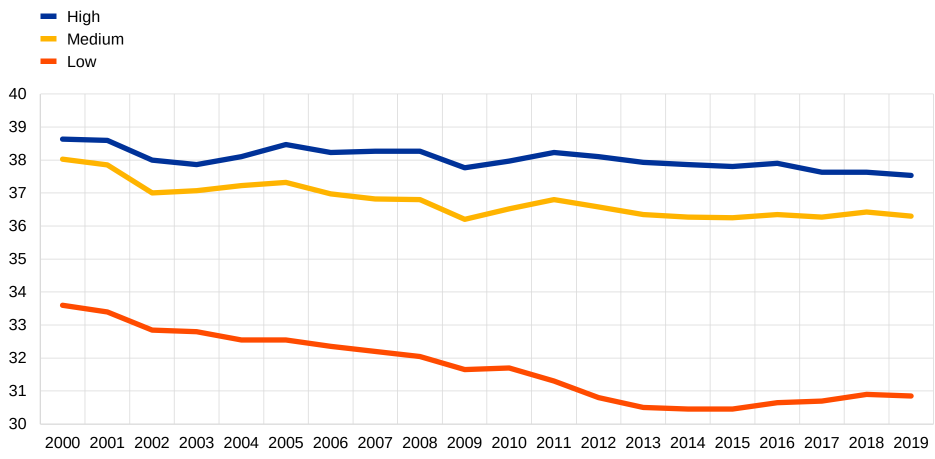
85 Blanchard and Wolfers (2000).

worked as a margin of adjustment (see also Box 2). Moreover, actual hours worked tend to be more cyclical for employees in high and medium-paying occupations than for those in low-paying occupations (see Chart 22).[86] This can be in part explained by both the higher proportion of employees in low-paying occupations already on low or part-time hours, and the higher likelihood of them losing their jobs during recessions, which in turn has implications for the assessment of wage developments.[87] While there is a declining trend in average hours worked overall, it is more pronounced in low-paying occupations, partly due to the increase in part-time work. Involuntary part-time employment grew more rapidly than voluntary during the financial and sovereign debts crises and started to decline only in 2015, two years after the beginning of the recovery in employment; in 2019, it remained substantially above the levels recorded before 2008. Involuntary part-time employment thus exhibits both cyclical and structural components in the euro area. This contrasts with developments in the United States, where involuntary part-time employment declined to levels close to those prevailing before the financial crisis.[88]

Chart 22

Actual hours worked per week by occupational pay

(percentage of total employment)



Source: Calculations based on Eurostat data.
Notes: High-paying occupations include managers, professionals and technicians; Medium-paying occupations include clerical workers, skilled agriculture workers, craft workers and machine operators; low-paying occupations include sales workers and elementary activities.

Long-term unemployed typically earn lower wages than short-term unemployed upon re-employment. The literature suggests several reasons for this, including lower job search intensity and being less attractive to employers.[89] However, it is important to control for the scale and depth of the shock, for example, following a deep downturn, the long-term unemployed may not necessarily be substantially different from other workers.

86 Usual hours can be interpreted as hours worked as per the employment contract and actual hours as hours effectively worked. Actual hours can differ from usual hours due to, among other reasons, sick and annual leave, short-time work and extra hours.

87 See Kouvavas et al. (2019).

88 See Valletta et al. (2020).

89 See Krueger and Mueller (2011); Eriksson and Rooth (2014).

Households with lower incomes face more countercyclical employment and income uncertainty. Employment of households with lower incomes is substantially more sensitive to changes in aggregate employment – in fact, more than three times as sensitive as the highest (permanent) income households (Chart 23, left panel).[90] Lower income households also *perceive* substantially higher uncertainty about their labour incomes (Chart 23, right panel): the mean perceived probability of losing their job is roughly three times as high for workers in the lowest income quintile as for workers in the highest quintile. These results have implications for the effectiveness of *monetary policy transmission*, as we investigate in simulations of heterogeneous agent New Keynesian (HANK) models in Chapter 5.

Chart 23

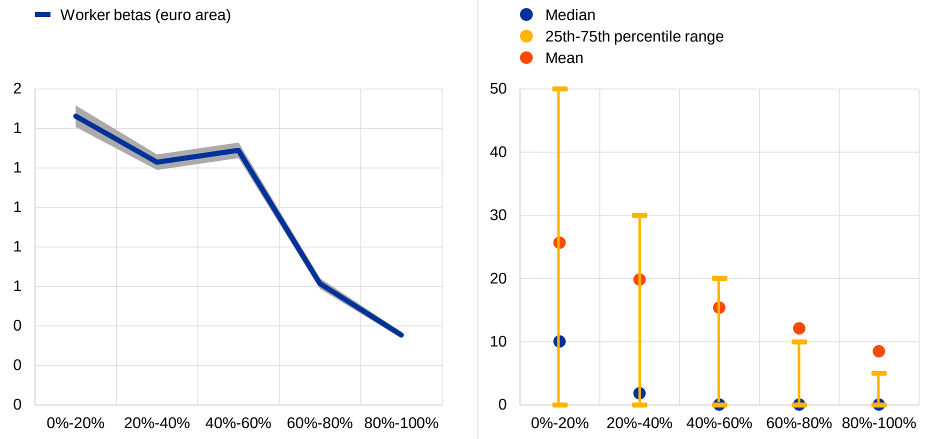
Sensitivity of individual employment to aggregate employment across quintiles of permanent income (left panel) and distribution of perceived probability of losing one's job across quintile of income (right panel)

Sensitivity of individual employment to aggregate employment across quintiles of permanent income

(x-axis: household permanent income quintile)

Distribution of perceived probability of losing one's job across quintile of income

(percentage of total employment)



Sources: Slacalek et al. (2020); calculations based on the Household Finance and Consumption Survey 2017, Labour force survey and EU Statistics on income and living conditions.
Notes: Left panel: The chart shows the sensitivity of individual employment to aggregate employment across quintiles of permanent income. Permanent income is estimated by regressing actual income on demographic variables, such as age, gender, education, marital status and the sector of employment. The estimates are based on an aggregate of France, Germany, Italy and Spain. Right panel: The chart shows the distribution of self-assessed probability of losing one's job across income quintiles. The survey question is: On a scale of 0 to 100, what do you think is the likelihood that you will lose your current job in the next 12 months for reason, such as expiration or termination of your contract, dismissal or other similar reason?

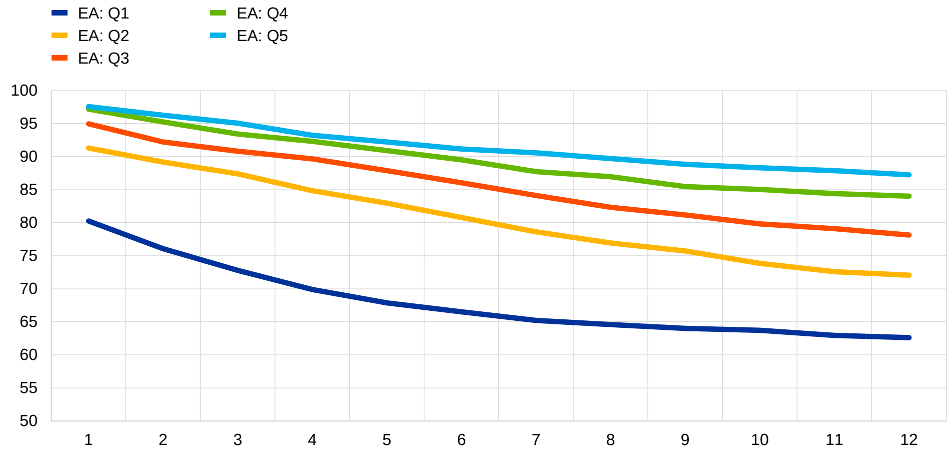
Households in lower income quintiles have fewer savings to see them through an income shock. After two months of unemployment about 25% of households in the lowest income quintile would not have enough resources to finance their spending on necessities (Chart 24). Difference are large across countries: for Germany, the same figure is just 12%, for Italy, 54%.

[90] Related results are reported in Dossche and Hartwig (2019) and Slacalek et al. (2020).

Chart 24

Simulated share of euro area households whose liquid assets are *not* depleted after a period of unemployment

(by income quintile, percent; x-axis: months)



Sources: Household Finance and Consumption Survey 2017, ECB calculations.
Notes: The chart shows a simplified euro area aggregate made up of Germany, Spain, France and Italy. It is based on a simulation of the number of months over which households can finance their consumption of necessities with their liquid assets, assuming that they become unemployed (and receive unemployment benefits). Household consumption of necessities includes expenditures for food and beverages consumed at home, housing (plus maintenance), health, personal transport, communication, education, insurance and debt service. Consumption of necessities is imputed from the Household Budget Survey (HBS) assuming households in each quintile consume the average consumption level reported in the HBS. Unemployment benefits are calibrated using 2017 OECD data on net replacement rates. Liquid assets consist of deposits, mutual funds, bonds and publicly traded shares. The chart includes only households whose reference person was in employment prior to the shock.

Box 3
Labour markets and fiscal support during the COVID-19 pandemic

The exposure of labour income to the COVID-19 crisis has been particularly pronounced for younger workers, women and lower income households.[91] Restrictions on economic activity (lockdowns) have particularly affected firms and workers in hospitality, travel, arts and entertainment, sectors with a greater concentration of both younger and female workers (Chart A). Pandemic unemployment and labour income risk is skewed towards households in lower quintiles (Chart B). These results are consistent with evidence from other countries.[92] Looking ahead, the pandemic has the potential to amplify existing income inequalities, in line with similar historical episodes.[93] Southern euro area economies often have higher shares of employees working in lockdown sectors, driven, in part, by higher shares of employment in tourism.[94]

[91] The following sectors are classified as being subject to lockdown measures: wholesale and retail trade, and the repair of motor vehicles and motorcycles; transport and storage; accommodation and food service activities; and arts, entertainment and recreation (in line with Joyce, R. and Xu, X., “Sector shutdowns during the coronavirus crisis: which workers are most exposed?”, Briefing Note BN278, Institute for Fiscal Studies, 2020).

[92] See Béland, L.-P., Brodeur, A. and Wright, T. (2020); Carta, F. and De Philippis, M. (2021); Mongey, S., Pilossoph, L. and Weinberg, A.,(2020); Joyce, R. and Xu, X., (2020); Alvargonzález, P., Pidkuyko, M.; Villanueva, E., (2020).

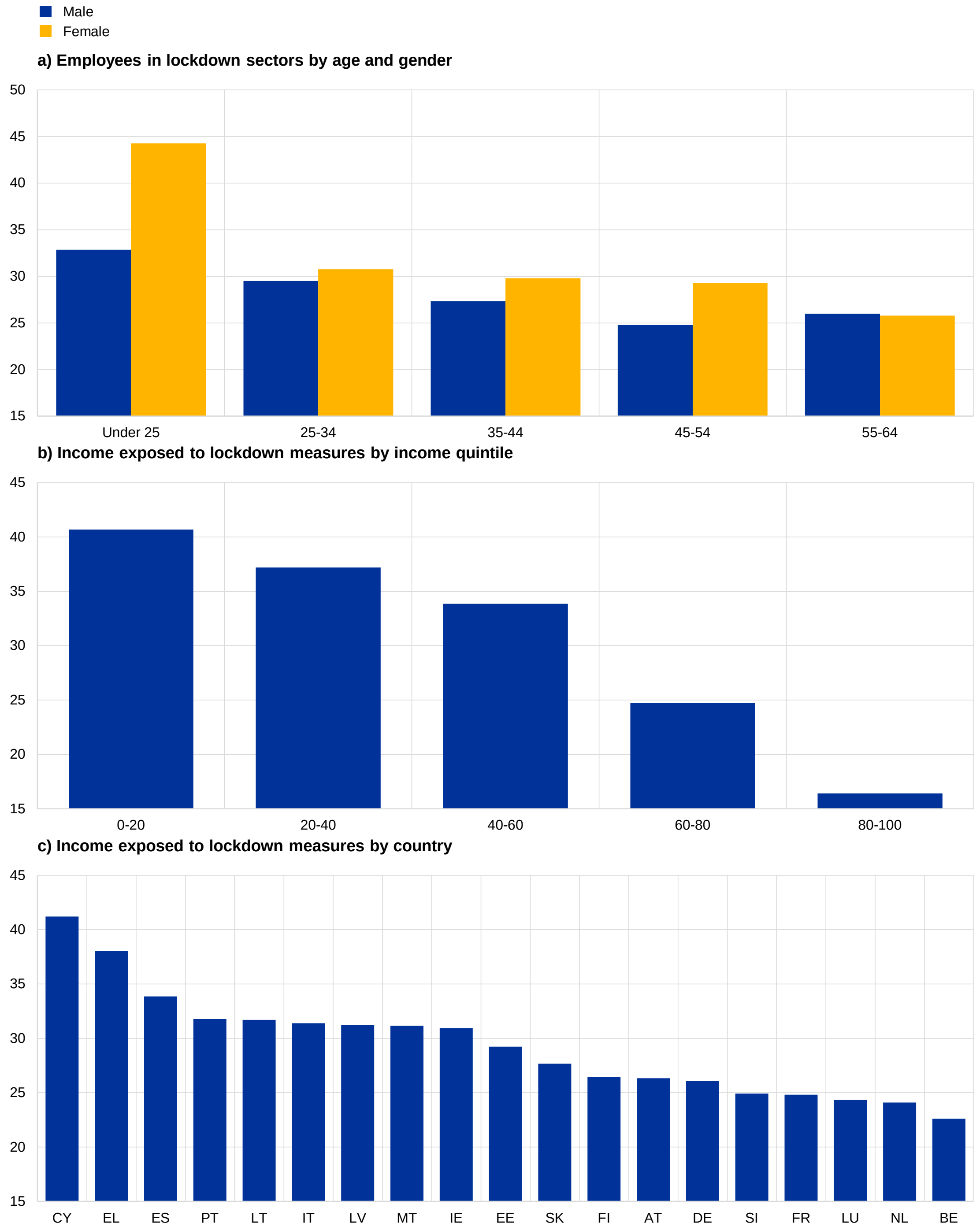
[93] See Furceri, D., Loungani, P., Ostry, J. and Pizzuto, P.(2020).

[94] See Gunnella V., Krustev G. and Schuler, T. (2020).

Chart A

Impact of COVID-19 by age, gender, income quintile and country

(percentages)

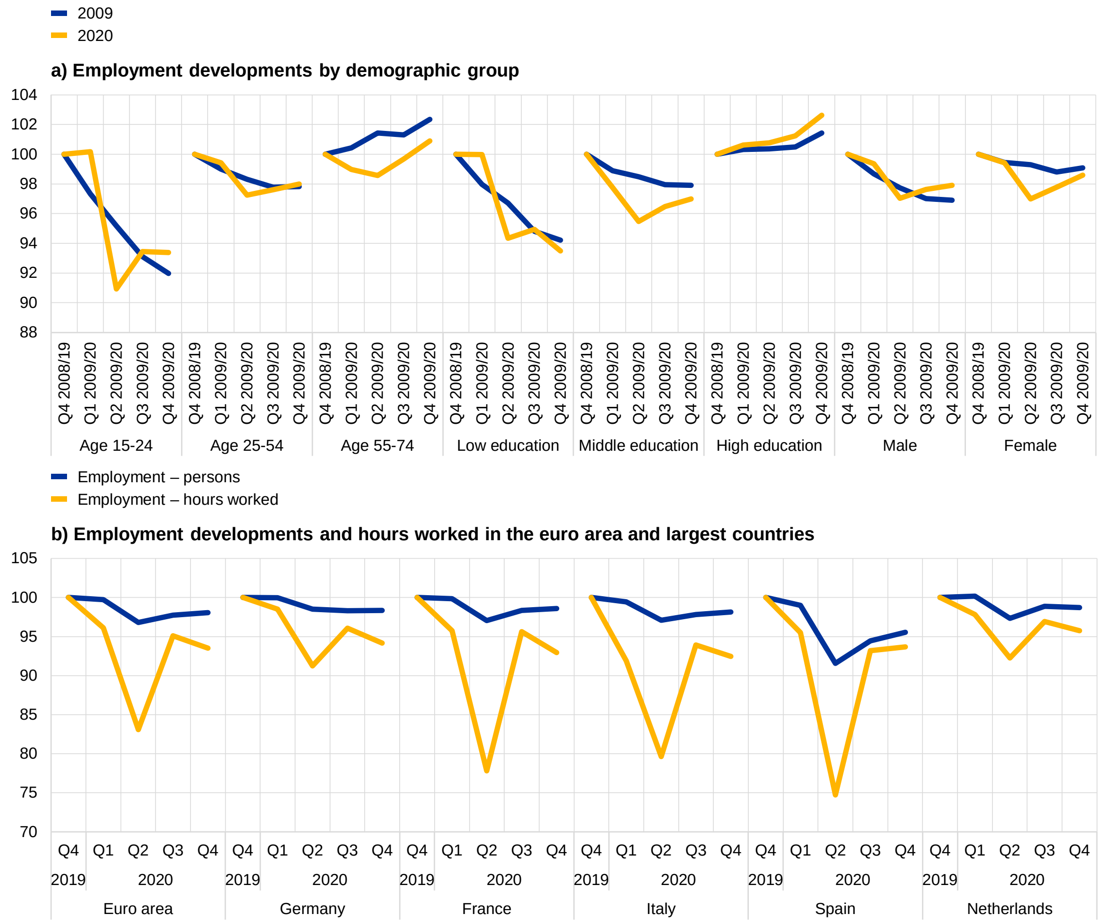


Sources: Panel a: EU Statistics on income and living conditions (EU SILC) (2017 data for Ireland and Slovakia; 2018 data for all other countries); Panel b and c: EU SILC (2017 data for Ireland and Slovakia; 2018 data for all other countries) and Eurostat Household Budget Survey.
Notes: Panel a: This panel shows, for each age category, the percentage of total employees (broken down by gender) who are working in lockdown sectors. The following sectors are considered to be subject to lockdown measures: wholesale and retail trade, and repair of motor vehicles and motorcycles; transport and storage; accommodation and food service activities; and arts, entertainment and recreation (sectors G, H, I and R respectively in the Statistical Classification of Economic Activities in the European Community (NACE classification)). Panel b: This panel shows, for each income quintile, the percentage of labour income that is exposed to lockdown measures. It considers the same sectors as in panel a. Panel c: This panel shows, for each country, the percentage of labour income that is exposed to lockdown measures. It considers the same sectors as in panel a.

Chart B

Employment developments by demographic groups and across countries

(index: Fourth quarter of 2009 = 100 for blue line of panel a) and fourth quarter of 2019 = 100 for the remaining)



Source: Authors' calculations based on the Eurostat Labour force survey (panel a) and Eurostat national accounts (panel b).
Note: During the global financial crisis employment started falling in the fourth quarter of 2008 and the sharpest falls occurred in the first three quarters of 2009.

Since the end of the fourth quarter of 2019, employment has declined more strongly for young and less-educated workers. Women were affected harder than in the 2009 recession (Chart B, panel a). Older workers and workers with middle education were relatively more affected during this pandemic than they were during the global financial crisis. The disaggregation by gender offers a more nuanced picture. The fall in employment of women was very similar to that of men. Compared with the global financial crisis the current recession had a much more symmetric, adverse impact on employment across gender. In past recessions, employment of women would contract less than employment of men, as women are more likely to work in less cyclical sectors (e.g. public sector).[95] In addition, caring responsibilities (for both children and the elderly) has fallen disproportionately on women during the pandemic.[96] Among the largest euro area countries, Spain saw the largest decline in employment (panel b). Hours have been the main adjustment margin across all countries, a direct result of job retention schemes such as short-time work and wage-subsidies.

95 See Alon T., Coskun S., Koll D. and M. Tertilt (2021), Guvenen F., Schulhofer-Wohl S., Song J., and M Yogo (2017).

96 See, for example, Adams-Prassl et al. (2020); Fuchs-Schündeln et al. (2020); Giurge et al. (2021).

Fiscal and monetary policies mitigated the economic fall-out from COVID-19. In many countries, firms and workers were supported through measures such as short-time work, wage subsidies or temporary lay-off schemes.[97] In April 2020 the number of workers in these schemes reached 30 million in the euro area, almost three times higher than the number of unemployed.

Chart C

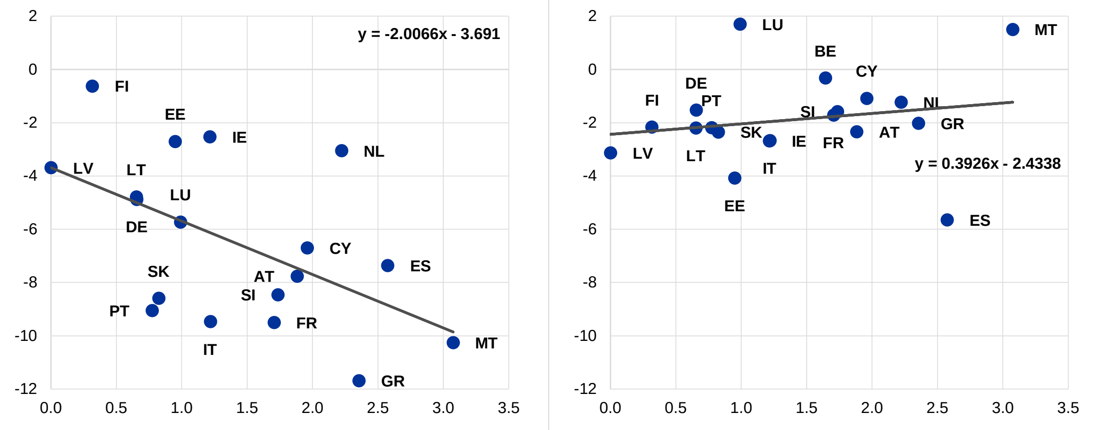
Budgetary costs of short-time work schemes and the change in average hours worked per employee/employment

a) Budgetary costs of short-time work schemes

b) Change in average hours worked per employee/employment

(y-axis = percentage change; x-axis = percentage of GDP)

(y-axis = percentage change; x-axis = percentage of GDP)



Sources: ESCB Working Group of Public Finance, June 2021 BMPE; Eurostat.

Short-time work schemes have been an efficient tool for providing targeted macroeconomic stabilisation in a heterogeneous monetary union. They accounted for budgetary costs in the order of 1.4% of euro area GDP in 2020, more than a third of the overall pandemic fiscal support measures and led to budgetary costs of more than 2% of GDP in some euro are countries. As shown in Chart C (left panel), there is a strong negative correlation between fiscal support and the average hours worked per employee. Cross-country variation in employment growth (right panel) has remained relatively small (standard deviation of 1.7%) compared with the cross-country variation in average hours worked (3.1%). This suggests that fiscal policy has been effective in preserving jobs during the COVID-19 crisis, by supporting an adjustment of the labour market via the intensive margin.

Despite a very heterogeneous impact of the COVID-19 crisis across age, education, gender, sector or country, job retention schemes have played a key role in limiting the direct impact of the crisis. When vaccination campaigns allow economies to open up again, this should, subject to demand, help to speed up the recovery, especially for the hardest hit groups. Authorities would then be able to gradually balance the protection of jobs with support for the reallocation of workers across firms and sectors.

[97] See OECD (2020).

3.6 Nature of labour market shocks

The nature of the shocks in the labour market is key to understanding potential inflationary effects. Supply shocks tend to move prices and output in opposite directions, while aggregate demand shocks generate a positive co-movement between them. Specific shocks, specific to labour or financial markets, tend to have a mixed (supply and demand) aggregate effect. Durations can differ, with short-term shocks usually having limited impacts on real variables.

Aggregate demand shocks move output/employment and prices in the same direction. For example, an increase in consumer demand due to optimistic income expectations will increase production by companies and thus increase employment, wages and prices in the short run, i.e. approximately one to two years. Eventually, capacity constraints start to show and, via a mechanism of rising prices and interest rates, the economy reverts to its long-run (supply-side determined) productive capacity employment level, as well as the original pre-shock *real* wage.[98] Nevertheless, as is shown in Chapter 6 when discussing hysteresis, a non-negligible part of the demand expansion may also leave some permanent beneficial effects on the long-run levels of these variables (positive hysteresis), which suggests that monetary policy could respond less to short-run fluctuations, of course without prejudice to maintaining price stability. Similarly, adverse shocks would by this reasoning require significant counteracting monetary policy shocks to avoid permanent economic scars (negative hysteresis). Other examples of demand shocks with similar implications are export demand shocks, discretionary monetary policy tightening or loosening, and fiscal policy changes.

A supply shock can cause output/employment and prices to move in opposite directions. An example is a permanent increase in productivity, resulting in permanently higher output, employment, real wages and a negligible or downward impact on inflation.[99] Productivity shocks can also have heterogenous employment effects, making the overall employment effect ambiguous in the short-run, e.g. automation resulting in higher total factor productivity (TFP) but reducing labour demand for some occupations/skills.[100] A positive labour supply shock, like migration, supports labour and output in the short as well as in the long-term, but with temporarily lower real wage growth and inflation.[101] Commodity price shocks, e.g. oil prices, have the potential to increase inflation and reduce real wage growth for some time, while at the same time negatively affecting output and employment.[102] Mark-up changes are another potential supply side shock resulting from changes in competitive or bargaining positions in product and/or labour markets. Examples are an increase in workers' bargaining power through wider union coverage or workers asking for higher

---

98 In Smets and Wouters (2002), the long-run adjustment is more or less over after about four to five years.

99 Christoffel et al. (2008).

100 Smets and Wouters (2002).

101 Smets and Wouters (2002).

102 Adjemian and Darracq Pariés (2008) provide empirical analysis of oil shock responses. The employment reaction is not significantly different from zero in their example, but in general it is more likely to move hand-in-hand with output, as in Abbritti et al. (2020). Gubler and Hertweck (2013), using US data, show that the total hours response is significant, driven by a significant response of the intensive margin.

wages due to more generous unemployment benefits. This would most likely result in lower employment and output both in the short and long-term with temporarily higher real wage growth and inflation.[103] A price mark-up increase due to reduced competitiveness of domestic producers would have similar effects, although without the temporary upward real wage effects.

The nature of shocks originating in the labour market are important fora better understanding of the inflationary developments for monetary policy. Foroni et al. (2017) show the role of labour supply and workers' wage bargaining shocks. While a labour supply shock increases unemployment and dampens price and wage inflation, a wage bargaining shock leads to a positive co-movement of unemployment and wage and price inflation. In assessing the strength of the overall labour market, it is thus fundamental to know whether the reduction in slack is, for example, driven by an improvement in aggregate demand conditions (lower unemployment and higher prices and wages) or by lower bargaining power, which results in lower unemployment, but also lower prices and wages. Such a multivariate approach provides a richer description of the labour market and can usefully complement univariate models based on the Phillips curve.

The response of labour market variables to shocks can be affected by the institutional setting of euro area labour markets. Hijzen et al. (2017) show how employment protection legislation can result in labour market duality, i.e. a large proportion of temporary contracts, meaning that any adverse shock will result in easier lay-offs and slower job creation during the recovery. Coordinated bargaining systems can make incumbent employees' wages and working hours more responsive to downturns with the benefit of reduced lay-offs. Active labour market policies or other expansionary fiscal measures (e.g. public investment), if introduced in a timely manner, can help towards returning to pre-shock employment levels. Boeri et al. (2011) and Brey and Hertweck (2016) review the effectiveness of short-time work schemes across OECD countries in limiting the impact of the global financial crisis. They tend to be most effective when used as a fast-responding automatic stabiliser. This results in lower cyclicality of labour inputs, limiting firm-specific human capital losses.

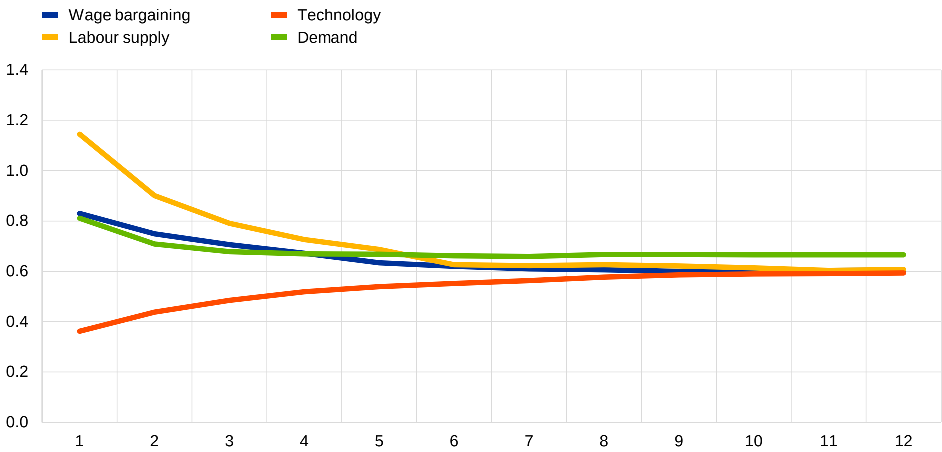
The response of the labour market to economic developments depends on the nature of the shock and is relevant for price and wage inflation. The way economic activity affects employment is important for correctly measuring both the resilience of the labour market adjustment and labour productivity. The latter is a key driver of marginal costs and long-term growth. Chart 25 shows the ratio of the impulse response functions between hours and output to different shocks. It highlights how demand and wage bargaining shocks tend to move output and hours in a stable fashion over time, while other shocks (like labour supply shocks) tend to have a stronger impact in the short run.

[103] Impulse responses presented by, for example, Christoffel et al. (2008) and Smets and Wouters (2002).

Chart 25

Conditional Okun Law elasticities

(y-axis: ratio of the impulse response functions between hours and output to various shocks; x-axis: quarters)



Source: ECB staff calculations.
Notes: ECB staff estimation of a structural vector autoregressive model (SVAR). All shocks and their signs are identified and normalised so that they are assumed to increase hours worked on impact, i.e. the lines reflect the impacts of positive shocks of demand, technology and labour supply, and a negative shock to wage bargaining. The identification of these four shocks follows the approach described in Box 1 entitled "Key drivers of labour market developments: an SVAR analysis"", *Economic Bulletin*, Issue 8, ECB, 2020. The instantaneous impacts of these shocks on output as an additional variable in this analysis are not constrained and are therefore primarily data driven.

3.7 Shocks, hysteresis and policy

Temporary shocks might have a persistent impact on employment in the future, i.e. hysteresis. This phenomenon is thus at odds with the more traditional separation of business cycles drivers from supply-side driven structural changes in the economy. Labour market rigidities can contribute to the potential for hysteresis effects, e.g. Blanchard and Summers' (1986) insider-outsider effects preventing wages from adjusting in response to a rise in unemployment. The interaction of shocks and labour market institutions can be a factor in hysteresis. For example, supply-side factors (workers' search effort, level of the unemployment benefits, etc.) can increase the persistence of temporary shocks.[104] Other channels include depreciation of human capital, job search discouragement with rising duration of unemployment and negative signalling to employers. Finally, the complementarity of capital and labour means that demand shocks that reduce investment and productivity can lead to a permanent decline in labour demand.[105]

Standard trend-cycle models tend to capture effects from labour market rigidities. This notion of hysteresis is captured, at least to some extent, by time-varying NAIRU/NAWRU estimates that are based on a price or wage Phillips curve, (Chart 26). For instance, when a negative demand shock hits the economy and the unemployment rate increases, wages will not fall proportionately if they are rigid downwards. A Phillips curve-based filter will then conclude that the unemployment

104 Sargent and Lungqvist (1998) and Blanchard and Wolfers (2001).

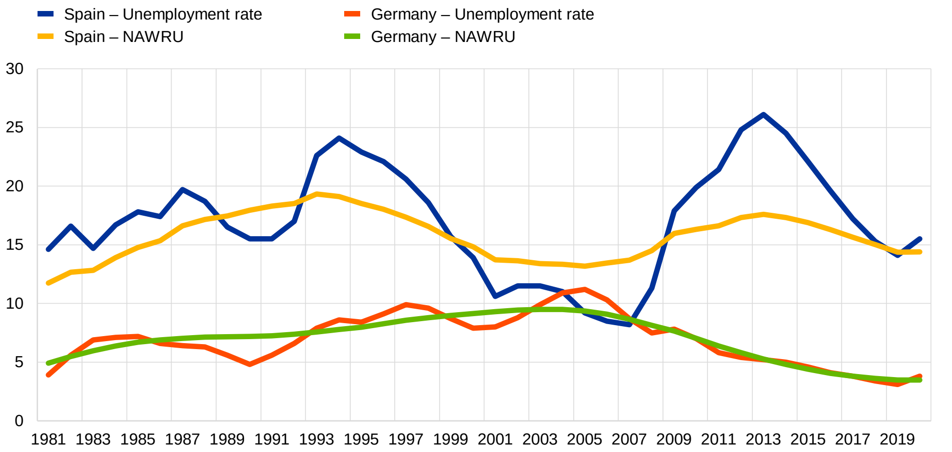
105 Girardi et al. (2020).

gap must be relatively small and the NAWRU/NAIRU must have increased to some extent. This might work both ways, i.e. also if the unemployment rate falls, but wages do not increase proportionately.

Chart 26

The unemployment rate and NAWRU estimates in Germany and Spain

(percentage of the labour force)



Source: European Commission.

Recent macro studies find evidence of persistent impacts on output and employment, indicative of hysteresis. Table 1 summarises some of this literature. From micro studies, scarring shows up in persistent future earnings losses, most likely due to depreciation and sub-optimal use of human capital, as well as a lower chance of being employed at a future date. A review by Quintini and Venn (2013), for example, shows that job displacement typically leads to long-term earnings losses of around 5 to 20% over three to ten-year horizons.

Table 1

Hysteresis results in the literature

Result	Channels	Numerical illustration	Source
Demand shocks lead to persistent impacts on output	Lower capital accumulation; reduced R&D spending; financial intermediation channels; lower labour supply via labour hysteresis	52 or 63 % of demand-led recessions output remains below prior trend; 4 % shortfall vs. pre-shock trend after 12 years	Blanchard, Cerutti, Summers (2015) ; Jordà et al. (2020)
Demand shocks lead to persistent impacts on employment	Capital accumulation (and labour complementarity); rigid labour market institutions; lower search effort; discouragement; skills depreciation; negative signalling	Ten years after the shock unemployment is 1 to 2 percentage Points Above pre-shock level; a job loss raises the probability of non-employment in subsequent year by 30 to 40%	Blanchard (2018); Nilsen, Reiso (2010); Biewen, Steffes (2010); Yagan (2019)
Demand shocks lead to persistent impacts on earnings	Lower productivity; less efficient matching	5 to 20% loss of earnings three to ten years after displacement	Quintini and Venn (2013); Lachowska et al. (2020); J. Schmieder et al. (2021)
Hysteresis effects are stronger if labour market more rigid	Rigid wage-setting, high minimum wages, generous benefits, high employment protection legislation all limit return of workers to labour market; more likely to become persistently unemployed	Panel regressions show strong interactions of institutions and shocks to affect subsequent unemployment reactions	Blanchard and Wolfers (2001)
Both negative and positive (reverse) hysteresis likely	Channels of adverse hysteresis act in reverse; labour is pulled back into employment after underutilisation	Employment up by 1% ten years after a significant positive demand shock	Girardi et al. (2020)
Ultimately hysteresis effects should fade in the very long run	If positive and negative shocks roughly alternate, negative and positive persistence should offset each other eventually; long-run equilibrium unemployment rate given by institutional features	NAIRU reacts persistently to boom-bust behaviour, but ultimately should be driven by institutional settings	Orlandi (2012)

3.7.1 Are some groups more or less prone to hysteresis effects?

Hysteresis affects socio-economic groups differently and especially affects those more prone to unemployment in the first place. Unemployment or joblessness incidence in downturns affects various segments of the society differently, mainly youth, elderly, low-skilled and low-educated workers. There is ample evidence of these effects in the literature.[106] It shows that scarring effects/persistence of unemployment are substantially larger for anyone with a higher propensity of being unemployed in the first place.

3.7.2 Potential for demand shocks to lead to hysteresis

This section deals with drivers of output or unemployment hysteresis that are related to adverse aggregate demand shocks, instead of the well-known

[106] For example Adamopoulou et al. (2020), Reiso (2011), Cockx and Ghirelli (2016), Cockx (2016), Quintini and Venn (2013), Hotchkiss and Moore (2018) and Cutuli and Grotti (2020).

supply-side factors. Yellen (2016) identifies the global financial crisis as a rare historical episode for rethinking whether there is any shortcoming in the toolbox of the economic profession. A key question she identifies is under which circumstances changes in aggregate demand can have a substantial, persistent effect on aggregate supply. From a theoretical perspective, the possibility that demand-type shock could affect the long-term growth of the economy could lead to a violation of the natural rate hypothesis – in other words, the idea that the long-run level of output/employment is independent from monetary policy and other short-lived aggregate demand factors (see Blanchard, 2017). Benigno and Fornaro (2018), Anzoátegui et al. (2019), Abbritti et al. (2021) and Acharya et al. (2021) show how demand-type shocks can permanently affect the long-term potential growth of the economy and, similarly, the employment level.[107]

3.7.3 Unemployment hysteresis following demand shocks

The combination of endogenous economic growth and frictional capital and labour markets can explain unemployment hysteresis that is relevant for monetary policy. The key mechanisms may differ across studies with some of them focusing on a tangible investment and time-to-build model (Benigno and Fornaro, 2018 and Hamilton, 2021), while other works focus on intangible investment such as R&D investment for generating an endogenous growth mechanism (Anzoátegui et al., 2019, Spitzer and Schmöller, 2020 and Abbritti et al., 2021). The empirical work from Grigsby et al. (2021) confirms early findings by Dickens et al. (2007) on the role of downward wage rigidity. Abbritti et al. (2021) show how adding downward wage rigidity in an endogenous growth model leads to larger asymmetric effects resulting in a higher degree of output and unemployment hysteresis following an aggregate demand shock.[108]

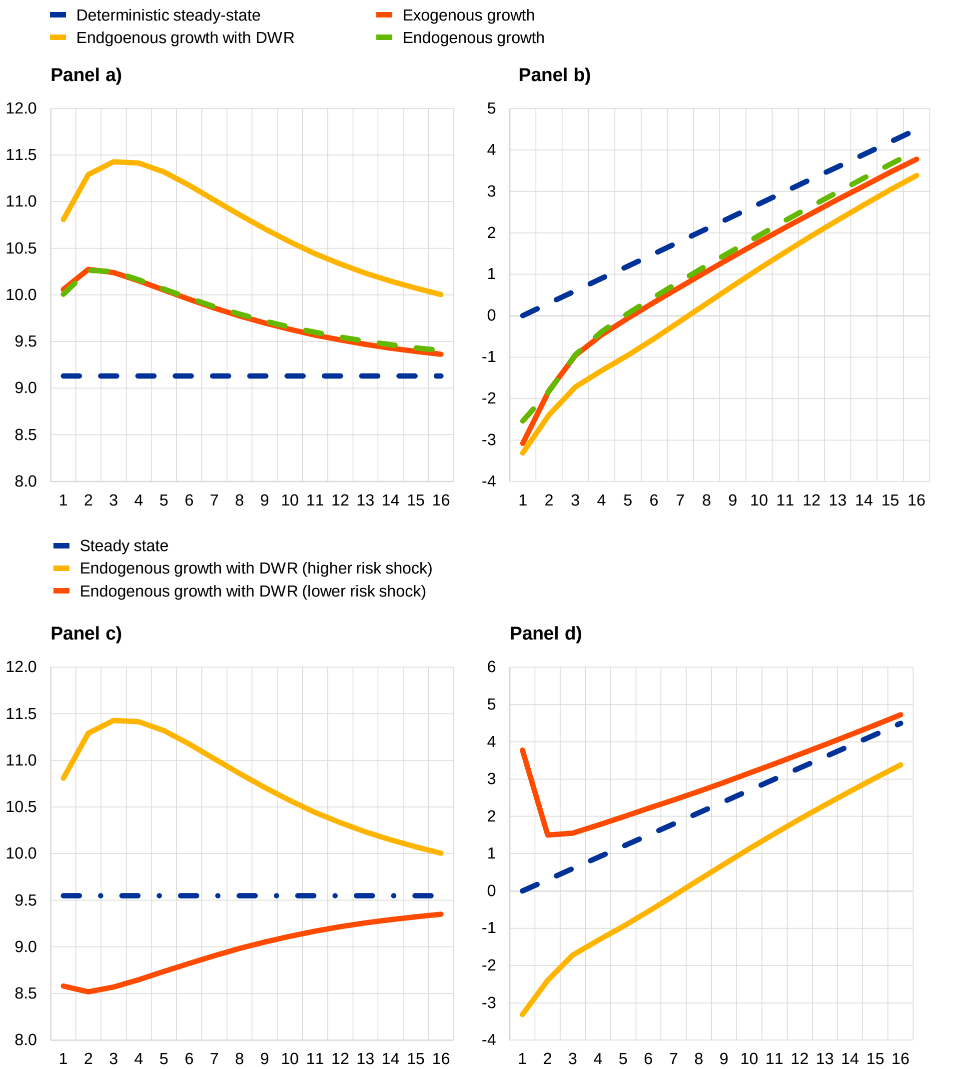
[107] This would also have implications for econometric methodologies as trend-cycle decomposition would need to feature correlated demand and supply shocks. For an econometric review of the issue with correlated demand and supply shocks, see the work by Morley et al. (2003).

[108] For evidence of wage rigidities in the EU and the euro area, see, for example, Marotzke, P., Anderton, R., Bairrao, A., Berson, C. and Tóth, P. (2020); Anderton, R., Hantzsche, A., Savsek, S.; Tóth, M. (2017).

Chart 27

Unemployment and output response to a risk premium shock

(percent and percentage deviations from the non-stationary steady state)



Source: Abbritti et al. (2021).

Notes: The x-axis shows the number of quarters and the shock hits at time 0. The two top panels show the impulse responses to an adverse aggregate demand shock (risk premium shock) for three models with (i) exogenous growth (black), (ii) endogenous growth (red) and (iii) endogenous growth and downward wage rigidity (DWR) (blue). The two bottom panels show the impulse responses from the model with endogenous growth and DWR to an adverse aggregate demand shock (bullet line) and to a favourable aggregate demand shock (dashed line).

Drawing on Abbritti et al. (2021), Chart 27 illustrates the magnitude of persistent employment and output effects following an adverse demand (risk premium) shock,[109] with and without endogenous growth and wage rigidity. Initially, both output growth and unemployment rate are negatively affected by a risk premium shock. The impact in the endogenous growth model is stronger as the endogenous productivity mechanism leads to lower trend growth. R&D investment is negatively affected from a lower value of innovations as firms profits and funding (both external

109 A risk premium shock should be interpreted as an aggregate demand shock following the work by Fisher (2015).

and internal) are affected by negative demand shocks. This is in line with empirical findings on R&D investment being highly procyclical (Fernando and Preuss, 2018). Finally, the nature of the shock is relevant in this class of models as negative supply shocks lead to real wages decreases, while negative aggregate demand shocks increase real wages. Only in the latter case, downward wage rigidity (DWR) worsens the overall adjustment in the labour market and in the economy.

Demand-driven hysteresis effects are even more pervasive in a low growth and low inflation environment. The main rationale for this result has to do with the famous quote from Tobin (1972) about the “grease-the-wheel” effect. By and large, nominal wages in equilibrium should reflect productivity and inflation developments. A lower equilibrium nominal wage would trigger the lower bound on wages even with relatively smaller shocks. It would thus make hysteresis effects more likely and persistent. Table 2 shows long-term values for economic growth and inflation before the 2003 ECB strategy review and the current one. Weak long-term productivity developments (e.g., Summers, Gordon, 2015) and the low inflation environment have basically halved the prevailing steady state nominal wages.

Human capital accumulation and skill depreciation are also important factors behind hysteresis and their effects can be amplified by monetary policy action. Demand-driven hysteresis effects can also be related to a situation in which monetary policy is constrained at the lower bound and a delayed response may lead to unemployment traps, as in Acharya et al. (2021). In this framework, there is a transition to a bad equilibrium with high unemployment – mostly driven by low-skilled people. As in Abbritti et al. (2021), the interplay of downward wage rigidity and the endogenous growth mechanism (through human capital appreciation in the Acharya case) significantly change the way aggregate demand shock transmits to the economy and affect the long term. Additionally, Garga and Singh (2021) show that, in a New Keynesian model with Schumpeterian growth, at the zero lower bound, the optimal policy response is to credibly commit to keeping future interest rates low in order to incentivise a recovery close to the pre-recession trend level. However, if the central bank is unable to commit, a hysteresis bias arises with permanent output losses.

The special case of hysteresis in currency unions. Fahr and Smets (2010) show how large common shocks may have sizeable and persistent effects on the intra-union terms of trade, whereby the country characterised by downward real wage rigidity adjusts with a persistent loss of competitiveness and higher and persistent unemployment.

Table 2
Annual long-term growth and price inflation in 2003 and 2020

(annual average; percentages)

Historical average	Price inflation	GDP growth
10-year:		
2003	1.99	2.17
2020	1.31	1.02
20-year:		
2003	2.92	2.32
2020	1.68	1.13
ACW Model:	1.80	1.20

Sources: Abbritti et al. (2021).
Notes: Ten-year and 20-year average growth rates in 2003 (first ECB strategy review) and 2020. ACW model stands for the calibration used in the Abbritti et al. (2021) paper which is based on the average growth rates over the period 1999-2019.

3.8 Risks of cyclical shocks becoming more structural

The impact on unemployment from the two recessions in 2008-09 and 2011-13 was particularly severe and long-lasting, in comparison with the recessions in the 1980s and the 1990s. For instance, in 2014, six years after the start of the first euro area recession and one year after the end of the second, euro area employment remained some 2.4% below its pre-crisis peak (2008) with five-and-a-half-million people having lost their jobs. The euro area unemployment rate rose from a pre-crisis low of 7.3% to a peak of 12.0% early in 2013 and declined only modestly. It took almost nine years (35 quarters) for euro area employment to reach its pre-crisis level, whereas the unemployment rate only in 2019 reached levels close to those observed at the onset of the Great Recession.

This employment outlook was quite heterogeneous across euro area countries. In some countries (Greece, Spain, Latvia, Lithuania, Portugal and Slovenia), employment has never recovered to the level observed in 2008. Unemployment rates in seven euro area countries are still above their 2008 levels. To some extent, this strong impact reflects the interaction of sectoral and institutional features of the euro area economies, which led to considerable cross-country heterogeneity in labour market outcomes, with heavy and persistent job losses in some euro area economies, but modest and relatively short-lived deteriorations in others.

From a policy perspective, the marked rise in long-term unemployment has been one of the most serious labour market consequences of the crisis. At the beginning of the first stage of the crisis, in 2009, the initial strong increase (by 3 to 3.5 percentage points) in the euro area unemployment rate was driven largely by increases in short-term unemployment. However, a subsequent decline in job-finding rates led to longer unemployment spells. This raised both the unemployment rate and the share of long-term unemployment. With the start of the second stage of the crisis, both metrics worsened further, the unemployment rate rising by a further 2 percentage points, while long-term unemployment rose from around 45% to around 52% of total unemployment. By the end of 2013 the stock of long-term unemployed accounted for over 6% of the total euro area labour force, more than double its pre-crisis level. The risk of long spells of unemployment translates into a deterioration of skills, contributing to the persistency of unemployment (hysteresis).

There are also other factors explaining the record high unemployment rates which are related to the presence of jobless recoveries and limited job mobility. Uncertainty about aggregate demand conditions during a recovery, together with labour hoarding behaviour as seen during the previous recession, tend to delay the hiring process. When job creation remains insufficient to bring unemployment down, then unemployment duration and skill depreciation start increasing. During a deep recession, the degree of job reallocation tends to automatically increase as the distribution of skills in the labour force is fixed in the very short run. As a result, the mismatch worsens significantly and the effectiveness of the matching process deteriorates, thereby amplifying the persistence of unemployment.

4 Inflation and employment: trade-off considerations for monetary policy

4.1 Introduction

The scope for the ECB's monetary policy to support the general economic policies in the European Union so as to contribute to the achievement of "full employment" as a secondary objective, without prejudice to its primary objective of maintaining price stability, depends critically on the presence of trade-offs between inflation and employment stabilisation. In many instances, inflation and *aggregate employment* move together without creating an obvious stabilisation trade-off for monetary policy.[110] This is generally true for shocks to aggregate demand. Importantly, also changes in the stance of monetary policy, irrespective of the particular policy instrument used, move inflation and employment in the same direction. If a stabilisation trade-off arises, there is widespread consensus that policies which seek to fully stabilise inflation at all times and at any cost are undesirable. This consensus, together with the long and variable lags of monetary policy transmission, has been underlying the "medium-term orientation" of the ECB's monetary policy from its start.[111]

This chapter reviews distinct dimensions of the inflation-employment trade-off and discusses implications for the ECB's scope to contribute to the achievement of full employment without compromising its primary price stability objective. Section 4.2 examines the inflation-employment trade-off through the lens of a structural model, with a particular focus on the consequences arising from a flat Phillips curve. Section 4.3 takes a normative perspective and assesses the benefits of a flexible medium-term policy horizon that caters for employment stabilisation subject to the primacy of price stability. Section 4.4 revisits the implications of the high degrees of uncertainty surrounding conventional measures of slack and fundamental economic relationships, notably the Phillips curve. Finally, Section 4.5 examines the implications for employment stabilisation that may result from the adoption of history-dependent make-up strategies that have been proposed to overcome the impairments of the efficacy of monetary policy in the presence of the effective lower bound on nominal interest rates. Several boxes provide complementary insights from the literature, supporting model-based analyses and a review of relevant aspects of the Federal Reserve System's earlier monetary policy framework review.

---

110 The implications of different dimensions of employment heterogeneity for the transmission and for the conduct of monetary policy are discussed in Chapter 5.

111 For an extensive discussion of these principles in the context of the evaluation of the ECB's monetary policy strategy in 2003, see Box 1, "The medium-term orientation of the ECB's monetary policy", *Monthly Bulletin*, ECB, Frankfurt am Main, June 2003.

4.2 The inflation-employment trade-off in the presence of a flat Philips curve

Analysing the inflation-employment trade-off through the lens of a structural model allows us to identify and quantify its fundamental sources and structural determinants. In particular, the cross-correlation pattern implied by an empirically grounded structural model allows us to gauge the strength of the co-movement of inflation and employment at different horizons in a synthetic way and to identify and quantify the contributions of different types of economic shocks to the overall correlation pattern. It also permits us to study the sensitivity of the correlations to important structural factors that are shaping the trade-off, such as the slope of the price and wage Phillips curves, and to the way monetary policy is typically conducted, as reflected in the central bank's interest-rate reaction function. Such quantitative exploration, though inevitably dependent on the particular model used, constitutes a useful reference point for the assessment of the normative implications of the inflation-employment trade-off for the conduct of monetary policy, which is the subject of the following section.[112]

Illustrative analysis based on the ECB's New Area-Wide Model (NAWM) suggests that shocks which give rise to an inflation-employment trade-off only account for a moderate share of the overall cross-correlations between inflation and employment, but they may be pervasive at times. Chart 28 displays the cross-correlation pattern for inflation and employment implied by the NAWM – an estimated medium-size New Keynesian model of the euro area – and the contributions to that pattern which can be attributed to its different types of shocks.[113] For the benchmark version of the model, the correlation pattern shown in the upper left panel of the chart reveals the important role of price and wage mark-up shocks, i.e. cost-push shocks, as the primary source of the trade-off between inflation and employment stabilisation over the medium term.[114] In particular, the contributions of the mark-up shocks to the correlations of employment with respect to lagged inflation are negative and sizeable, especially at the two-year horizon. All other shocks (including monetary policy shocks) make a positive contribution to the overall correlation pattern in aggregate terms. To appreciate the importance of the mark-up

---

[112] At a conceptual level, it is important to distinguish trade-off considerations that concern either the level of employment or the notion of an employment gap. Level-based considerations have a primarily empirical orientation and are based on deviations of employment from a long-run mean or a possibly time-varying trend, whereas gap-based considerations are rooted in economic theory and typically focus on deviations of employment from a hypothetical level that, within mainstream New Keynesian models, is defined as the level of employment that is obtained in the absence of nominal rigidities. With the exception of the normative analysis presented in Section 4.3, this chapter focuses on level-based trade-off considerations.

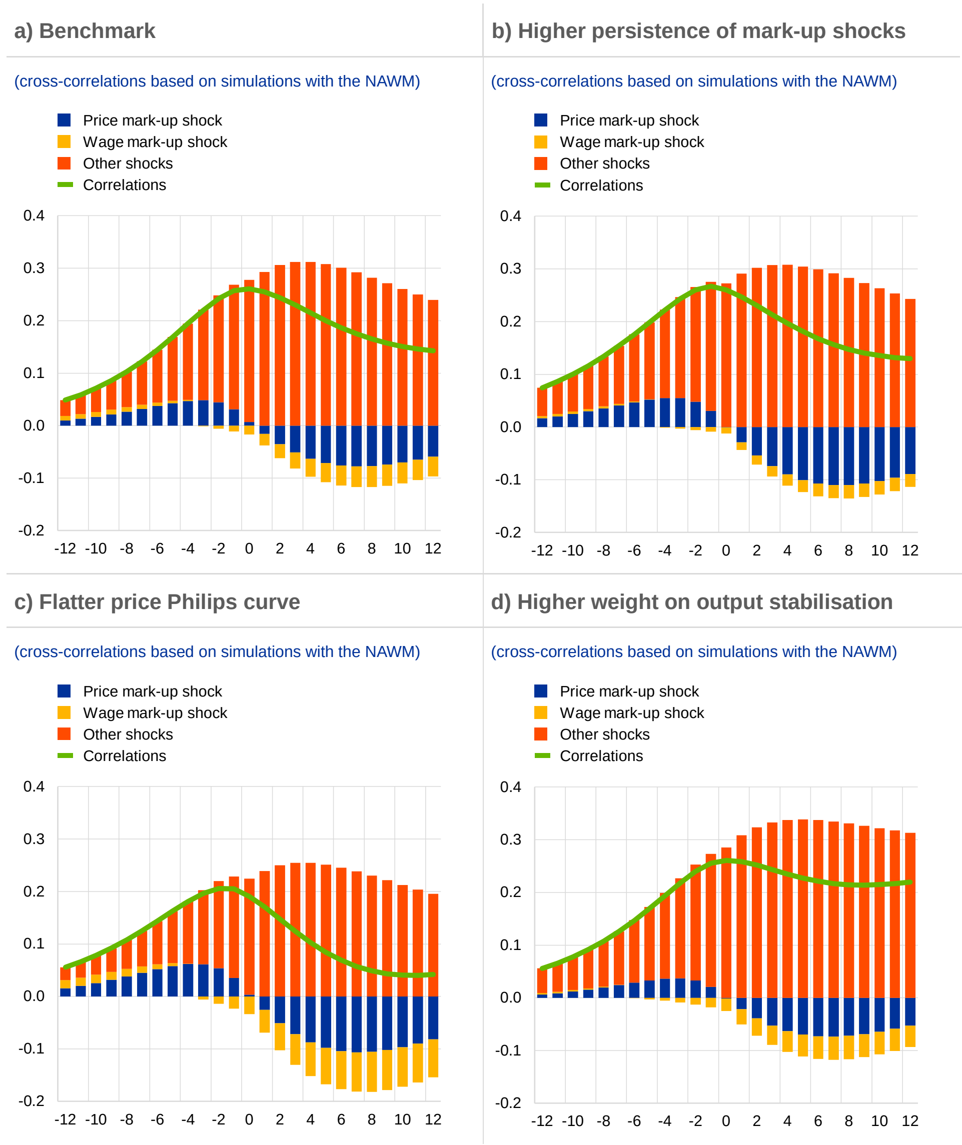
[113] For a description of the NAWM, its main properties and its uses for forecasting and policy analysis, see Coenen et al. (2018). The correlation analysis is detailed in Coenen and Warne (2021). The model-implied inflation-employment correlations are somewhat higher than those estimated on euro area data. The model-based correlation analysis uses fixed parameters (posterior mode estimates) and therefore does not account for parameter uncertainty. When allowing for such uncertainty, the data-based estimates of the correlations lie within 90% credible intervals of the model-based posterior distributions.

[114] It should be noted that New Keynesian models, such as the NAWM, with their focus on nominal price and wage rigidities, have limitations concerning the variety of other sources that are likely to give rise to inefficiencies in labour markets in practice, especially the existence of real labour market frictions resulting in involuntary unemployment.

shocks as the primary source of the trade-off, it should be noted that these shocks account for a substantial part of the overall fluctuations in inflation and employment (i.e. their variances), especially at the short and medium-term horizon. This further underpins their significance for the design and conduct of monetary policy.

Chart 28

The inflation-employment trade-off through the lens of an estimated structural model



Source: Eurosystem staff calculations based on simulations with the New Area-Wide Model (NAWM).
Notes: This chart depicts the decomposition of the model-implied correlation pattern between employment and inflation (green line) into contributions of price and wage mark-up shocks (blue and orange bars, respectively), which give rise to an inflation-employment trade-off, and of all other shocks (red bars). The x-axis indicates the number of time periods (quarters) that inflation is lagged relative to employment. The contemporaneous correlation is given in period zero, while positive (negative) values reflect lags (leads) of inflation. Panel a) shows the correlations for the model's benchmark specification. Panels b) to d) show the correlations for specifications for which the persistence parameters of the price and wage mark-up shocks are increased by 10%, the slope coefficient of the price Phillips curve is lowered by 25%, and the weight on output stabilisation is nearly doubled, respectively. The benchmark correlations are based on parameter values estimated over the sample period from the first quarter of 1985 to the fourth quarter of 2014.The parameter changes are all broadly within the uncertainty bands of the estimated parameters. Inflation corresponds to consumer price inflation measured in terms of the private consumption deflator, while employment is measured by total employment.

The strength of the inflation-employment trade-off depends, among other things, on the persistence of the underlying shocks, the slope of the price Phillips curve, and the weights in the central bank's reaction function. The remaining three panels in Chart 28 illustrate three key determinants of the strength of the trade-off between inflation and employment stabilisation caused by price and wage mark-up shocks. First, the more persistent the mark-up shocks, the larger is their negative contribution to the overall correlation over the medium-term horizon. Within the NAWM, the basic reason is that forward-looking price and wage-setters are more willing to adjust their contracts already at the time when the shocks occur, over and above the adjustment implied by equally sized, but less persistent shocks. In a similar vein, a forward-looking central bank is more likely to counter the inflationary effects of the shocks by tightening policy and thereby curb employment, as they are not seen as transient and entail risks of second-round effects and a possible dislocation of inflation expectations. Second, the flatter the price Phillips curve, the larger the negative contribution of price mark-up shocks. This reflects the fact that, following a price mark-up shock, the reduction in employment that monetary policy is required to induce in order to stabilise inflation is larger in the presence of a flatter Phillips curve. By contrast, the pass-through of wages to price inflation is weakened and, hence, the contribution of wage mark-up shocks to the correlation pattern is diminished. And third, if the central bank attaches a higher weight to stabilising output and, thus implicitly, employment in its reaction function, the positive overall correlation over the medium term rises, albeit with little impact on the absolute size of the mark-up contributions.

In the presence of a flat price Phillips curve, the employment costs of short-term inflation stabilisation would be elevated, whereas policies aimed at getting close to full employment are likely to have a moderate impact on the build-up of inflationary pressures, at least in the shorter term. In view of the evidence of a flat euro area price Phillips curve accumulated since the time of the 2003 strategy evaluation (see the empirical findings revisited in Chapter 2 and the selective review of possible underlying structural factors in Box 4), the model-based correlation analysis is consistent with the view that, all else being equal, short-term inflation stabilisation would cause heightened employment costs. At the same time, policies aimed at getting close to full employment are likely to exert a rather moderate influence on the build-up of inflationary pressures via the wage-price pass-through channel. This implication, however, rests on the assumption that the sensitivity of wages and inflation does not increase non-linearly, or in a possibly state-dependent manner, when full employment is being approached (see Box 4 for further discussion). These considerations, among others, featured prominently in the Federal Reserve’s recent framework review, with its new strategy seeking to eliminate shortfalls from “maximum employment”, as opposed to minimising deviations in either direction, as reviewed in Box 5.

Box 4
Structural factors underlying a possible flattening of the price Phillips curve: selective findings from the literature

Several studies have documented a decline in the slope of the price Phillips curve for the US economy in recent decades, whereas for the euro area the evidence is much more nuanced. Against this background, this box reviews some candidate explanations for a possible flattening of the price Phillips curve, including alternative sources of non-linearity. It complements the empirical evidence revisited in Chapter 2 and focuses on likely structural factors behind the alleged flattening.

A key question for central banks is to what extent monetary policy affects inflation and to what extent employment and output. At the heart of it is economists' understanding of the Phillips curve, and its slope, summarising the inflation-unemployment trade-off. Views regarding the slope of the Phillips curve vary widely in the literature. At one extreme are economists who argue, on the basis of micro-founded structural models, that the Phillips curve should be very steep (Golosov and Lucas, 2007). At the other are economists who contend that empirically the US Phillips curve is quite flat (Hazell et al., 2021).

We organise structural explanations for the apparent flattening of the Phillips curve in three categories. The first group covers changes in monetary policy, including a stronger reaction to inflation and better anchoring of inflation expectations. Second come other economic factors having to do with technology, market structure, and worker bargaining. And third is the possible non-linearity of the Phillips curve itself, meaning that its slope differs depending on the precise location on the curve.

The first category of factors has to do with improved monetary policy. Roberts (2006) confirms the findings of Clarida et al. (2000) that monetary policy became more reactive to output and inflation around the 1980s. He also argues that policymakers' estimates of potential output have become more accurate. If monetary policy acts more aggressively to stabilise the economy, then any given deviation of output from potential will contain less of a signal of future inflation. Similarly, a reduction in the persistence of potential output mismeasurement would mean that an increase in output resulting from such a misestimate of potential output will not imply as much inflation because it is not expected to last as long.

A related explanation in the first group has to do with optimal monetary policy. McLeay and Tenreyro (2020) argue that if monetary policy was set with the goal of minimising welfare losses, subject to the standard New Keynesian Phillips curve, a central bank would seek to increase inflation when output is below potential. This targeting rule will impart a negative correlation between inflation and the output gap, blurring the identification of the positively sloped Phillips curve relationship between inflation and the output gap.

Yet another explanation in this group is due to better anchoring of inflation expectations. Jørgensen and Lansing (2021) make the case that if agents solve a signal extraction problem to disentangle temporary versus permanent shocks to inflation, then an increase in the policy rule coefficient on inflation serves to endogenously anchor agents' inflation forecasts. Improved anchoring reduces the correlation between changes in inflation and the output gap, making the Phillips curve appear flatter.

In the second category, weakened worker bargaining may also have played a role. Since the end of 1980s, employment protection laws have become looser, the minimum wage has decreased, trade union density and collective bargaining coverage has fallen, globalisation has made workers more vulnerable to threats of job loss due to delocalisation (Stansbury and Summers, 2020). Lombardi et al. (2020) show that the erosion of workers' bargaining power weakens the inflation-output gap relationship as it modifies the relative contribution to total hours worked of the extensive and intensive margins of the labour input, i.e. the number of heads vs hours worked per head. In their model, the lower workers' bargaining power, the more firms react to changes in demand by adjusting the extensive margin rather than the intensive one. Therefore, the marginal wage decreases, and so does the marginal cost, muting the cyclical movements of inflation.

Automation of production has led to a reduction in employment, wages and the labour share (Acemoglu and Restrepo, 2018, 2020, Acemoglu et al., 2020, and Hubmer and Restrepo, 2021). Basso and Rachedi (2021) provide an insight into how automation can shape inflation outcomes as well. In their model, firms use either machines or labour to produce and can convert a labour task into a machine whenever the price of opening a vacancy exceeds that of producing with a machine. Robot adoption by firms then shrinks workers' bargaining power and the labour share. As a result, a higher degree of automation in the economy lowers the sensitivity of wage inflation to changes in unemployment and the pass-through of wages into prices, thus reducing the slope of the Phillips curve.

Finally, changes in market structure including industrial polarisation may have been important too. Andrés et al. (2021) explore the connection between rising market concentration and the flattening of the Phillips curve in a New Keynesian model with Bertrand price competition and endogenous choice of technology level by firms. In the model, mark-ups are positively correlated with a firm's market share. After an increase in marginal costs, a firm raises prices, undermining its market share and therefore reducing its mark-up. By internalising this effect, firms moderate the response of prices to shocks; this is especially the case for large firms. Hence, in an economy characterised by a high level of polarisation, the response of inflation to shocks becomes more muted relative to what it would be in a similar economy with a more even distribution of firms.

The third category of explanations invokes the possible non-linearity of the Phillips curve itself, especially in its tails. Benigno and Ricci (2011) introduce nominal downward wage rigidities and idiosyncratic shocks in an otherwise standard New Keynesian model. They show how in their framework the output-inflation trade-off flattens at low inflation, a result which suggests that the observed reduction in the slope of the Phillips curve in recent years may simply be due to the decline in inflation. In a similar vein, Costain et al. (2021) suggest that the decline in trend inflation alone can account for roughly half of the observed flattening of the US Phillips curve. These authors demonstrate that, in a model of state-dependent price and wage-setting, lower trend inflation calls for less frequent price and wage adjustment, making short-run inflation less reactive to monetary shocks.[115] Yet another study based on non-linearity of the Phillips curve is that of Lindé and Trabandt (2018), who consider strategic complementarities in price and wage-setting. The latter lead to a state-dependent demand elasticity for goods and labour input and result in a lower elasticity between inflation and output in large recessions.[116]

---

[115] Consistent with this finding, Busetti et al. (2021) estimate that the slope coefficient of the euro area price Phillips curve is only about half as large at the lower quantiles of the distribution of inflation outcomes when compared with the slope at the higher quantiles. A possible explanation for such non-linearity is the presence of downward nominal rigidities (see also Forbes et al., 2020).

[116] In a similar vein, state dependence may emerge because the reaction of wages depends on the persistence of the underlying economic shocks (Conti et al., 2019).

Box 5

The outcome of the Federal Reserve System's policy framework review, with a focus on its maximum employment leg

On 27 August 2020, the Federal Open Market Committee (FOMC) released a revised "Statement on longer-run goals and monetary policy strategy" that was unanimously endorsed. This revised statement was the outcome of the Federal Reserve System's comprehensive review of its monetary policy framework, which was launched in early 2019; see Board of Governors of the Federal Reserve System (2019, 2020a,b). The scope of the review took the Federal Reserve System's statutory dual mandate as given, as well as a longer-run inflation rate of 2% as being most consistent with the congressional mandate.

The revised statement outlines a new strategic framework that includes significant changes relating to both legs of the Federal Reserve System's dual mandate – maximum employment and price stability – with employment gaining more prominence. The greater emphasis on employment is clearly evident in the redrafting of the statement on longer-run goals and monetary policy strategy, where the order of discussion of the employment and price stability goals has been reversed relative to the January 2019 statement. Two elements of the greater emphasis on employment stand out: (i) the focus on employment shortfalls and (ii) maximum employment as a "broad-based and inclusive goal".

The Federal Reserve System's focus on employment shortfalls

The FOMC's policy decision will be informed by an assessment of the "shortfalls" of employment from its maximum level rather than by "deviations" as in the previous statement. Adopting a "shortfall" approach places a greater emphasis on employment when it is below its maximum level than above, thereby introducing an asymmetric reaction function to employment. The Federal Reserve System's rationale for this is that a robust job market can be sustained without causing an outbreak of inflation, which is consistent with its assessment that the (price) Phillips curve has flattened over the past decades. The observed muted response of inflation to labour market tightness since 2012 could also signal that policymakers' estimate of the natural rate of unemployment has been too high.

The change in focus on employment shortfalls complements the FOMC's adoption of a flexible average inflation strategy to address the impairments of the effectiveness of monetary policy due to the zero lower bound (ZLB). Estimates of the natural rate of interest have trended lower since the 2008-09 financial crisis, implying that monetary policy could be constrained more often by the ZLB on nominal interest rates. As a result, long-term average inflation could fall somewhat below the target level and thereby drag down inflation expectations, reinforcing the constraint of the ZLB and resulting in a sub-optimal equilibrium.

A model-based approach shows that concentrating on shortfalls rather than deviations from maximum employment can counteract the downward inflation bias due to the ZLB. To help better understand the recent changes to the FOMC's monetary policy strategy, Penalver and Siena (2021) present a simple model in which a sub-optimal equilibrium arises; they use it to evaluate the benefits of switching from a concern about "deviations" of unemployment from its natural rate to a concern for "shortfalls from maximum employment". The evaluation builds on the theoretical framework by Barro and Gordon (1983) in which inflation, π, and unemployment, u, are determined by two linear equations, a Phillips curve and an investment-saving relationship. As a first step, the model assumes that the central bank seeks to minimise a quadratic loss function subject to the nominal interest rate i≥0 (i.e. the central bank cannot use unconventional tools) as follows:

$$L(d) = \frac{1}{2}(\pi - \pi^*)^2 + \frac{\lambda}{2}(u - u_N)^2$$

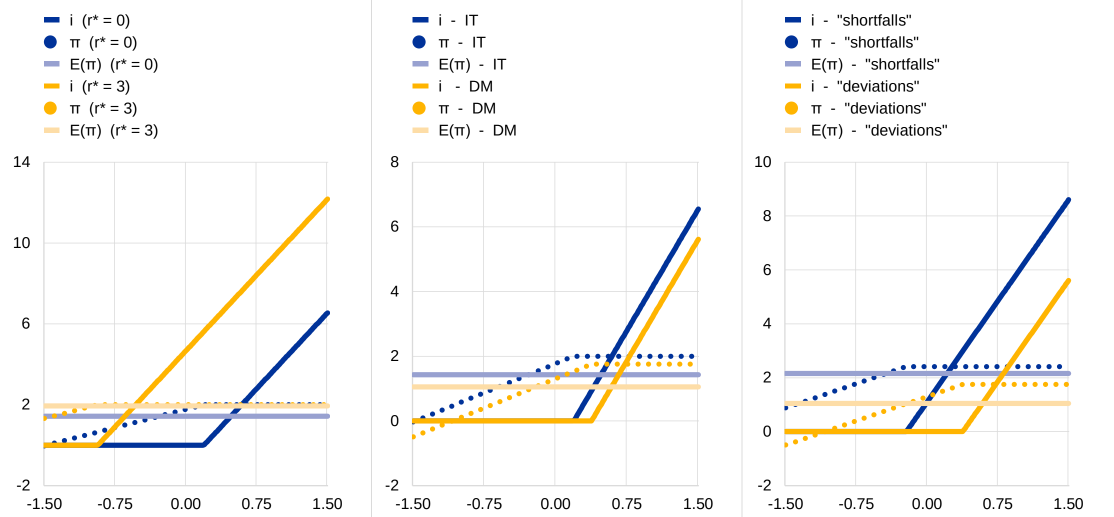
where π^* and u_N denote the inflation target and the natural rate of unemployment, respectively. The quadratic term in unemployment means that the central bank wants to stabilise the unemployment rate around its natural rate. The left panel of Chart A illustrates the deflationary bias from the perspective of a pure inflation targeter (assigning zero weight in the loss function to deviations of the output from its natural level) for two different values of r^*, the natural rate of interest. The economy is disturbed by uniformly distributed demand shocks, which are observed by the central bank but not by economic agents. The ZLB starts to bind for some realisations of the shock and inflation falls linearly as the shock becomes more negative. When the realised shock is greater than a certain threshold, the ZLB does not bind and the inflation targeter sets $\pi = \pi^*(= 2\%)$. However, the possibility of a binding ZLB, which is amplified when r^* falls, pushes inflation expectations, π^e, below π^*, which drives down realised inflation during the ZLB episode. This is the reinforcing nature of the sub-optimal ZLB equilibrium.

Chart A

Inflation outcomes under different loss functions in the presence of the ZLB

a) Inflation targeting for r*=0 or 3% | **b) Inflation targeting vs dual mandate (r*=0%)** | **c) Concern about "deviations" vs. "shortfalls" (r*=0%)**

(y-axis: percentages; x-axis: demand shock)



Source: Penalver and Siena (2021).

Notes: This chart shows the evolution of inflation π, inflation expectations E(π), and the nominal interest rate i for alternative values of a demand shock in the presence of the ZLB. Panel a) presents the problem from the perspective of a pure inflation targeter (assigning a zero weight to deviations of unemployment from its natural rate in its loss function) for two values of the natural rate of interest: r*=3 (yellow) and r*=0 (blue). Panel b) shows the equilibrium for a strict inflation targeting central bank (blue line) relative to that of a central bank with a dual mandate (yellow), which, in addition to stabilising inflation, also minimises "deviations" of unemployment from its natural rate (blue). Panel c) shows the equilibrium for a central bank with a dual mandate considering either "deviations" of unemployment from its natural rate (yellow) or "shortfalls" from maximum employment (blue).

Inflation-targeting central banks are able to stabilise inflation at higher levels than dual-mandate central banks that also target employment, if the employment target implies a less-aggressive easing of monetary policy in the face of a demand shock as unemployment falls below the estimated natural rate. The middle panel shows the equilibrium for a strict inflation targeting central bank relative to that of a central bank with a dual mandate. Both types of central banks face the problem that $\pi^e < \pi^*$. As before, the inflation targeting central bank responds by aggressively lowering i so that $u < u_N$ in order to ensure that $\pi = \pi^*$ when the ZLB does not bind. The dual mandate central bank, on the other hand, experiences a loss when $u < u_N$ and thus trades off an undershoot of the inflation objective during non-binding times for small deviations from the unemployment objective. This trade-off lowers π^e even further, causing the ZLB to bind at higher values of the shock. As a consequence, actual and expected inflation are much lower for the dual mandate central bank compared to the inflation targeting central bank (see the middle panel of Chart A).

However, the situation is different when considering a switch from "deviations" to "shortfalls". To model this, the quadratic term in unemployment in the loss function is replaced by a linear term:

$$L(d) = \frac{1}{2}(\pi - \pi^*)^2 + \lambda(u - u_N)$$

Such an adjustment induces an upward bias in inflation when the ZLB does not bind. The switch from "deviation" to "shortfalls" has a powerful impact, as shown in the right panel of Chart A. Not only is inflation higher when the ZLB does not bind, the resulting increase in expected inflation drags up inflation when the ZLB does bind and shifts the ZLB threshold to the left. Using "shortfalls" instead of "deviations" is thus a way of compensating for the potential downward bias to inflation in a dual mandate framework.

Maximum employment as a "broad-based and inclusive goal"

The Federal Reserve System's new framework also emphasises that maximum employment is a "broad-based and inclusive goal". This change recognises the benefits of a strong labour market, particularly for disadvantaged groups for which unemployment rates often fall only late in the economic cycle. The public "Fed listens" events showed that, for the benefits of low unemployment to be shared more widely across all groups within society, including disadvantaged groups, the headline unemployment rate needs to be lower than the level previously thought to be compatible with full employment for a considerable time. As (un)employment rates vary significantly according to sex, race, age and educational attainment, this also implies basing the assessment of the labour market on a wider range of indicators than before to ensure that maximum employment has been reached for broad swathes of society. However, the Federal Reserve System has left undefined the degree and duration of inflation overshooting it is willing to tolerate and what exactly constitutes maximum employment. It is therefore unclear how a policy of "running the economy hot" would be implemented in practice.

In the Federal Reserve System's communication since the introduction of its new monetary policy framework, employment considerations have played a significant role in justifying a continued expansionary monetary policy stance. For example, in his 28 April 2021 press conference, Federal Reserve Chair Jerome Powell emphasised that overall employment still remained 8.4 million below its pre-pandemic level and that the Federal Reserve System's policy was aiming to get those unemployed by the pandemic back to work; see Board of Governors of the Federal Reserve System (2021). Moreover, he added that the recovery remains uneven, with still very high unemployment rates in the service sector and among African Americans and Hispanics.

4.3 The design of an effective central bank reaction function, and implications for the ECB's monetary policy

According to the literature on optimal monetary policy, strict inflation targeting is optimal only when the central bank does not face meaningful policy trade-offs. The simple text-book New Keynesian framework (Galí, 2008, and Woodford, 2003) implies a trade-off between stabilising inflation and the output gap (which can be recast as an employment gap) only in the case of cost-push shocks, notably price and wage mark-up shocks. Instead, in the case of other types of economic shocks, stabilising inflation is equivalent to stabilising the welfare-relevant output gap (defined as the deviation of the level of actual output from the hypothetical level of output obtained in the absence of nominal price rigidities). In the simple New Keynesian model only two variables affect welfare: fluctuations of inflation and fluctuations of the output gap. For common economic shocks, such as productivity or preference shocks, the "divine coincidence" holds: by stabilising inflation perfectly, the central bank also stabilises the output gap perfectly, and strict inflation targeting emerges as the optimal policy. The divine coincidence is, however, a specific and not very realistic case.

For price or wage mark-up shocks, it is optimal for the central bank to tolerate some fluctuations of inflation around its inflation target in order to reduce fluctuations of the output gap.[117] In the simple New Keynesian framework, only such cost-push shocks justify expanding the list of policy goals assigned to the central bank and pursuing e.g. a flexible inflation targeting policy. These shocks generate a trade-off for the monetary authority by inducing time variation in the gap between the efficient and natural levels of output.[118] There are, however, also other potential sources of variation in this gap, such as fluctuations in labour income taxes. The extent to which the central bank can credibly commit in advance to future policy actions has important consequences for the economy's response to a cost-push shock. Commitment can help alleviate the trade-off between the output gap and inflation by lowering the initial impact of the cost-push shocks on inflation and causing smaller output gap fluctuations.

Once other realistic imperfections such as nominal and real wage rigidities are accounted for, strict inflation targeting is no longer optimal, even for standard preference or productivity shocks. The simple New Keynesian model may overemphasise the role of inflation stabilisation and understate the importance of stabilising the output gap because it ignores different labour market frictions that break the divine coincidence. In particular, in the presence of staggered wage setting, strict

---

[117] Illustrative scenario analysis using the large-scale semi-structural model EA-BDF of the Banque de France (see Zhutova, 2021) shows that a cost-push shock resulting in a 1% increase in the GDP deflator increases the central bank's loss under a Taylor rule that only stabilises inflation by 13%, compared with the case where the output gap is also stabilised. The loss function is computed as the equally weighted sum of squared annualised inflation and squared unemployment.

[118] The *efficient* level of output refers to the level of output in the equilibrium allocation of the decentralised New Keynesian economy under monopolistic competition and flexible prices once an appropriately chosen subsidy is in place to undo firms' market power, while the *natural* level of output corresponds to the flexible-price level of output. In the absence of real imperfections, they are the same. In line with these definitions, the welfare-relevant output gap is equal to the difference between actual output and the *efficient* level of output; see Galí (2008).

price inflation targeting can induce substantial welfare costs, due to excessive variation in nominal wage inflation and the output gap (Erceg et al., 2000, and Debortoli et al., 2019).

Wage rigidity is a key source of trade-offs between inflation stabilisation and the stabilisation of output or (un)employment, irrespective of whether search and matching frictions are modelled in detail or not.[119] Given that central banks have traditionally been concerned with the joint dynamics of inflation and unemployment, models which integrate search and matching frictions into the New Keynesian framework are of particular interest in studying optimal monetary policy. A key finding is that search and matching frictions alone do not alter the policy conclusion from the simple New Keynesian model that stabilising inflation is optimal. This is because, as long as wages are flexible, unemployment can still be stabilised by targeting inflation (Blanchard and Galí, 2010, and Walsh, 2014). When staggered wage-setting or explicit real wage rigidity are introduced, the central bank faces a trade-off between inflation and unemployment stabilisation (Thomas, 2008, and Faia, 2008, 2009). All models that include unemployment and are consistent with realistic labour market fluctuations imply that optimal policy is found somewhere between the two extremes of strict inflation targeting and unemployment stabilisation.

In the presence of material trade-offs, a medium-term policy horizon which caters for employment without compromising the primacy of price stability – consistent with the ECB's medium-term orientation – can lead to more favourable outcomes in terms of society's welfare than a short-term horizon focused on strict inflation stabilisation. The presence of a material inflation-employment trade-off gives rise to the pertinent question of whether (un)employment can, or should, be taken into account in the design of monetary policy when the primary objective of monetary policy is to stabilise inflation. In this regard, model-simulations (see Box 6) indicate that short policy horizons for stabilising inflation come with very high welfare losses to society irrespective of the precise loss functions for the central bank and society. The simulations also show that, for a medium-term policy horizon, explicitly considering unemployment in the central bank's loss function in addition to inflation is likely to achieve better outcomes in terms of society's welfare. This is consistent with the view that a policy oriented towards price stability in the medium term allows the central bank to take into account, to a flexible degree, other considerations that affect society's welfare such as concerns about employment.

However, a medium-term policy horizon may occasionally imply prolonged deviations of inflation from the central bank's inflation target and entail the risk of a de-anchoring of inflation expectations. If the medium-term horizon over which monetary policy is set to return inflation to the inflation target is prolonged due to other considerations, such as concerns about employment, long-term average inflation

---

[119] One advantage of search and matching models is that, contrary to sticky-wage models á la Erceg et al. (2000), they are not subject to Barro's critique, i.e. the idea that firms and workers could easily undo the allocative effects of sticky wages through Pareto-improving bilateral wage renegotiations given that they have an on-going relationship. If wages are not allocational, then wage rigidity does not influence model dynamics. By contrast, in a search and matching model, wages affect employment at the extensive margin, and in this kind of setting the Barro critique does not apply.

could drift away from the target level. Burdening the medium-term policy horizon with other considerations than inflation stabilisation could therefore create a de-anchoring risk for inflation expectations. Moreover, it may also create a communication challenge by increasing uncertainty among the public about the central bank's reaction function and policy aim.

Box 6
Can or should employment be taken into account in the design of monetary policy when the primacy is maintaining price stability?

This box presents illustrative model-based simulations addressing the pertinent question of whether employment can or should be taken into account in the design of monetary policy when the primary objective of monetary policy is price stability, as enshrined in the ECB's mandate. The simulations contrast outcomes under different central bank loss functions taking into account a pre-specified policy horizon for achieving price stability, following Smets (2003), and are thus consistent with a "hierarchical ordering" of policy objectives, with price stability being the primary one.[120] Yet the central bank is allowed to pursue other considerations, while maintaining the primacy of price stability. In particular, the central bank aims to minimise fluctuations in inflation and unemployment or, alternatively, the output gap in addition to meeting the price stability objective at the pre-specified policy horizon. The outcomes for different policy horizons are subsequently benchmarked against society's loss function, which approximates social welfare and minimises fluctuations in inflation and unemployment or, alternatively, the output gap.

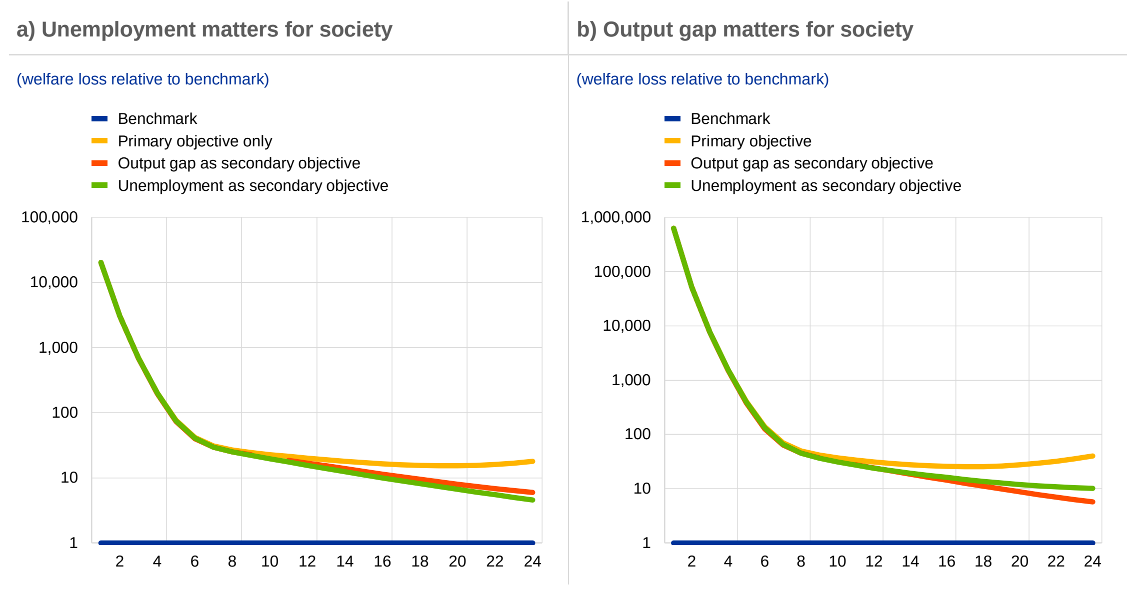
The simulations show that short policy horizons for stabilising inflation come with very high welfare losses for society irrespective of the precise loss functions for the central bank and society, but these losses are contained for increasingly longer horizons. As can be seen in Chart A, for short policy horizons, the loss function which approximates social welfare assumes high values for each case considered due to the unfavourable trade-off between stabilising inflation and stabilising the output gap or unemployment. This reflects the fact that, for short horizons, the distinction between a policy that focuses exclusively on price stability and a policy that also caters for unemployment or output gap stabilisation as a secondary objective does not matter because of the strict hierarchical ordering of policy objectives: the central bank is not allowed to trade-off other considerations against price stability. By contrast, lengthening the pre-specified policy horizon to at least two years allows the central bank to take into account, to a flexible degree, other considerations that enter society's welfare, such as unemployment or the output gap, even when these other considerations do not enter the central bank's loss function explicitly.

The simulations also show that for a medium-term policy horizon, society's welfare is higher when the central bank also gives some weight to unemployment stabilisation. Relative to a central bank adhering only to the primary objective, society's welfare is higher when the central bank takes into account not only fluctuations in inflation but also in unemployment. If society cares about unemployment as in the left panel of Chart A, it is better in terms of society's welfare for the central bank to also target unemployment. Likewise, if society cares about the output gap as in the right panel, it is better for the central bank to target the output gap in its loss function.

[120] The simulations are performed using an estimated dynamic stochastic general equilibrium (DSGE) model for the euro area with a labour market set-up featuring unemployment (Smets et al., 2014). They are based on the assumption that the central bank conducts optimal monetary policy under commitment.

Chart A

Society’s welfare across policy horizons for different central bank loss functions



Source: Eurosystem staff calculations based on simulations with a small-scale New Keynesian model.
Notes: This chart illustrates the role of the medium-term horizon for the conduct of monetary policy. Specifically, the central bank conducts optimal monetary policy under commitment and achieves the primary objective of price stability at a pre-specified policy horizon following Smets (2003). The central bank pursues a hierarchical ordering of objectives when minimising volatility in either unemployment (green) or the output gap (red) in addition to volatility in the policy instrument, i.e. the nominal interest rate. All results are evaluated in terms of a loss function for society, approximating society’s welfare, depending on inflation and either unemployment or the output gap. Indicated with “benchmark” (blue) is the fictious case that the central bank pursues a policy that minimises society’s loss function. “Primary objective only” (yellow) shows the case of a central bank only stabilising inflation at the pre-specified policy horizon while minimising volatility in the policy instrument. Losses are shown on a log scale relative to the benchmark (normalised to one).

4.4 Inflation and employment stabilisation in the presence of uncertainty

Uncertainty surrounding the measurement of slack in goods and labour markets is sizeable and can come from different sources. Output gaps are unobserved and typically need to be extracted from GDP data that are subject to revisions. This requires the use of an estimation procedure involving – implicitly or explicitly – the specification of a statistical or an economic model for potential output. Similarly, measures of labour market slack are based on unobserved concepts such as the NAIRU or an equilibrium level of employment that require operationalisation and estimation (see Chapter 2). These challenges render available estimates of goods and labour market slack highly uncertain and may result in recurrent and, at times, large revisions.

The literature on the optimal conduct of monetary policy in the presence of measurement uncertainty suggests attenuating the weight given to unreliable estimates of goods and labour market slack. Large and persistent measurement errors of the output gap have been identified as a key factor in explaining the policy mistakes in the 1970s that resulted in steep rises in inflation, especially in the United States (Orphanides, 2002, 2004). Lessons from the literature on the optimal conduct of monetary policy in the presence of measurement uncertainty suggest that these policy mistakes could have been avoided, at least in part, if policymakers had attenuated the weight given to unreliable indicators that enter the estimation of measures of goods and labour market slack (Svensson and Woodford, 2003). In a similar vein, it has been shown that a lower weight should be given to the stabilisation of unreliable output gaps relative to inflation, and that a more gradual approach in adjusting the stance of monetary policy should be pursued (Lippi and Neri, 2007).

Model-based simulations can help to gauge the macroeconomic consequences of mis-measuring the amount of slack in goods and labour markets. Compared with the simple price and wage Phillips curve analyses regularly used as a cross-check of the inflation and wage forecasts in the ECB and Eurosystem staff projections, model-based simulations of the macroeconomic impact of revisions in the amount of slack in goods and labour markets provide a general equilibrium perspective on the interaction of demand and supply factors underlying the revisions and, thereby, on endogenous adjustments in output and employment versus adjustments in prices and wages. This general equilibrium perspective is arguably also of relevance for adequately calibrating the monetary policy stance in response to revisions in the perceived amount of slack in the economy.

In particular, model-based simulations suggest that the consequences of mis-measuring the amount of slack can be sizeable, and that erring on the side of underestimating slack is more harmful in an environment where interest rates are near to the effective lower bound (ELB). Simulations with the ECB's NAWM (see Box 7) demonstrate that the consequences of underestimating the amount of slack in goods and labour markets can be sizeable, with inflation and both output and employment moving in opposite directions following revisions in the misperceived amount of slack. Moreover, in the current low-interest rate environment, the ELB on nominal interest rates is shown to impair the ability of monetary policy to support the economy in absorbing upward revisions in the amount of slack and to amplify the resulting fluctuations in inflation, output and employment in an asymmetric way. Compared with the consequences of underestimating goods market slack, the asymmetric effects due to the ELB tend to be more muted when underestimating labour market slack, especially if the price Phillips curve is flat. Consistent with these findings, the ramifications of underestimating slack, which was reflected in recurrent overpredictions of inflation, have been identified as one element of the causes of the lasting shortfall of inflation in the aftermath of the financial and sovereign debt crises (see Koester et al. (eds.), 2021).

Measurement uncertainty is compounded in the presence of uncertainty about fundamental macroeconomic relationships such as the Phillips curve and, especially, its slope and calls for a data-driven and state-dependent approach to monetary policy to avoid making policy mistakes. The "Brainard conservatism principle" (Brainard, 1967) calls for a more cautious monetary policy in the presence of parameter uncertainty affecting macroeconomic relationships. Yet more recent research suggests that optimal policy prescriptions are more nuanced, with policy responses that are robust to parameter uncertainty eventually being more responsive to fluctuations in inflation and output, or employment, than in the absence of uncertainty.[121] In particular, when uncertainty concerns the slope of the price Phillips curve, research shows that it is optimal for the central bank to alter its policy depending on the degree of persistence of the shocks affecting the Phillips curve (Ferrero et al., 2019). If the uncertainty is high, it is beneficial to remain patient and forego the temporary fluctuations in inflation and output, as an aggressive policy response could in practice destabilise inflation and output. In contrast, when the shocks are more persistent, the Brainard principle is reversed and a more aggressive response is warranted since it helps to keep inflation expectations anchored. Hence, it is advisable to pursue a data-driven and state-dependent approach to monetary policy in a changing economic landscape where the central bank is uncertain about fundamental macroeconomic relationships and the nature, size and persistence of shocks. Such an approach will also provide insurance against the risks of overheating and creating excessive inflation in the endeavour to reach full employment if the Phillips curve were to become steeper and private-sector expectations were to adjust in a disorderly fashion.

Box 7
Consequences of mis-measuring the amount of slack in goods and labour markets

Counterfactual simulations suggest that the consequences of underestimating the amount of goods market slack can be sizeable. In a first counterfactual simulation conducted with the ECB's NAWM, the underestimation of the true amount of slack in goods markets is linked to the underestimation of the level of potential output. The simulation is carried out around the baseline of the December 2019 Broad Macroeconomic Projection Exercise (BMPE).[122] Specifically, it is assumed that, at the beginning of the BMPE horizon, both private sector agents and the central bank realise that potential output in the third quarter of 2019 is actually one percentage point above the figure incorporated in the BMPE baseline, which translates into a proportionate downward revision of the output gap.[123] The left panel in Chart A shows the cumulated effects of the implied revisions on key macroeconomic variables. First, the marked increase in real GDP relative to the baseline reflects upwardly adjusted private sector demand owing to higher current and expected future income. Second, higher potential, which is tantamount to an increase in productivity, translates into diminished domestic price pressures via its downward impact on firms' production costs. However, because of the high degree of price rigidity in the model, which manifests itself in a flat price Phillips curve, firms' *desired* price adjustments are transmitted to actual price developments only sluggishly, even though noticeably. And third, both employment and wages are somewhat stronger. Stronger employment reflects an increase in labour demand commensurate with higher real GDP, whereas stronger wage

---

[121] There are two distinct approaches to characterising robust policymaking in the presence of parameter uncertainty: the Bayesian approach (e.g., Söderström, 2002) and the minmax, or robust control, approach (e.g., Giannoni, 2002, and Grasso and Traficante, 2021).

[122] The outbreak of the COVID-19 pandemic in early 2020 resulted in an exceptionally high level of uncertainty concerning the nature of the shocks and their propagation, which has been compounded by measurement issues and the deployment of unprecedented policy measures. As a consequence, the baseline paths of the subsequent ECB/Eurosystem staff projection exercises do not lend themselves easily to counterfactual model-based simulations of mis-measurement without appropriately adapting the model to the pandemic.

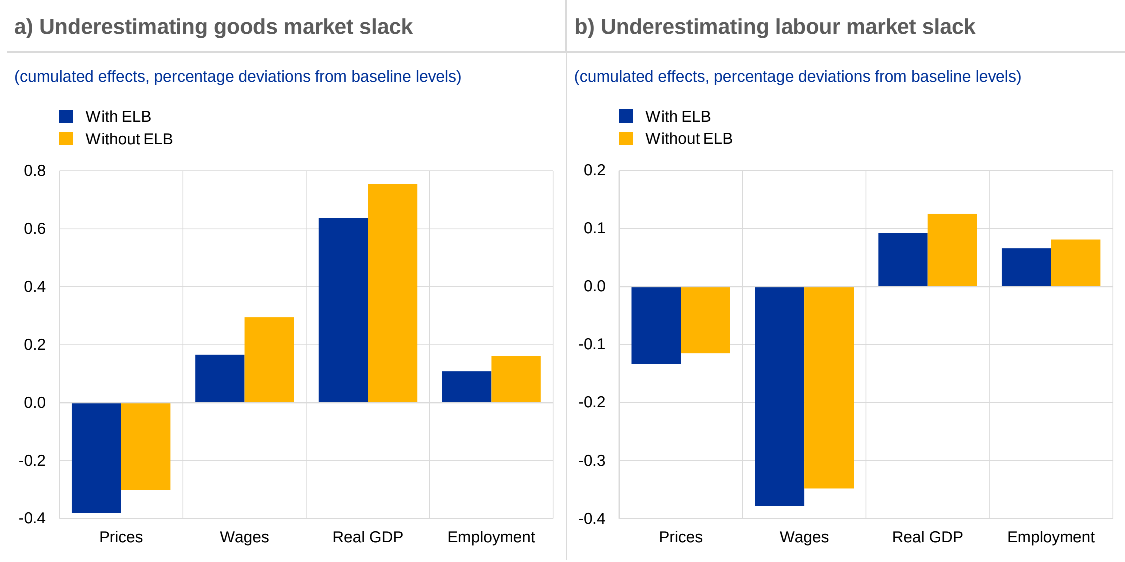
[123] The counterfactual is implemented via a sequence of upward revisions in the level of potential output by one-fourth of a percentage over a four-quarter period prior to the start of the BMPE horizon, consistent with a gradual correction of past estimation errors. With the historical data for real GDP not being affected, this translates into a proportionate downward revision of the output gap.

inflation is driven by the combination of increased labour demand and higher productivity. These two factors offset the downward impact on wages of weaker price developments.

The effective lower bound (ELB) on nominal interest affects the consequences of misperceiving goods market slack in an asymmetric way. Because of the downward revision of the output gap and the ensuing downward inflation pressures, the central bank in the counterfactual simulation would like to reduce the short-term nominal interest rate to provide additional monetary accommodation with a view to supporting the economy in absorbing the larger amount of slack. In the absence of the ELB, equal-sized downward and upward revisions in the output gap would result in effects that are equal in absolute value, but opposite in sign, because of the otherwise linear structure of the NAWM. However, as the short-term interest rate cannot be materially lowered as it is near the ELB, current and expected future real interest rates are increasing, curbing demand and aggravating downward inflation pressures. The extent of the impairment of the central bank's ability to support the economy can be inferred from the differing length of the bars for the simulations with and without taking into account the ELB. While the asymmetry in the present counterfactual simulation remains modest, it tends to rise with the magnitude of the underestimation of slack and the proximity of the interest rate to the ELB.

Chart A

Consequences of mis-measuring the amount of slack in the economy



Source: Eurosystem staff calculations based on simulations with the New Area-Wide Model (NAWM).
Notes: Panel a) of this chart depicts the cumulated macroeconomic effects of a one percentage-point upward revision in the perceived level of current and past potential output which translates into an equally sized downward revision in the output gap at the start of the simulations. Panel b) shows the cumulated effects of a widening of the employment gap by half a percentage point, which, within the model, is mapped into a corresponding wage gap using the steady state relationship between the employment gap and the wage mark-up as detailed in Galí et al. (2011). The relative size of the two gaps is broadly commensurate with Okun's law relationship. The simulations are carried out around the baseline projection of the December 2019 BMPE, either imposing the effective lower bound (ELB) on nominal interest rates (blue bars) or without imposing the ELB (yellow bars). In the simulations the ELB constraint is set equal to the minimum of the EONIA forward curve over the BMPE horizon. Prices are measured in terms of the private consumption deflator, and wages and employment correspond to compensation per employee and total employment, respectively.

In contrast, the asymmetric effects due to the ELB tend to be more muted when underestimating labour market slack, especially if the price Phillips curve is flat. A second simulation with the NAWM illustrates the consequences of underestimating the amount of labour market slack; see the right panel of Chart A. To this end, it is assumed that more favourable than foreseen labour supply developments have resulted in an upward shift in the equilibrium level of employment, leading to a widening of the employment gap. Within the model, the wider employment gap affects workers' wage-setting decisions and results in a lowering of wage contracts. Lower wages, in turn, lead to an increase in firms' demand for labour and diminish their production costs, with the latter giving rise to downward price adjustments. Ultimately, the increase in both labour supply and demand at lower wages and prices translates into higher employment and GDP. However, the overall increase in employment is rather moderate because of the fall in wages, and the only very gradual pass-through of wages to prices keeps the disinflationary effects contained. As a consequence, the asymmetric amplification effects due to the ELB are more muted compared with the case when the amount of goods market slack is misperceived.

4.5 The implications of make-up strategies for employment stabilisation[124]

The ELB impairs the stabilisation performance of monetary policy in a low interest rate environment, resulting in downward biases in inflation, output and employment, as well as heightened macroeconomic volatility. The secular decline in the long-run equilibrium real interest rate observed over the past decades has materially limited the room for commensurate interest rate reductions in the face of adverse shocks and has led to a marked increase in the incidence of episodes where interest rates are at or near the ELB. As a consequence of the induced asymmetry in the effectiveness of monetary policy at the ELB, inflation may remain systematically below the central bank's inflation target and output and employment may fall short of potential output and full employment, respectively. Moreover, the volatility of inflation, output and employment is likely to be materially heightened.

Make-up strategies, notably price level targeting and average inflation targeting, have been proposed as a possible means for central banks to overcome the impaired effectiveness of monetary policy in stabilising the macroeconomy in the presence of the ELB. They seek to compensate, at least in part, for past episodes of too low or too high inflation by temporarily aiming for a rate of inflation above or below the central bank's inflation target. The two best-known monetary policy strategies of this kind are price level targeting (PLT) and average inflation targeting (AIT). Under PLT, the central bank aims to keep the price level close to a pre-announced target path that grows at a rate consistent with the inflation target. Under AIT, the central bank aims to stabilise an average rate of inflation over a pre-specified time window. The longer the averaging window under AIT, the smaller the difference between AIT and PLT. A common element of these two strategies is that they make monetary policy "history dependent", in the sense that today's monetary policy actions depend on past inflation outcomes. In contrast, under standard inflation targeting (IT), past inflation levels are largely immaterial for today's

[124] This section builds on the model-based analysis presented in Work stream on the price stability objective (2021), Chapter 4, and the extensive review of the literature therein. The section first recalls key conceptual considerations regarding the working of make-up strategies, as well as the main findings concerning their efficacy in stabilising inflation, and then studies their implications for employment stabilisation.

policy actions ("bygones are bygones").[125] The history-dependent element of each make-up strategy is intended to act as a lever for the central bank's ability to influence private-sector expectations and thereby enhance the efficacy of monetary policy. In general, such policy instils a more persistent response to disinflationary shocks and is particularly relevant when the policy rate is at or near the ELB and cannot be materially lowered to provide additional accommodation in reaction to adverse shocks.

Model-based simulations make it possible to assess the performance of alternative make-up strategies in overcoming the impairments to effective macroeconomic stabilisation induced by the ELB. Model-based analyses have been carried out by conducting stochastic simulations with a suite of macroeconomic models for the euro area and following a common protocol to enhance the comparability of findings across models. The models, which are developed and maintained by Eurosystem staff, differ in terms of their specification, the set of variables covered and the empirical approaches employed, but remain within the New Keynesian tradition, with an important role for nominal wage rigidities and otherwise little detail on the labour market structure.[126] With a view to broadly capturing the present configuration in the euro area, the simulations assume an inflation target of 2%, a long-run equilibrium real interest rate of 0.5% (noting that this value lies at the upper end of the range of current estimates) and an ELB of -0.5%. The alternative make-up strategies are specified in the form of simple feedback rules that suitably augment an inertial Taylor-type interest rate rule which is representative of the standard IT approach.[127]

According to the simulations, make-up strategies can succeed in attenuating the negative biases in inflation and in reducing inflation volatility, albeit to a varying degree, with strategies that feature a higher degree of history dependence performing better overall. Chart 29 shows that, according to the median outcome of the model simulations (yellow circles), the PLT rule, which has the highest degree of history dependence, basically eliminates the negative inflation bias while also significantly reducing the elevated volatility of inflation (measured in terms of the standard deviation of inflation normalised with respect to the unconstrained IT rule). With regard to the two AIT rules, the inflation bias is smaller (in absolute terms) and the inflation volatility is reduced more strongly for the rule with the longer averaging window (of eight years as opposed to four).

[125] Alternative make-up strategies that have received attention are temporary price level targeting, when the policy rate is at the ELB, and nominal-GDP targeting. These strategies are beyond the scope of this section, as are asymmetric formulations of IT and AIT strategies which are designed to offset the asymmetry in inflation outcomes induced by the ELB. Further discussion of these strategies and some limited simulation results are provided in Work stream on the price stability objective (2021), Chapter 4.

[126] See Annex 2 for a list of the ten models and model variants used and the respective references.

[127] Details on the specification of the different interest rate rules and their parameterisation are reported in Annex 2. Additional explorative analysis suggests that including the shortfall of employment from full employment in the make-up rules may have the potential to further reduce the downward biases of employment and output resulting from the ELB, albeit at the cost of increasing volatility.

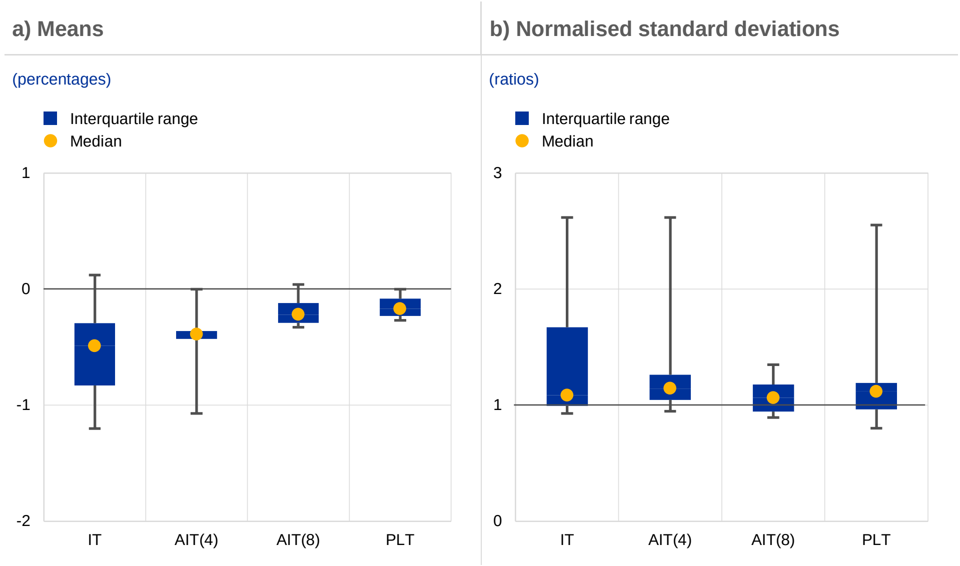
rigidities. Following a supply shock, the necessary adjustment in the real wage can occur through adjustments in prices and/or nominal wages, both of which are sticky. To the extent that make-up strategies stabilise the price level effectively, they force much of the burden of real wage adjustment onto nominal wages, leading to large fluctuations in nominal wages, employment and economic activity, as shown by Walsh (2019). The magnitude of this effect again depends on the specification of the interest rate rule representing the respective strategy.[129] In this context, it is noteworthy that asymmetric variants of make-up strategies such as temporary PLT, which are adopted only when the ELB binds, may have the potential to more generally mitigate the supply shock-driven amplification of employment fluctuations, as the central bank would not attempt to make up for surges in inflation following adverse supply shocks by forcing inflation to fall below the inflation target, which in turn would depress employment.

Consistent with the findings concerning employment stabilisation, make-up strategies tend to lower average levels of unemployment in the presence of the ELB, while at times increasing unemployment volatility. Within the set of New Keynesian models employed in the comparative simulation exercise, nominal wage rigidities are the primary source of labour market frictions, with only two of them modelling the labour market and unemployment explicitly, based on the extension of the New Keynesian approach by Blanchard and Galí (2010) and Galí et al. (2011). As nominal wage rigidities remain the main friction in these models, the simulation results for unemployment closely resemble those for employment: AIT and PLT strategies tend to give rise to lower average levels of unemployment but result in higher unemployment volatility.

[129] Bodenstein and Zhao (2019) analyse a cost-push shock and a productivity shock, both of which move inflation and the output gap in opposite directions in the presence of sticky nominal wages. They show that in an optimal policy setting where the weight on the output gap in the central bank's reaction function is optimised, PLT outperforms IT in terms of welfare in the presence of cost-push shocks. In the presence of productivity shocks, IT does slightly better than PLT, hinting to an increased variability of economic activity in the case of PLT, despite the optimal policy setting.

Chart 30

The implications of make-up strategies for employment stabilisation



Source: Eurosystem staff calculations based on simulations with a suite of macroeconomic models. See Table A2.1 in Annex 2 for details.
Notes: This chart depicts boxplots of the means and the standard deviations for the probability distributions of employment that are obtained by carrying out stochastic simulations around the models' non-stochastic steady state with an annual inflation rate of 2% and an annualised equilibrium real interest rate of 0.5%. The simulations are conducted for alternative make-up strategies, notably average inflation targeting (AIT) with a four or an eight-year averaging window, and price level targeting (PLT), taking into account the ELB constraint set at -0.5%. Inflation targeting (IT) serves as the benchmark strategy for assessing the effectiveness of the make-up strategies. See Table A2.2 in Annex 2 for details. The standard deviations for the individual models are normalised by the standard deviations obtained under the IT strategy, without taking into account the ELB constraint. Employment is measured in terms of total employment or hours worked and reported in terms of deviations from the models' respective steady state values.

These findings extend to a model with richer labour market dynamics. In the models considered in the comparative simulation exercise, employment only varies at the intensive margin, i.e. the only margin of adjustment is that of hours worked. In order to allow for variation in employment at the extensive margin, Bonam et al. (2021) consider a New Keynesian model with search and matching frictions in the labour market. As a result, the model features involuntary unemployment.[130] Consistent with the evidence from the comparative simulation exercise, make-up strategies lead to marginally higher average levels of employment (as a share of the labour force) when compared to the benchmark IT strategy. Moreover, make-up strategies are found to moderately reduce labour market volatility along both the intensive and extensive margin, and strategies with a higher degree of history dependence are associated with higher levels of employment.

While the model-based simulations support the case for make-up strategies as a means to address employment shortfalls due to the ELB, it should be recalled that the effectiveness of make-up strategies in general, and at times their ranking, depends on the way private-sector expectations are formed – with more backward-looking expectations generally lowering but not eliminating the stabilisation benefits – as well as on whether they are well understood by the private sector and their credibility. A number of important caveats apply concerning

130 The model also allows for endogenous firm entry, thus accounting for the fact that a sizeable share of job destruction and creation can be attributed to the entry and exit of firms into the market.

the environment in which make-up strategies are likely to be effective in improving macroeconomic performance. In particular, if private-sector expectations are myopic, or if private-sector expectations fail to adjust in a strategy-consistent manner because the strategy is not fully credible or not well understood, then make-up strategies are less effective at providing accommodation during ELB episodes. In models with hybrid forms of expectations formation, which augment forward-looking expectations with a material backward-looking element, make-up strategies tend to preserve some of their potency in attenuating the adverse consequences of the ELB constraint, albeit at a markedly lower level than in models with primarily forward-looking and strategy-consistent expectations.[131] Allowing for such deviations from the standard forward-looking expectations assumption may at times change the ranking of the make-up strategies in terms of their stabilisation performance, especially concerning the volatility of output and, by implication, employment and unemployment.

131 See the sensitivity analysis summarised in Work stream on the price stability objective (2021), Box 8.

5 The role of employment heterogeneity for the conduct of monetary policy

5.1 Employment heterogeneity and monetary policy

In this chapter, we analyse how employment heterogeneity affects the transmission and design of monetary policy. Relative to non-heterogeneous settings (i.e. models in which a single household represents the whole macroeconomy), economies with households that differ in skills, productivity, geographical location, labour incomes, marginal propensities to consume out of incomes, uncertainty or asset holdings can react differently to public policies and macroeconomic shocks. Accordingly, considering employment heterogeneity in monetary policy offers important and realistic insights about developments in aggregate demand, business cycle dynamics and the transmission and design of monetary policy.

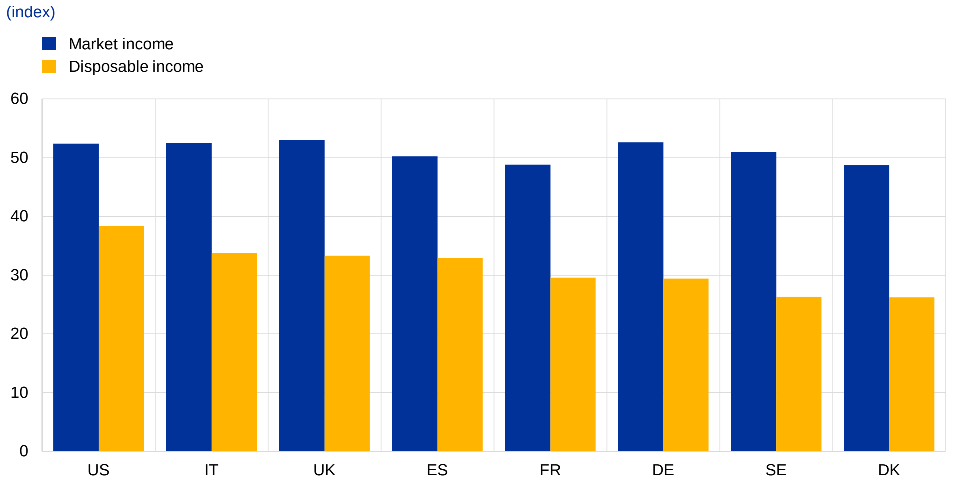
Employment heterogeneity affects the propagation of business cycle dynamics. A key source of household and employment heterogeneity in advanced economies over the last 40 years has been the increase in income inequality and the substantial premium attached to education levels, which has only been moderately alleviated by taxes and transfers (see Chart 31). Empirical evidence also suggests that inequality rises in downturns and falls in upturns, that wealthy households adjust their savings rates and marginal propensities to consume in accordance with prevailing economic conditions, and that poor households may not be able to save at all, having to adjust their expenditures to changes in employment and income in response to economic fluctuations. In heterogeneous settings, monetary policy therefore affects households asymmetrically and (on account of economic downturns increasing income inequality) may have stronger aggregate demand effects.

Firm heterogeneity is also significant for employment developments and monetary policy transmission. When firms face heterogeneous financing conditions, the impact of an output shock on employment is amplified, with monetary policy playing a role in cushioning employment adjustment over the business cycle (see Box 8).[132]

[132] Labour market frictions associated with the cost of hiring workers and letting workers go can lead to a situation where it is optimal for certain firms to hold onto workers (“labour hoard”) during downturns. The dampening effects of such practices on overall volatility have been long documented (Burnside et al., 1993) and recent studies have shown that the cyclical sensitivity of employment is higher for disadvantaged groups of workers than for other groups (Aaronson et al., 2019).

Chart 31

Gini coefficients across advanced economies



Source: ECB staff calculations on World Inequality Database (WID).
Notes: Gini coefficient computed on pre-tax and transfers and post-tax and transfers income. This chart is based on data for 2017.

Box 8
Firm-level heterogeneity – the effect of financing conditions on labour demand and the impact of monetary policy

This box assesses the impact of monetary policy on firms' labour demand in an empirical framework that explicitly accounts for firms' heterogeneity. We find that an important source of heterogenous labour demand across firms is driven by the degree to which firms are financially constrained: financially-constrained firms tend to adjust employment more in response to an output shock and, as a result, show limited ability to "labour hoard''. By means of an instrumental variable approach using high-frequency monetary policy surprises as instruments, we show that for a given change in output, a monetary policy-driven reduction in credit market frictions across firms supports labour hoarding and, as a result, reduces employment volatility. Simulation exercises indicate that a reduction of 100 basis points in the interest rate spread faced by firms in the highest percentiles of the distribution would reduce the variance of aggregate employment growth by about 10%.

Over the last decade, the role of individual firm heterogeneity in explaining macroeconomic and labour market aggregate outcomes as well as earnings inequality has garnered considerable attention. This heterogeneity has been shown to explain much of the rise in earnings inequality among workers, fluctuations in GDP growth, unemployment dynamics, international trade, aggregate prices, market power and monetary policy transmission, as well as the impact of climate change-related shocks.[133]

Firms, workers and households respond heterogeneously to changes in the macroeconomic outlook, with firms adjusting employment levels to different degrees. While firm heterogeneity is marked even within very narrowly defined industries[134], the source of the heterogeneous response

[133] See Haltiwanger and Spletzer (2020); Song et al. (2018), Barth et al. (2016); Gabaix (2011); Moscarini and Postel-Vinay (2012); di Giovanni et al. (2014); Amiti et al. (2019); Akcigit et al. (2021); Auer et al. (2019); Bijnens et al. (2021).

[134] See Syverson (2011).

by firms is important. If it is driven by the different productivity levels of firms, this leads to positive aggregate outcomes[135], but if it reflects unfavourable macro-financing conditions, then the heterogeneous response has a negative impact on employment[136].

One mechanism explaining why certain firms adjust employment more in response to an output shock – i.e. have limited capacity to labour hoard – is the interaction between labour market and credit market frictions. Labour hoarding is a practice whereby it is optimal for certain firms to hold on to workers during downturns, which in turn results in their hiring fewer workers during upturns. This practice reflects the presence of labour market frictions, such as search costs associated with hiring workers and severance pay when letting workers go. The dampening effects of labour hoarding on overall volatility are well documented; recent studies have shown that the cyclical sensitivity of employment for disadvantaged groups of workers is higher than for more advantaged groups.[137] Nonetheless, there is less empirical evidence capturing how credit market frictions via firms' financing conditions help explain the degree to which firms are able to engage in labour hoarding. The logic behind the mechanism is that a firm will need to invest[138] in excess labour for a certain period and that the optimal level of hoarding can only be obtained if the firm has the necessary financing capacity to do so. When an output shock materialises, firms that face tighter financing conditions adjust employment more – i.e. are less able to obtain their optimal level of labour hoarding – than less financially constrained firms. This mechanism has been shown to be fairly symmetric, with only minor differences between the elasticity in upturns and downturns at the firm level.[139] Moreover, there are repercussions for the overall labour market, insofar as the ability of monetary policy to stabilise output and employment over the business cycle might be weakened when firms' financing conditions exhibit an excessive degree of fragmentation. In addition, it may be optimal for governments to implement policies that support firms' ability to hoard labour when faced with pronounced output shocks.[140]

This box examines both how firms' financing heterogeneity amplifies the impact of an output shock on employment, and the role of monetary policy in attenuating this heterogeneity and thereby reducing employment volatility. To this end, we use a workhorse model from empirical labour economics that focus on the elasticity of employment as a function of firm-level output.[141] We

---

135 See Hopenhayn (1992).

136 See Cantor (1990); Benmelech et al. (2011); Giroud and Mueller (2017).

137 See Burnside et al. (1993); Aaronson et al. (2019).

138 Over the past decades a large literature has been developed on how financially constrained firms have larger reactions to monetary policy shocks (e.g. Bernanke and Gertler, 1995; Hutchinson and Xavier, 2006) and how this affects corporate investment (e.g. Fazzari et al., 1987).

139 See Bäurle et al. (2018). By focusing on the symmetry with respect to the macro cycle, however, we find using our dataset that the overall elasticity of employment with respect to changes in output was approximately 1 percentage point higher during the global financial crisis compared with later years, which indicates that firms were more inclined to lay off workers during the Great Recession than they were to hire them during the subsequent recovery. This result is consistent with the findings from the literature emphasising the Great Recession's long-lasting effects on credit markets, unemployment and output ("secular stagnation"). See Kozlowski et al. (2020).

140 See Giroud and Mueller (2017). Recent furlough schemes implemented across Europe in the wake of the coronavirus (COVID-19) pandemic can be regarded as subsidies for labour hoarding.

141 See Bäurle et al. (2018), Nickell (1987) and Hamermesh (1993). They estimate the conditional labour demand equation $emp_{it} = (\mu_1 emp_{it-1}) + \mu_2 wage_{it} + \mu_2 output_{it} + \xi X_{it} + \epsilon_{it}$ with X_{it} being a vector of control variables. emp_{it-1} can be included to account for dynamic effects. The coefficient of interest is μ_2, which represents the elasticity of employment in function of output. $output_{it}$ interacts with monetary policy pass-through (spread between firm-level interest rate and 12-month EURIBOR). The model is estimated in first differences. For monetary policy pass-through the endogenous variables $output$ and *spread* are instrumented with the sectoral change in output (excluding the firm itself) and monetary policy surprises from the Euro Area Monetary Policy Event-Study Database.

estimate the model by combining financial and employment data of approximately 200,000 manufacturing firms from the Orbis database (2008-2017 for Belgium, Denmark, France, Italy and Netherlands) with novel data from the Euro Area Monetary Policy Event-Study Database that allows for identifying monetary policy shocks based on an instrumental variable approach using high-frequency monetary policy surprises as instruments.[142]

We find that for a given change in output, reducing credit market friction by restoring a more homogenous monetary policy transmission to firms' financing conditions supports labour hoarding and, as a result, reduces employment volatility (see Chart A, panel a). We construct a firm-level measure of financing conditions linked to monetary policy pass-through, which is defined as the spread between the individual firm's cost of borrowing and the 12-month EURIBOR – the main reference rate for pricing loans to non-financial corporations in the euro area. As this spread will be correlated with a host of factors unrelated to monetary policy that might simultaneously affect firm-level performance, we use the monetary policy surprises from the Euro Area Monetary Policy Event-Study Database to identify the impact of monetary policy transmission via instrumental variable estimation.[143] We find that for a given change in output, the more impaired the transmission of monetary policy to firms' financing conditions, the fewer firms can hoard labour. Conversely, restoring a more homogenous monetary policy transmission to firms' financing conditions can lead to a more favourable degree of labour hoarding across firms. Interestingly, we find that it is not the absolute level of a firm's interest rate that is significant for its capacity to labour hoard, but rather its relative value compared to the EURIBOR.[144]

Simulation exercises indicate that the effect of monetary pass-through on labour hoarding is quantitatively important for aggregate employment volatility. Panel b) of Chart A illustrates the distribution of firm-level interest rate spreads (black line). We simulate a linearly increasing reduction of the spread for all firms with a spread above the median, such that a firm at the median sees no reduction and a firm at the 90th percentile sees a reduction of 1 percentage point. This condenses the right-hand side of the distribution (red line) and results in a reduction of the variance of aggregate employment growth by approximately 10%.

[142] See Altavilla et al. (2019).

[143] More specifically, we use the monetary policy surprises estimated by Altavilla et al. (2019) as instruments for the euro area overnight index swap (OIS) yields and German, French and Italian sovereign yields, at two-year, five-year and ten-year maturities. The selected instruments cover the full maturity range, hence arguably reflecting the full set of monetary policy instruments deployed by the ECB over recent years (negative rate policy, forward guidance, asset purchase programme (APP)). Including not only the risk-free rate (OIS) but also individual country sovereign yields allow to capture both dimensions of the monetary policy impulse, namely the stance (injecting additional accommodation) and the transmission (addressing impairments in the transmission mechanism across credit segments and countries).

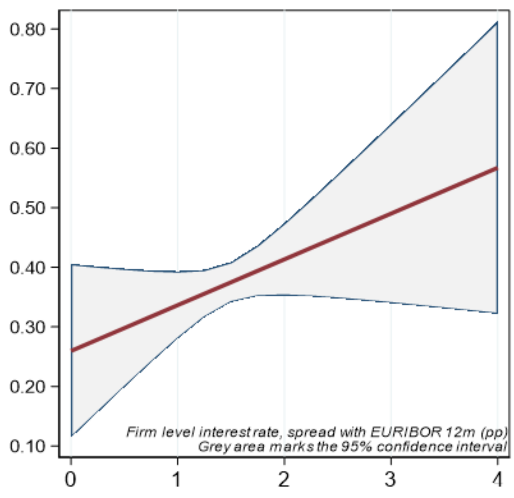
[144] This does not imply that the level of the EURIBOR is not relevant to firms, as its impact is typically captured through fixed effects.

Chart A

Monetary policy transmission (left panel) and actual and counterfactual distribution of the firm-level interest spread (right panel)

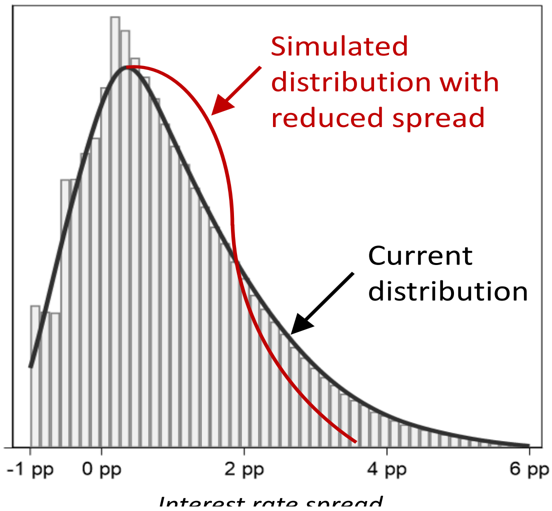
a) Monetary policy transmission

(percentage points)



b) Actual and counterfactual distribution of the firm-level interest spread

(percentage points)



Source: Bijnens, Hutchinson and Saint Guilhem (2021).
Notes: In panel a), the y-axis represents elasticity of employment with respect to an output change. A value of 0.2 implies that a firm will increase/decrease its employment by 2% when output increases/decreases by 10%. The grey area marks the 95% confidence interval. In both panels, the x-axis represents the spread between the firm-level interest rate and the 12-month EURIBOR. A normal distribution is fitted to the data (black line). A counterfactual distribution (red line) approximates the distribution if the spread of a firm at the 90th percentile is lowered by 1 percentage point.

Heterogeneity across households and firms can affect the design of optimal monetary policy. It can strengthen the case for more persistent or forceful easing policies, including asymmetric or make-up strategies, in response to demand shocks that, in a low-equilibrium interest rate environment, heighten the risk of monetary policy becoming constrained by the effective lower bound (ELB) on interest rates; it can propagate the impact of unconventional monetary policy instruments by boosting employment; and monetary policy may become more effective by also responding directly to changes in inequality. In fact, distributional considerations appear to have contributed to the Federal Reserve System's revising its definition of maximum employment as a broad-based and inclusive goal following its framework review.[145] In this framework review the Federal Open Market Committee discussed a study by Feiveson et al. (2020) showing that make-up strategies generate larger aggregate stabilisation effects and can be more effective in overcoming ELB constraints in a model with heterogeneous agents (compared with one with a representative agent).

[145] The Federal Reserve System now defines maximum employment as the highest level of employment that does not generate sustained pressures that put its price stability mandate at risk. The Board of Governors of the Federal Reserve System's "Statement on Longer-Run Goals and Monetary Policy Strategy" (2020a) further clarifies the concept of maximum employment as follows: "The maximum level of employment is a broad-based and inclusive goal that is not directly measurable and changes over time owing largely to nonmonetary factors that affect the structure and dynamics of the labour market. Consequently, it would not be appropriate to specify a fixed goal for employment; rather, the Committee's policy decisions must be informed by assessments of the shortfalls of employment from its maximum level, recognizing that such assessments are necessarily uncertain and subject to revision. The Committee considers a wide range of indicators in making these assessments."

Specifically, such strategies were shown to generate disproportionate improvements for disadvantaged households.

When factoring heterogeneity into macroeconomic modelling (instead of assuming one representative household) incomplete markets and uninsurable employment-income risk become crucial in understanding monetary policy transmission. In a representative agent economy, changes in real interest rates trigger a reallocation of consumption and savings over time (the intertemporal substitution channel). Households can borrow or save as much as needed to keep their consumption stable over time and all of them consume the same amount of goods. When, by contrast, households are heterogeneous, some of them are not able or do not want to borrow or save to keep their consumption stable as a result of unemployment or variations in labour income. As firms respond to the interest rate changes by altering their demand for labour, wages and employment flows change, with poorer households being more heavily affected.[146]

Lower-income households and those with few liquid assets have a higher marginal propensity to consume (MPC) out of income, so their spending is particularly sensitive to income and wealth shocks – and to monetary policy. A large body of literature supports the differences in MPCs, based on various microdata sources (e.g. household surveys, administrative data and internet-based data on financial accounts) that analyse numerous instances of fiscal rebates and effects of regular income shocks.[147] Rich households (in terms of income or liquid wealth) save at a higher rate out of their income (low MPC) and are therefore less sensitive to economic shocks (see Chart 32 left panel). Poor households may not be able to save at all (high MPC) and will adjust their expenditures according to how their employment and disposable income change with such economic shocks. To illustrate the empirical relevance of differences in MPCs, the right panel of Chart 32 reproduces estimates of MPCs across income and skill groups for the four largest euro area economies. Considering, in addition, that income inequality increases during recessions and decreases during recoveries (i.e. it is countercyclical), and that, according to these differences in MPC estimates, lower-income (constrained) households have higher MPCs, heterogeneity amplifies the effects of aggregate shocks.[148] The same effects apply to the transmission of monetary policy; empirical work using regional and sectoral data indeed confirms that monetary easing stimulates incomes of

---

146 Kaplan et al. (2018) show that while both the intertemporal substitution and labour income channels are active in both heterogeneous agent New Keynesian (HANK) and representative agent New Keynesian (RANK) models, the intertemporal substitution channel accounts for most of the transmission in a RANK model, while the labour income channel determines almost all of the transmission in a HANK model. The relative importance of these two factors depends on the households' MPCs, which in turn depend on the extent to which the households are able to insure against different types of risk.

147 See, for example, the review of the empirical literature by Jappelli and Pistaferri (2010).

148 The conceptual analysis can be done in a model with simple heterogeneity (a "two-agent New Keynesian (TANK)" model, in which one agent represents the unconstrained households with low MPCs and the other represents constrained households with high MPCs, or in a model with "tractable" heterogeneity which can be solved analytically; see, for example, Bilbiie (2020). Werning (2015) studies the links between the cyclicality of income risk and aggregate demand. Quantitative analysis of heterogeneity requires more realistic HANK models which are able to capture relevant features of microdata (e.g. idiosyncratic income risk, search and matching frictions, and illiquid assets) and need to be solved numerically. The next sections present analysis with such realistic HANK models. Gornemann et al. (2016) is an early example of a HANK model in which matching frictions render labor market risk countercyclical and endogenous to monetary policy.

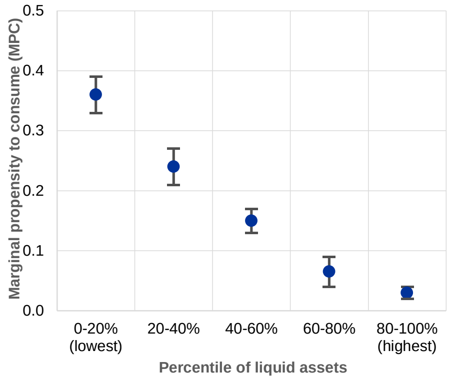
lower-income regions and groups of workers with lower labour force attachment particularly strongly.[149]

Chart 32

Differences in marginal propensities to consume out of income across income brackets (left panel) and estimated MPC distribution across four euro area countries and across income and education groups in response to a 1% shock to transitory income (right panel)

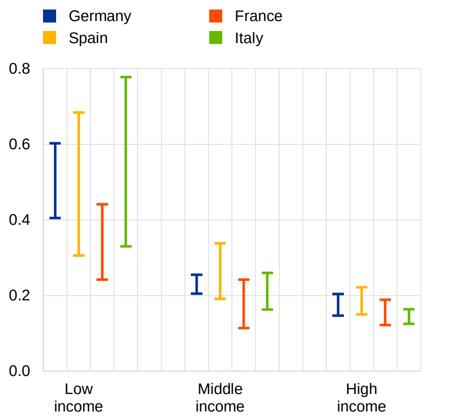
Differences in marginal propensities to consume out of income across income brackets

(percentiles)



Estimated MPC distribution across four euro area countries and across income and education groups in response to a 1% shock to transitory income

(whisker diagram)



Sources: Left panel: Ganong et al. (2020) and US data; Right panel: Ampudia et al. (2018).
Notes: Left panel: This chart shows that the marginal propensity to consume non-durable goods out of transitory income shocks declines with holdings of liquid assets. The horizontal lines show the 95% confidence intervals. Right panel: The whisker plots summarise the distribution of MPC in response to a 1% transitory income shock. The three columns (low, middle and high income) represent three levels of permanent income. The minimum and maximum (horizontal lines) respectively represent MPC for high and low educational attainment for all households as well as those participating in asset markets.

In addition to the heterogeneity in MPCs, substantial empirical evidence suggests that lower-income households are more sensitive to aggregate shocks, facing greater unemployment risk and income fluctuations. First, unconditional evidence on correlations between individual incomes and aggregate incomes ("worker betas"), as illustrated in Chart 23 and reviewed in Chapter 3, indicates that incomes and employment rates of households in the lowest income quintile are more than twice as sensitive to aggregate income changes as those of households in the higher income quintiles.[150] Analogous evidence shows that perceived labour income uncertainty is likewise higher for lower-income households. Second, there are broadly similar findings with regard to the effects of monetary policy shocks (not just unconditionally): employment and incomes of lower-income

[149] See, for example, Nittai et al. (2021); Böck et al. (2020) and Hauptmeier et al. (2020).

[150] Guvenen et al. (2017) estimate a U-shaped exposure of individual earnings to aggregate GDP growth for the United States, which rises in the top tail (above the 99th percentile of earnings). Similarly, Amberg et al. (2021) use administrative data for Sweden, essentially covering every Swedish tax resident for the period 1998-2018, to show a similar U-shaped response to monetary policy. Unfortunately, to our knowledge, corresponding evidence on the exposure for the highest income percentiles from euro area countries is not available because of data limitations.

households substantially increase in response to surprise monetary easing.[151] The bulk of the increases in income at the bottom of the distribution are due to unemployed workers finding new jobs (i.e. the extensive margin), rather than increases in wages of all existing workers. This empirical evidence also underpins the modelling framework for quantitative policy analysis in the following sections.

Differences in income risk (e.g. faced by high or low-income households) are also significant for monetary policy transmission. Fluctuations in income uncertainty amplify aggregate shocks as households that are unable to insure themselves against income fluctuations increase precautionary saving and reduce consumption. Lower-income households are particularly exposed to the effects of higher labour market uncertainty (see Chapter 3). The size of these effects depends on the ability of households to insure against their income risk, and hence on the size of liquid asset holdings and their distribution across households, meaning that these effects are stronger for households with few liquid assets. These differences also matter for the transmission of monetary policy because they drive the "earnings heterogeneity" channel, which is one of the key indirect channels of transmission.[152] Chart 33 both panels, and Chart 34 show that the bulk of the fall in unemployment and increases in income gains on account of monetary easing occurs in poorer households – and that these income gains are almost exclusively due to their employment income.[153]

The expectations channel can be attenuated in a heterogenous agent setting – but whether overall forward guidance is strengthened or weakened in a HANK model (and whether make-up strategies are effective) is highly model-specific. In a model with complete asset markets, the intertemporal substitution channel amplifies the macroeconomic effects of forward guidance announcements. The same channel is active in an incomplete markets model with heterogenous agents, but not all households can immediately increase their consumption, owing to their lack of

---

[151] For evidence for Germany, see Broer et al. (2020). For the euro area, see also Lenza and Slacalek (2018). Applying the same methodology to Finnish household data and focusing on asset purchases as a monetary policy instrument, Mäki-Fränti et al. (2021) find that in response to expansionary monetary policy, low-income households disproportionately benefit from employment gains, whereas high-income households benefit more in terms of wage gains, with the net effect on inequality being small but positive, owing to the comparatively stronger impact of monetary easing on wages than on employment (see Chart 8). Likewise, Casiraghi et al. (2018), using a micro dataset on the income and wealth of Italian households, show that larger benefits accrue to households at the bottom of the income scale.

[152] Monetary transmission consists of two groups of channels: direct and indirect. Indirect, general equilibrium channels refer to the transmission of shocks via the responses of prices and wages, and hence of labor income and employment, to the policy shock. These indirect channels make up roughly 60% of the effect of monetary policy on aggregate consumption and are dominant for constrained, lower-income households (see, for example, Kaplan et al., 2018) and Slacalek et al., 2020). In contrast, direct effects, such as intertemporal substitution, arise through the immediate, partial-equilibrium consequences of the change in interest rates for households, holding their labour income fixed. Direct effects of monetary policy have been extensively studied in representative agent New Keynesian models.

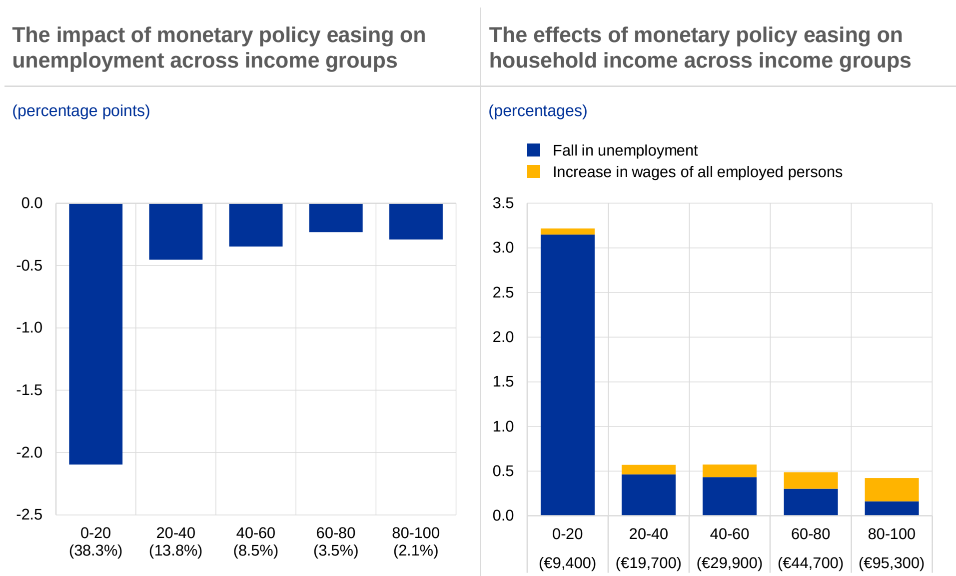
The literature suggests that inequality is relevant for the transmission of monetary policy if the economy features a large proportion of agents with close to zero liquid wealth. This is in line with the data for many advanced countries; see Kaplan et al. (2018). These agents are not sensitive to interest rate changes, but significantly change their consumption in response to changes in income. In this case, monetary policy is not transmitted to the economy through the conventional interest rate channel (direct effects), but through general equilibrium forces, namely, the responses of prices and wages, and hence of labor income and employment (indirect channels), to the policy shock.

[153] See Chart 24 in Chapter 3, which shows that about 25% of households in the lowest income quintile would not have enough resources to finance their spending on necessities after two months of an unemployment shock.

access to financial markets or to the risk of their borrowing constraint becoming binding for a too-large increase in consumption. Monetary policy then works also through the income channel; however, in a realistic calibration wages are negotiated infrequently and there are frictions to increasing employment, leading to lags in transmission (McKay et al., 2016). In contrast, firms have access to financial markets and can respond more strongly to forward guidance, despite adjustment costs. However, when profits are small and not redistributed back to households, and furthermore at least some of the government debt is nominal, the forward guidance puzzle is attenuated (Hagedorn et al., 2019). Finally, wealthier households with access to financial markets prefer to hold some precautionary savings as a buffer for future income shocks, an effect that dampens forward guidance, as they do not fully increase their consumption. Some recent evidence points to amplification of the forward guidance puzzle in incomplete market models. Higher elasticity of consumption by poor households in response to monetary policy is one driver of this effect (Bilbiie, 2020). When the income risk is countercyclical, forward guidance is amplified (Acharya and Dogra 2020).[154]

Chart 33

The impact of monetary policy easing on unemployment across income groups (left panel) and the effects of monetary policy easing on household income across income groups (right panel)

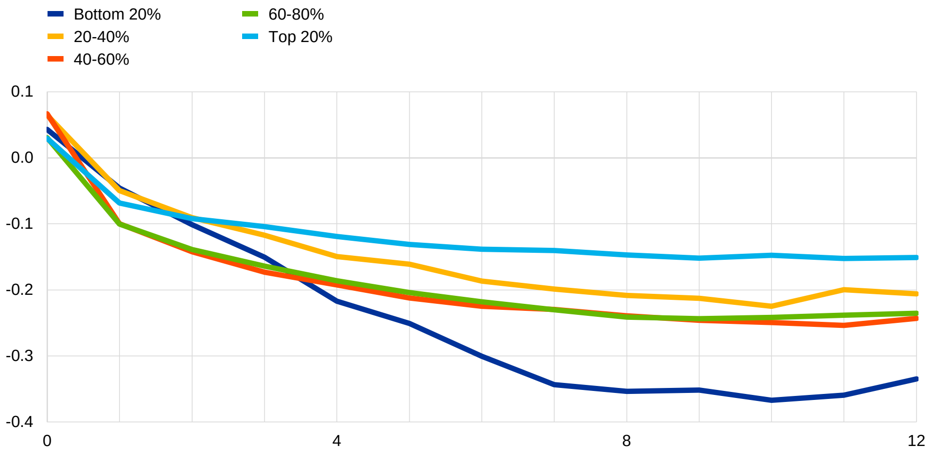


Source: Lenza and Slacalek (2018).
Notes: Left panel: This chart shows the estimated decline in unemployment rate for each quintile of household income distribution four quarters after the materialisation of the asset purchase programme (APP) shock. The figures in parentheses show the initial unemployment rate for each quintile. Euro area aggregated data for Germany, Spain, France and Italy. Right panel: This chart shows estimates of the percentage change in mean gross household income for each quintile of household income distribution four quarters after the materialisation of the APP shock. The figures in parentheses show the initial level of mean gross household income for each quintile. Euro area aggregated data for Germany, Spain, France and Italy.

[154] Bilbiie (2019) also shows that even if income risk is countercyclical and consumption of poor households increases more in response to increased demand, price level targeting resolves the forward guidance puzzle.

Chart 34

The impact of asset purchases on unemployment across different income groups in Finland



Source: Mäki-Fränti et al. (2021).
Notes: This chart shows the estimated unemployment rate response to an expansionary quantitative easing (QE) impulse of 25 basis points by gross household income quintiles. The x-axis shows the time horizon in quarters.

The heterogeneous agent models used for policy analysis in the following section account for various heterogeneities in wealth, income, and employment, making it possible to quantitatively analyse the effects of demand and supply shocks and monetary policy (and to compare them to the effects in the representative agent set-up).[155] Fernández-Villaverde et al. (2021) calibrate and partially estimate a heterogeneous agent New Keynesian (HANK) model that aims to match selected stylised facts found in the literature on US business cycles and inequality. While households are subject to idiosyncratic shocks that determine the efficiency unit of hours supplied by each household, there are no unemployed households and therefore no unemployment gap measure exists. This feature stands in contrast to the other models considered in the exercises, all of which feature an unemployment gap that is defined as the difference between observed unemployment and its steady state value. Herman and Lozej (2021) calibrate a HANK model that aims to match stylised facts on employment risk dispersion over the business cycle in the euro area economy. Ferrari et al. (2021) estimate a HANK model on euro area business cycles. Den Haan et al. (2021) calibrate a HANK model with an age structure and structural parameters in line with the euro area business cycle literature. Abbritti and Consolo (2021a) calibrate a two-agent New Keynesian (TANK) model to match first and second moments of euro area macroeconomic time series and the historical incidence of hitting the effective lower bound. Jacquinot et al. (2018) have developed a multi-country dynamic stochastic general equilibrium (DSGE) model, similar to the standard euro area and global economy (EAGLE) model, but with search and matching frictions on the labour market that differ across countries. While it is not a HANK model, it addresses cross-country heterogeneity on the labour market.

155 A detailed overview of all models with explanations of the sources of inequality and the channels through which inequality affects the business cycle and shock transmission dynamics is included in Annex 3.

Model settings with labour income heterogeneity may imply that – depending on the nature of the shock hitting the economy – the performance of monetary policy geared to price stability can be improved by either responding to changes in the employment rate and income inequality or taking their macroeconomic effects into account in setting the target inflation level or adopting make-up strategies. While these implications are still novel and require further analysis (which is challenging because of the high computational costs of counterfactual policy analysis in this modelling class), the literature tends to find that the optimal response of monetary policy is different in economies with heterogeneity compared with in representative agent models. Typically, changes in labour income and labour market risk are the key sources of uncertainty affecting households; they tend to be correlated with household assets, meaning that households with few liquid assets tend to be subject to more labour market risk. Accordingly, in downturns, the performance of monetary policy can be improved by responding to changes in unemployment, redistributing resources and providing insurance to constrained households, who may disproportionately suffer from adverse labour market shocks.[156] Specifically, in the empirically relevant case of countercyclical inequality, the central bank needs to be much more aggressive than prescribed by the "Taylor principle" (which recommends increasing nominal interest more than one-to-one with inflation).[157] Likewise, as the case of combining ELB risk with uninsurable labour income risk suggests, the central bank should not choose an inflation objective that is too low, as otherwise higher precautionary savings can amplify ELB risks.[158]

While lower for longer policies may diminish returns on retirement savings, the positive general equilibrium effects of such policies on incomes outweigh their negative effects (see Box 9).[159] [160] All these implications for monetary policy also depend on the effectiveness of fiscal policy in providing insurance against adverse

[156] Bhandari et al. (2018).

[157] Bilbiie (2019). In addition, some work finds that in presence of uninsurable labour income risk and precautionary saving, monetary policy should be more accommodative after a contractionary aggregate shock to prevent deflationary pressures from higher desired precautionary savings and lower aggregate demand; see Challe (2020).

Similarly, in a set-up with search and matching frictions, a systematic monetary policy rule which puts greater weight on stabilising unemployment than on stabilising inflation could be more beneficial for poorer than for richer households, as it provides partial insurance against unemployment risk; see Gornemann et al. (2016).

Finally, a Fisher channel arising from the impact of inflation on the initial price of long-term bonds may give the central bank a reason to inflate for redistributive purposes, because debtors have a higher marginal utility than creditors. Over time, as this inflationary motive fades and bonds mature, the central bank may wish to pursue a deflationary path to raise bond prices and thus relax borrowing limits, which results in an optimal inflation front-loading; see Nuño and Thomas (2020).

[158] Fernández-Villaverde et al. (2021) show that the impact of the zero lower bound (ZLB) varies with household inequality. Household spending decisions depend on the frequency of the ZLB binding, which in turn depends on the central bank's inflation target and on inequality. A decline in the inflation target reduces the level of the real interest rate because households increase their precautionary savings in anticipation of the higher risk of ZLB events, in turn increasing precisely this risk. Higher inequality amplifies this mechanism.

[159] Den Haan et al. (2021).

[160] More persistent strategies, e.g. make-up strategies, should lead to higher nominal rates on average, thus lowering the need for a lower-for-longer policy. Evidence from stochastic simulations with representative agent models shows that make-up strategies exhibit a tendency to reduce the frequency of ELB spells compared with inflation targeting – see the Work stream on the price stability objective (2021).

labour market shocks and in redistributing incomes: activating such fiscal instruments can be more efficient at mitigating downturns than monetary policy.[161]

Box 9

Low-for-longer accommodative monetary policy – side effects of saving needs versus favourable general equilibrium effects supporting employment

While low-for-longer policy strategies can have side effects on the saving needs of people accumulating resources for their retirement, these direct effects of low interest rates need to be considered in relation to general equilibrium effects on incomes and on sustaining employment and thus supporting savings. This box reports that general equilibrium effects prevail, thus providing a theoretical underpinning for the empirical findings of Lenza and Slacalek (2018) that monetary policy compresses the income distribution by supporting employment.

While persistent monetary policy easing strategies can have adverse partial equilibrium effects on returns on retirement savings, the positive employment effects of such policies dominate in general equilibrium. The direct side effects of lower returns on savings must be balanced against indirect effects of higher wages and higher employment levels that have positive effects on all households, including those that are close to retirement. We consider one such cohort, made of households close to retirement that are thus in need to save relatively more at lower remuneration due to low interest rates. Higher savings and thus reduced consumption from this cohort can cause macroeconomic conditions to deteriorate rather than improve. Through the lens of a macroeconomic model that accounts for employment and age heterogeneity, this box shows that while lower interest rates may indeed have direct side effects by decreasing financial income from accumulated life-time savings, middle-aged labour groups who are building up their retirement savings are also benefitting from accommodative monetary policy via general equilibrium effects that support their labour income, which allows them to increase their retirement savings, and consumption.

Once general equilibrium effects are taken into account, all cohorts benefit from low interest rates through higher labour income, with the poorest households benefitting most and inequality declining. Chart A documents that lowering interest rates generates two competing effects. The first effect is the direct downward pressure on returns on assets. The impact of lower interest rates in the absence of general equilibrium effects on the middle-aged households is displayed by the dashed lines.[162] Without these general equilibrium effects, middle-aged households' wages do not increase as a result of the monetary policy expansion, and consumption of the middle-aged labour cohort declines (left panel). The middle panel shows that the decline in consumption is due to the reduction in financial income, the slower pace at which wealth is accumulated. This effect validates conjectures about low-for-longer policies putting downward pressure on the returns to retirement savings. But there is a second effect at play. Once we allow wages of the middle-aged workers to become responsive to monetary policy and the general equilibrium effects to have an impact on their wages (solid lines), wages rise, and hence consumption also increases. The increase in labour income leads the middle-aged group to allocate part of this

161 See Le Grand et al. (2021). The negative feedback loop from adverse income shocks to higher precautionary saving and lower aggregate demand is also present in Ferrari et al. (2021).

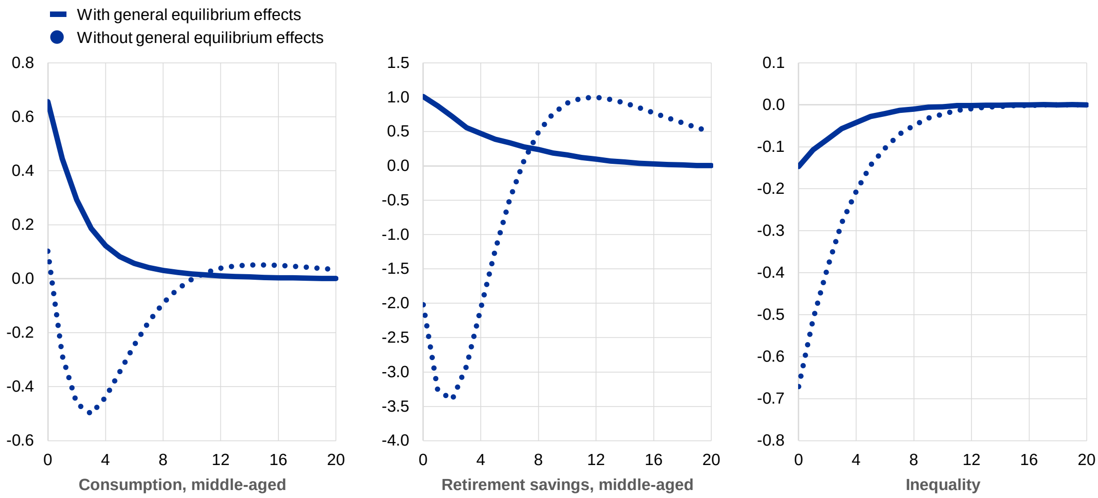
162 General equilibrium effects are excluded by making the wages of the middle-aged households constant over time and hence unresponsive to monetary policy or other shocks.

income to consumption and part to savings, thereby more than compensating the negative direct effect of lower interest rates on their wealth on both consumption and savings.[163] All households whether employed, or young or old are positively affected by the low interest rates. As the poorest households benefit most, inequality declines. The right panel shows the reduction in inequality.[164] The reduction is larger in the case with no general equilibrium effects because consumption of the wealthiest group, the middle-aged, declines. In general, side effects of low-for-longer policies must be considered in a richer context where the general equilibrium effects on employment and income may outweigh any costs of such policies

Chart A

IRFs to a monetary policy shock

(percentage points)



Sources: Den Haan et al. (2021).
Notes: The IRFs show consumption and retirement savings by the middle-aged who are close to retirement in response to a monetary policy shock that drives an annualised interest rate down by approximately 1 percentage point.

Specifically, labour market heterogeneity, including the extent of hysteresis, has implications for the desirability of make-up strategies (including average inflation targeting). In addition to labour income losses, spells of unemployment may also result in a loss of human capital and perpetuate a fall in the participation rate, an effect that is likely to be heterogenous across households (see Chapter 3 of this report and Chapter 3 of the IMF's World Economic Outlook, April 2021). Accordingly, recessions can cause persistent increases in inequality, as illustrated in the top panel of Chart 35, (taken from a study using US data). Such circumstances may call for a longer period of lower interest rates, for example by adopting make-up strategies or asymmetric approaches that reduce the magnitude of the downturn and mitigate the ELB incidence. Such an approach would limit adverse effects of unemployment on vulnerable households and help to bring the long-term unemployed back into the labour market.[165] Chart 35 (top panel) illustrates this effect in a stylised model with two households (high-skilled, high-income versus low-skilled, low-income). Labour income

[163] The relative weight of the direct and indirect effects may change for different calibrations of the model.

[164] Inequality is measured as one minus the share of poorest consumption of the total.

[165] See Nittai et al. (2021), op. cit. and Feiveson et al. (2020).

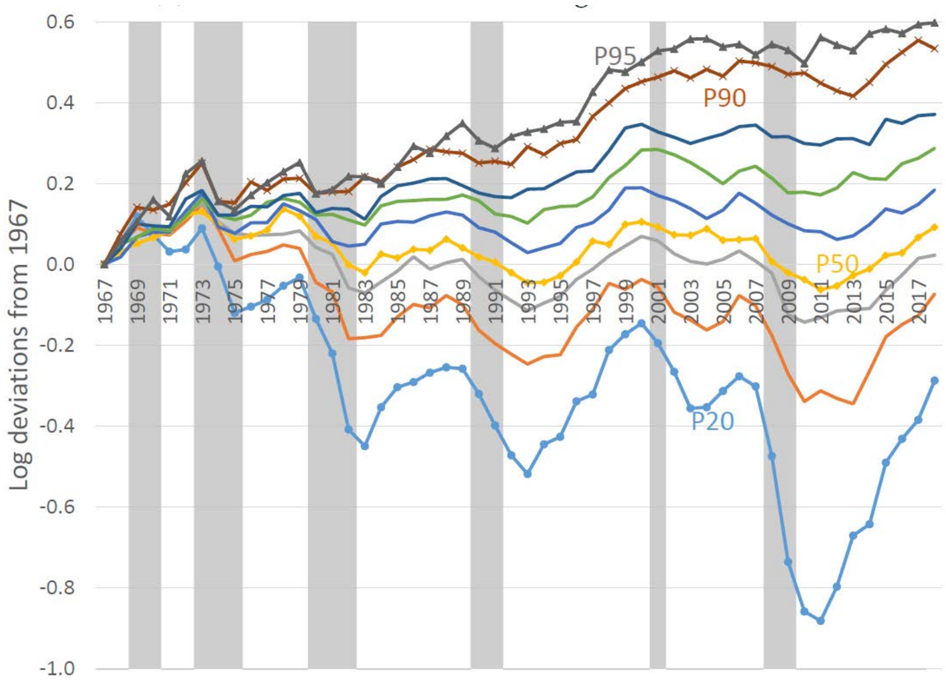
disparities persist for much longer under a benchmark inflation targeting rule than under an average inflation targeting rule.

Chart 35

US earnings inequality over the past 52 years (upper panel) and hysteresis and inequality effects of a slump in demand under ELB and alternative monetary policy rules (lower panel)

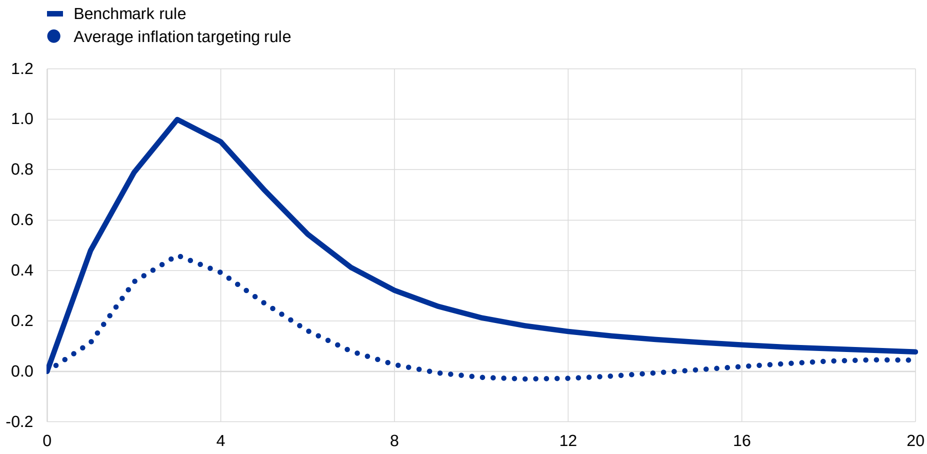
US earnings inequality over the past 52 years

(percentiles of US earnings contributions)



Hysteresis and inequality effects of a slump in demand under ELB and alternative monetary policy rules

(percentage point deviations from steady state, impulse-response functions)



Sources: Upper panel: Heathcote, Perry, Violante (2020); Lower panel: Abbritti and Consolo (2021b).
Notes: Upper panel: Each line in the panel plots a given percentile of the earnings distribution, where the 1967 value of each percentile is normalised to 1. Thus, for example, a person at the 95th percentile of the 2018 earnings distribution earned 0.6 log points (47%) more than a person at the 95th percentile of the 1967 distribution. The latest observation is for 2018. Lower panel: The line chart shows an impulse response function of inequality to a demand shock when the ELB binds. Inequality is measured as the employment share of high-skilled to low-skilled workers.

5.2 The impact of heterogeneity on the transmission and design of monetary policy: model-based analysis

In this section, we analyse the performance and transmission of monetary policy under alternative policy rules using a set of structural heterogeneous agent models, also in comparison to their corresponding representative agent versions. We present results in a selective, model-specific manner, since harmonisation of dynamic responses to shocks and, in particular, stochastic simulations exposing our model economies to historical shocks proved too challenging to commonly implement for all available models. Corresponding analysis by Feiveson et al. (2020) for the Federal Reserve's framework review was conducted on the basis of one model.[166] The multiplicity of models used in our analysis, as presented in Annex 3, features important differences in sources of heterogeneity – i.e. what actually constitutes inequality, the role of inequalities in wealth, income, or employment risks, in how model parameters are informed by data, in shock transmission features, and in implications for monetary policy, pointing to greater challenges in cross-model comparison than when working with representative agent models. Our policy rule protocol in Annex 3 includes a benchmark inflation-targeting rule (with the output gap replaced by an employment gap), an asymmetric rule (with stronger responses to the inflation gap, if inflation is below target), and a four-year average inflation targeting rule. As far as the available models allow, we compute responses in key macroeconomic variables − especially inflation, output, and employment − to monetary policy easing, to a slump in aggregate demand, and to an adverse shock pushing employment or output down and inflation up. Likewise, as far as applicable, we illustrate the performance of alternative monetary policy rules in stabilising inflation and employment when exposing our model economies to historical economic shocks (as seen through the lens of the underlying model), using stochastic simulations.

Box 10
Cross-country heterogeneity

Using a multi-country model this box discusses implications of regional differences in employment for the conduct of monetary policy. Differences in labour market institutions and regulations among countries of the monetary union can give rise to heterogeneity *across* countries, even in response to a common shock. To assess the implications of cross-country heterogeneity in labour market institutions for the conduct of monetary policy, we use a version of the EAGLE model of

166 Key features of the heterogeneous agent New Keynesian (HANK) model used in that study include that "households can insure earnings risk only imperfectly because of frictions in financial markets, so that consumption levels vary with individual labour market histories. Because of bad luck, households are occasionally forced to cut back on consumption after exhausting all available access to credit… the proportion of hand-to-mouth consumers rises in downturns." (Feiveson et al. 2020). The model is parametrised to generate realistic levels of income and wealth inequality.

the euro area within the global economy, augmented with search-and-matching frictions in the labour market.[167]

We compute responses in inflation and the regional dispersion in unemployment rates to a slump in demand and, subsequently, to an adverse supply shock under different policy rules. We first compute responses to a common negative consumption demand shock across the monetary union under three different monetary policy rules (see Table A2.2 on benchmark rules): (i) a benchmark Taylor rule with unemployment, (ii) asymmetric inflation targeting, and (iii) average inflation targeting. For each rule we consider two cases, one case when there is an ELB constraint and one case where there is not.[168] In addition, for all these three rules, we distinguish between cases with zero weight on the unemployment gap ("without U") and a weight on the largest unemployment gap in the monetary union ("max U"). The shock size is the same across the simulations. Subsequently, we compute responses to an adverse supply shock under different policy rules giving rise to trade-offs in inflation and employment stabilisation. Results for unemployment dispersion and inflation are summarised in Charts A and B.

Qualitatively, the responses to a slump in aggregate demand can broadly be summarised as follows:

Attaching importance to (regional) unemployment in response to an aggregate slump in demand can attenuate the increase in unemployment and mitigate its disinflationary fall-out (Chart A). By and large, when there is no ELB, putting a non-zero weight or a zero weight on unemployment in the monetary policy rule does not appear to cause large differences in responses in unemployment dispersion, but does make a difference in terms of inflation shortfalls and aggregate unemployment. A more discernible attenuation of unemployment dispersion and inflation shortfalls arises under the rule responding to the largest regional unemployment rate, in particular if the rule is in the form of an asymmetric inflation targeting rule. At the same time, if the ELB is binding the benchmark inflation-targeting rule performs relatively poorly in terms of inflation, even with a higher weight on unemployment. Across the rules, unemployment rate outcomes tend to follow the reversed pattern of inflation outcomes. The rules that create the largest increase in unemployment also tend to generate an increase in dispersion of unemployment rates; some asymmetry in the rules may therefore be desirable when the ELB is not binding and not only dispersion is considered.

In the presence of the ELB, an average inflation targeting strategy, as opposed to the benchmark inflation targeting rule, can neutralise the adverse impact of a negative demand shock on inflation (Chart A, right panel). When the ELB constraint binds, a larger weight on unemployment in the monetary policy rule tends to cause the ELB to be reached faster, because the policy interest rate is reduced more rapidly in response to both lower inflation and in response to higher unemployment rate. We find no gains in terms of earlier exit from the ELB if unemployment is

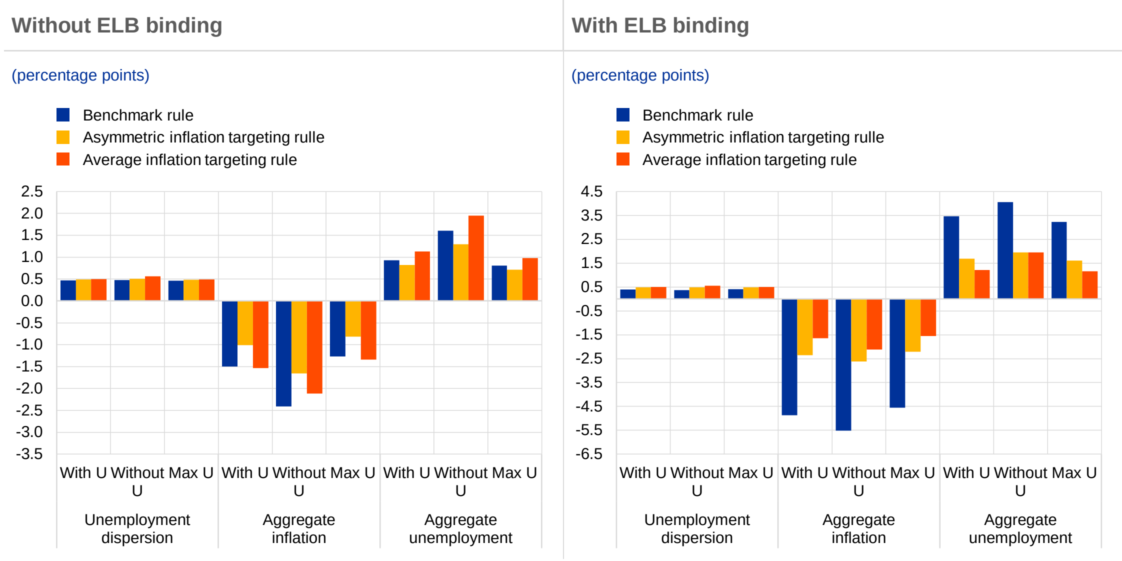
[167] For details see Gomes et al. (2012) and Jacquinot et al. (2018). The simulations were performed using a version of Jacquinot et al. (2018) augmented by wage rigidity and considering a set of monetary policy rules. The model is calibrated in line with the empirical estimates in Christoffel et al. (2008) for the euro area, and for the United States. and rest of the world in line with other models (Bayoumi et al., 2004, and Faruquee et al., 2007).

[168] The ELB is reached for the benchmark rule and for asymmetric inflation targeting, but not always for average inflation targeting. This applies for the case with zero weight on the unemployment gap.

in the monetary policy rule.[169] When the ELB is reached and is long-lasting, there is less dispersion in unemployment rates across the countries in the monetary union. The reason is that when the ELB is reached, the increase in the real rate depresses consumption in the region where prices are most flexible. This reduction in demand spills over to other regions of the monetary union, spreading the recession and leading to a strong fall in inflation everywhere, and therefore a rise in real rates across the union. This mechanism depresses demand symmetrically and therefore leads to higher unemployment, lower dispersion in unemployment rates and, in turn, amplifies the disinflationary fall-out. Under the ELB, rules that mitigate regional dispersion in unemployment may not necessarily be effective in containing the disinflationary pressure caused by the slump in demand. But again, the policy rule responding to the unemployment rate mitigates both unemployment increase and the fall in inflation. Specifically, in its average-inflation targeting and asymmetric-inflation targeting versions the inflation response is nearly the same as if the lower bound didn't bind.[170] More generally, irrespective of the specific weight on employment, average inflation targeting helps to mitigate the ELB constraint and prevents the ELB from becoming a binding constraint across regions for an extended period, so the impact of the fall in demand on regional disparities and on euro area inflation is largely the same, irrespective of whether the lower bound is binding or not.

Chart A

Unemployment dispersion, euro area inflation and unemployment averages after an adverse demand shock under alternative monetary policy rules for different weights given to unemployment without the ELB binding (left panel) and with the ELB binding (right panel)



Sources: Gomes et al. (2021).
Notes: Inflation and unemployment are expressed in percentage points and annualised, while the unemployment dispersion is measured as absolute percentage point difference in unemployment rates in the home country and the rest of the euro area. "With U" denotes rules that consider unemployment gap, "without U" denotes rules with zero weight on unemployment gap, and "max U" denotes the rules that consider the maximum unemployment gap in the euro area.

Responses to an adverse supply shock point to a classical trade-off between employment and inflation stabilisation (Chart B). For this exercise we posit a persistent 100 basis points

[169] For the shock considered, the economy tends not to exit the ELB faster if the unemployment gap features in the monetary policy rule, even though the path of the interest rate after the exit is above the path of the interest rate when the weight on the unemployment gap is zero. For demand shocks with different persistence, the exit from the ELB may be faster when the unemployment gap is considered in the rules.

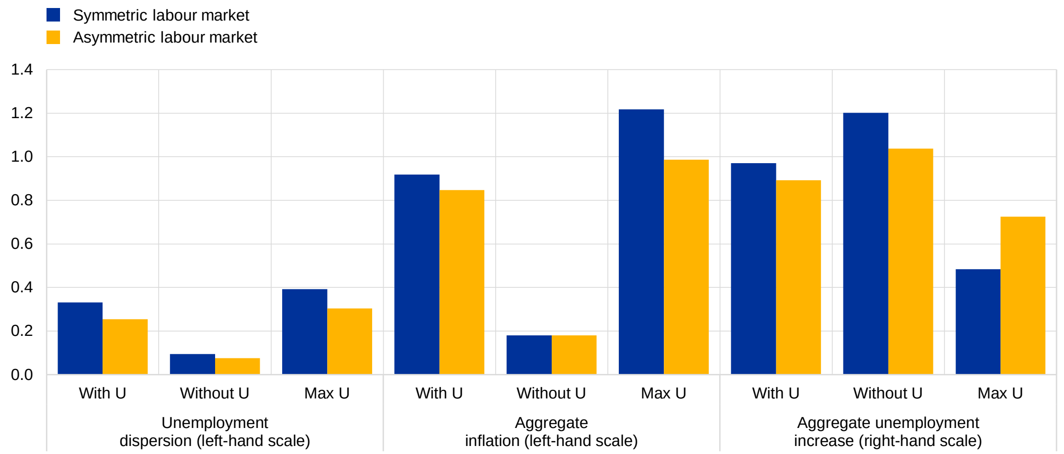
[170] The reason is that for the same shock size across rules, the ELB only binds for a short period of time under AIT, while it binds longer for the other rules considered.

inflationary productivity shock in the euro area to calculate responses of unemployment, unemployment dispersion, and euro area inflation under policy rules attaching different weights to unemployment. Chart B illustrates the increase in unemployment (roughly 0.5 percentage point) under the benchmark rule and a rise in inflation, but without much effect on unemployment dispersion. By contrast, if we assume that the monetary authority responds to unemployment developments in the bloc where unemployment is the highest with the view to reducing unemployment dispersion in the euro area, the increase in *aggregate* euro area unemployment is lower, but without significant gains on dispersion and at a cost in terms of higher inflation in the short run. Overall, trying to address regional unemployment disparities directly when the economy is hit by an adverse, inflationary supply shock, can somewhat reduce unemployment costs and unemployment heterogeneity, but at the cost of a rather significant rise in inflation.

Chart B

Unemployment dispersion, euro area inflation and unemployment peak effects after an inflationary productivity shock for different weights given to unemployment

(percentage points)



Sources: Gomes et al. (2021).
Notes: Inflation and unemployment are expressed in percentage points and annualised, while the unemployment dispersion is measured as absolute percentage point difference in unemployment rates in the home country and the rest of the euro area. “With U” denotes rules that consider unemployment gap, “without U” denotes rules with zero weight on unemployment gap, and “max U” denotes the rules that consider the maximum unemployment gap in the euro area.

Monetary policy is effective at mitigating rising inequality following adverse demand shocks which are more prevalent in an environment with low equilibrium interest rates. Adverse demand shocks reduce consumption of poor households, especially as their incomes and employment decline more than that of richer households who are able to insure themselves against such shocks (top right panel of Chart 36). This asymmetry is confirmed in a range of models that measure inequality in different ways (Abbritti and Consolo, 2021b, den Haan et al., 2021, Ferrari et al., 2021), with the exception of Fernández-Villaverde et al. (2021).[171] The model results also confirm the empirical findings that expansionary monetary policy is effective at countering rising inequality through larger effects on employment or

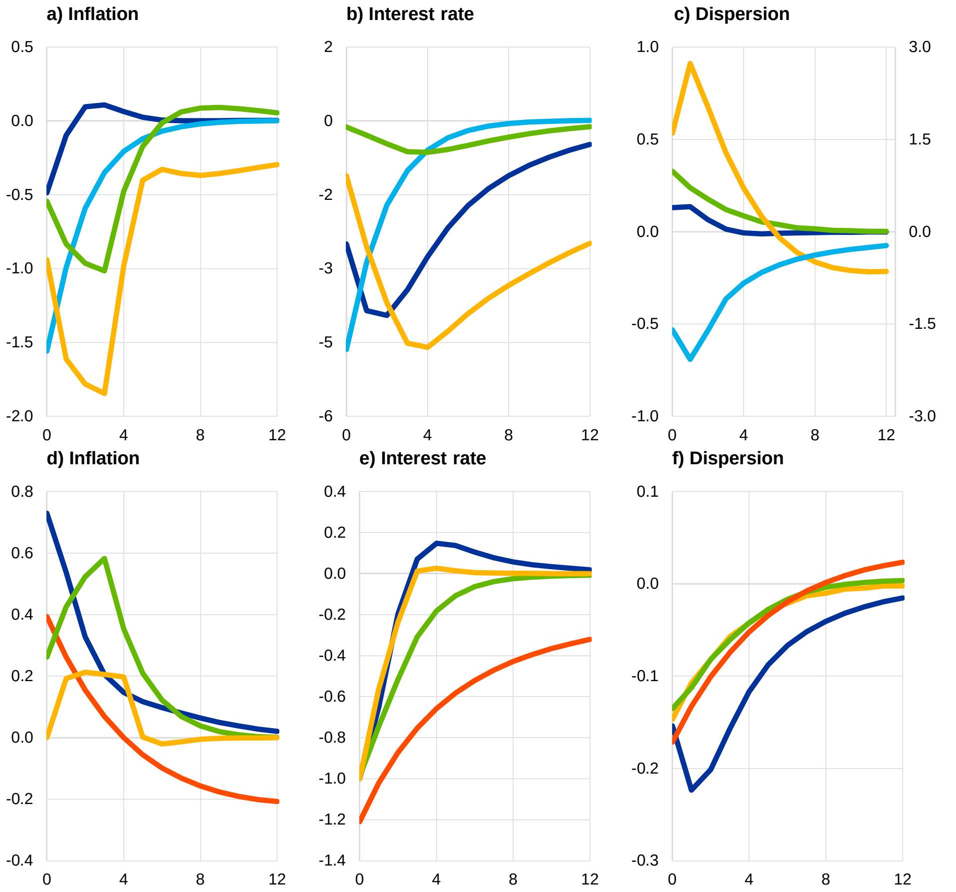
[171] The model features three groups with different productivity levels: low, medium and high. Inequality of both income and consumption increases straight after the negative demand shock within each group, so the poorest agents within each group are worse off after the shock compared with the other agents within the group. However, as the shock also affects wage differences across groups, wage differences fall (akin to a compression of wage premium due to productivity differences). This wage compression is a strong force in decreasing income inequality which also reduces consumption inequality.

incomes (or both) and hence on consumption of poorer households (bottom right panel).

Chart 36

Responses to adverse demand shock with ELB binding (top panels) and monetary policy easing shock (bottom panels)

(percentage points)



Sources: Ferrari et al. (2021) – dark blue lines; Fernández-Villaverde et al. (2021) – light blue lines; Herman and Lozej (2021) – red lines; den Haan et al. (2021) – green lines; Abbritti and Consolo (2021b) – yellow lines.
Notes: Responses in HANK models under the benchmark inflation-targeting rule, without ELB binding. Dispersion is defined differently across the models: Fernández-Villaverde et al. (2021) – Gini-coefficient on consumption; Herman and Lozej (2021) – consumption of poor households/total consumption; den Haan et al. (2021) – share of consumption by poorest households in total; Abbritti and Consolo (2021b) – share of consumption of low-skilled workers relative to that of high skilled workers. The dispersion response to a monetary policy shock refers to the right-hand axis for Fernández-Villaverde et al. (2021). See Annex 3 for details of the protocol of assumptions for calculating these responses.

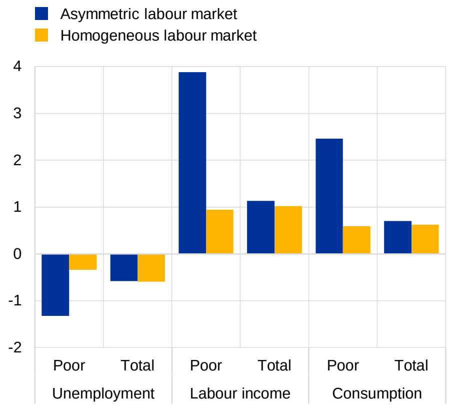
Responses in key macroeconomic variables to an easing of monetary policy suggest that labour market heterogeneity has significant effects on employment, but do not generally lead to overall amplification in the aggregate. Chart 37 left and right panels, (based on Herman and Lozej 2021) illustrate that employment, labour income, and consumption of poor households benefit disproportionately from an easing in monetary policy in a realistic setting with labour market asymmetries where employed poor households respond more to shocks, compared with a model setting where labour market responses are similar for poor and wealthy households. Yet, while inequality is visibly affected, the differences in *aggregate* outcomes do not generally lead to amplification: asymmetry on the labour market indeed boosts the response in output, but not in inflation. The reason is two-fold. First, wages for poor households are somewhat more rigid in the asymmetric labour market case. Second, more job creation for poor households implies a faster increase in aggregate employment compared with the case where labour markets are symmetric, with a higher proportion of lower-wage workers. The aggregate wage increase that is needed to satisfy labour demand by firms is therefore somewhat lower, and marginal costs and inflation increase by less than in the symmetric labour market case.

Chart 37

Responses of unemployment, labour income and consumption (to monetary policy easing) in a model featuring asymmetric versus symmetric labour market across income groups (left panel) and responses of output, inflation and labour income shares (to monetary policy easing) in a model featuring asymmetric versus symmetric labour market across income groups (right panel)

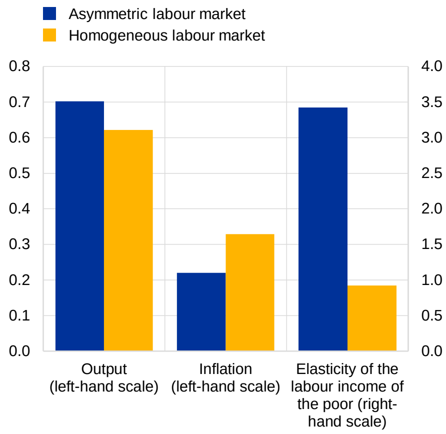
Responses of unemployment, labour income, and consumption (to monetary policy easing) in a model featuring asymmetric versus symmetric labour market across income groups

(percentage changes; average impulse response function over four quarters in response to monetary policy shock)



Responses of output, inflation, and labour income shares (to monetary policy easing) in a model featuring asymmetric versus symmetric labour market across income groups

(percentage changes; average impulse response function over four quarters in response to monetary policy shock)



Sources: Herman and Lozej (2021).
Notes: Left panel: The bar chart compares the responses of unemployment, labour income and consumption in asymmetric and homogeneous labour market regimes for both low wealth population bracket and the total. Right panel: The bar chart compares the responses of output and inflation in asymmetric and homogeneous labour market regimes for both low wealth population bracket and the total. The elasticity of the labour income of poor households is defined as the ratio of the labour income response of poor households over the labour income response of the aggregate.

The amplification of the impact of a recessionary demand shock through the ELB on inequality can possibly be mitigated by more persistent policy easing. Chart 35 bottom panel (based on Abbritti and Consolo, 2021b, featuring a two-agent economy with a low-skill-low-income and a high-skill-high-income household) illustrates that average inflation targeting, rather than a benchmark inflation-targeting rule, can reduce income inequality (measured here by the employment share of high-skilled workers relative to low-skilled). Likewise, Box 10 illustrates in a multi-country setting (with representative households, capturing regional disparities in employment across the monetary union) that under a benchmark inflation-targeting rule the ELB constraint creates significant losses in terms of unemployment and inflation shortfalls (Chart A, left panel, without ELB, compared with right panel, with

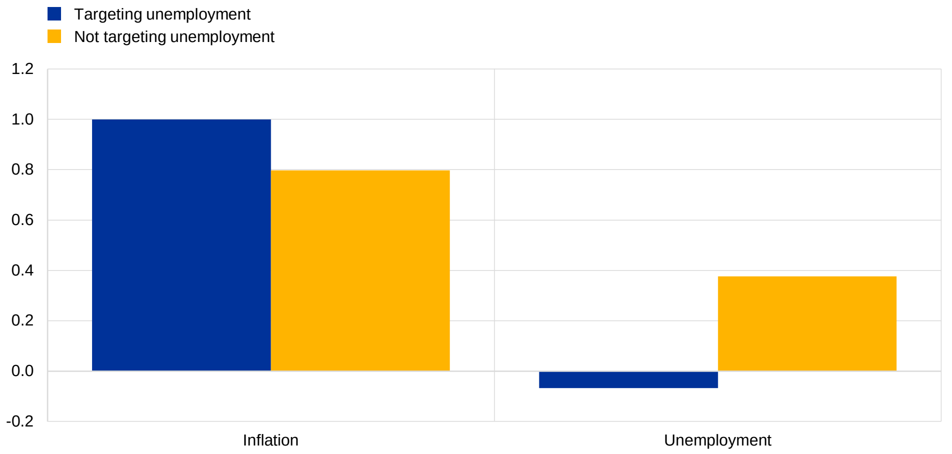
ELB binding). More persistent easing, for example through average inflation targeting, especially in combination with different weights on unemployment or regional unemployment, can neutralise this fall-out from the ELB constraint.

Employment heterogeneity is unlikely to attenuate short-term trade-offs between inflation and employment stabilisation. The inflation costs from focusing asymmetrically on employment stabilisation in the event of an adverse supply shock[172] are model dependent. In the model by Ferrari et al. (2021) (Chart 38) an approach effectively neutralising employment losses – instead of following a symmetric rule – leads to costs in terms of higher inflation. The costs are not large, however, on account of the flatness of the Phillips curve estimated in that model, consistent with empirical evidence from the euro area.[173]

Chart 38

Unemployment and inflation responses in HANK to a technology shock without the ELB binding with different weights given to unemployment

(percentage points)



Sources: Ferrari et al. (2021).
Notes: The bar charts show the unemployment and inflation peak effects after an adverse supply shock without the ELB hitting for both targeting and not targeting unemployment strategies.

Trade-offs between inflation and employment stabilisation also persist in a multi-country setting. Box 10 (Chart B) – with a focus on regional heterogeneity (but a representative agent setting) – suggests a classical trade-off between employment and inflation stabilisation: a rule responding to unemployment developments in the region where unemployment is the highest can reduce aggregate unemployment

[172] An adverse supply shock is understood as a model-specific shock depressing output and employment and increasing inflation, i.e. giving rise to a trade-off between inflation and employment stabilisation.

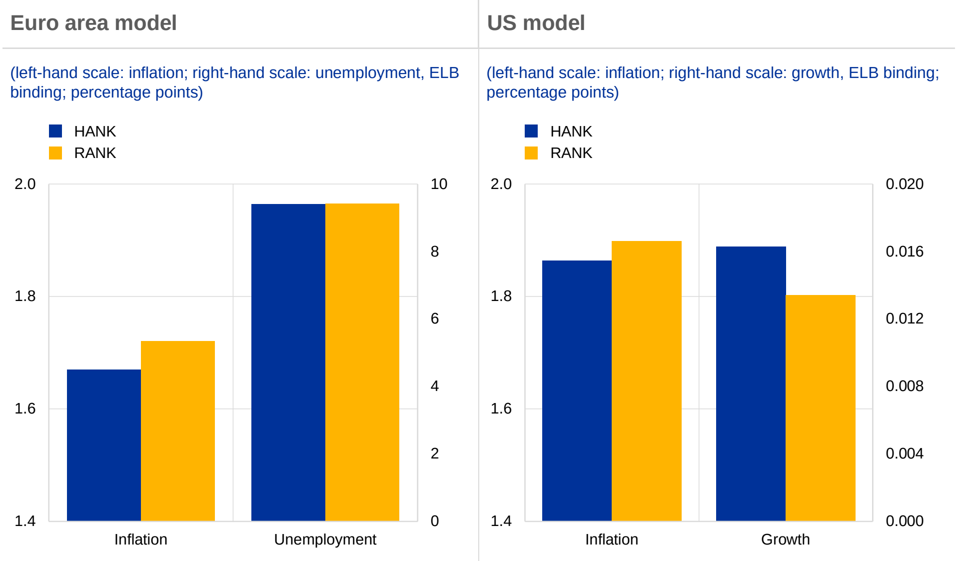
[173] Acharya et al. (2020) study optimal monetary policy in HANK and representative-agent New-Keynesian (RANK) models. They show that in a HANK model the central banker should care about consumption inequality in addition to inflation and output gap. This creates a new trade-off such that it is optimal for the central bank to keep interest rates lower than otherwise so that inequality falls through precautionary savings and reduced income risk, despite inefficiently high output and inflation. As a result, the response to a negative productivity shock in a HANK model differs from that in a RANK model. In a HANK model the central bank reduces interest rates to counter falling output so that inequality is mitigated, even though this leads to higher inflation and output. By contrast, in a RANK model the central bank stabilises inflation and allows output to fall to a flexible price level.

costs, but without significant gains in inequality and at a cost in terms of higher inflation (in the short run).

Stochastic simulations exposing model economies to historical structural shocks can confirm that the macroeconomic costs from the ELB constraint appear higher when taking heterogeneity into account. Chart 39 shows that, compared to their corresponding representative agent versions ("Inflation targeting in RANK"), inflation shortfalls (relative to a 2% inflation target) are higher under a benchmark inflation-targeting rule, when taking heterogeneity into account ("Inflation targeting in HANK" - for Fernández-Villaverde et al., 2021 and Ferrari et al., 2021, noting, however, that the picture on employment or output losses is inconclusive, as the shortfalls are small in these simulations).

Chart 39

Inflation outcomes with (HANK) and without (RANK) heterogeneity – stochastic simulations under symmetric inflation targeting



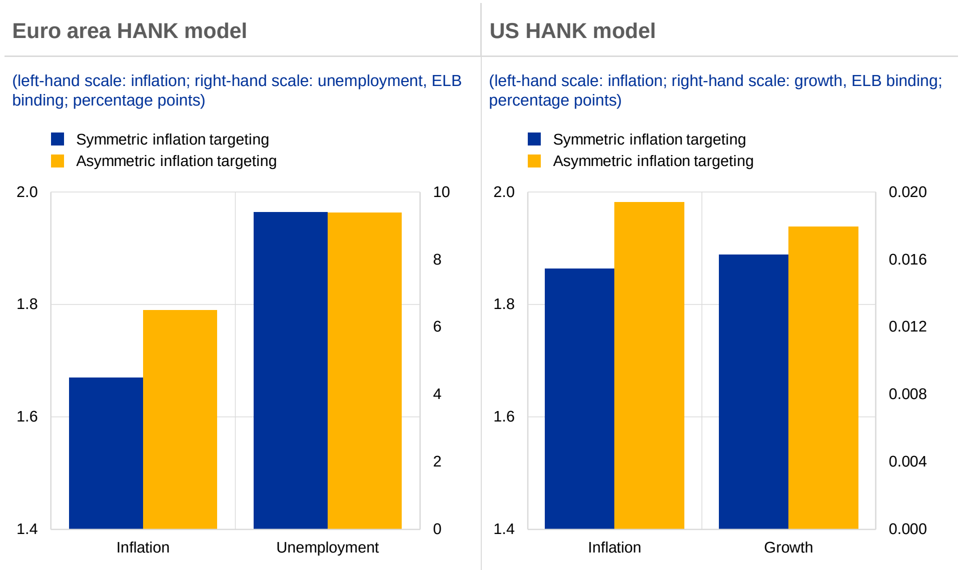
Sources: Ferrari et al. (2021) – Euro Area model; Fernández-Villaverde et al. (2021) – US model.
Notes: The bar charts show macroeconomic outcomes from stochastic simulations for both HANK and RANK models under a symmetric inflation targeting rule with the lower bound binding.

Stochastic simulations support the proposition that more forceful policy easing can mitigate a negative inflation bias arising from the ELB constraint, consistent with results in RANK models. Applying an asymmetric interest rate rule – commanding more forceful policy easing when inflation is below target – can reduce the costs of inflation shortfalls when the ELB poses a constraint on monetary policy (Chart 40).[174] These results derive from Fernández-Villaverde et al. (2021) and Ferrari et al. (2021). Such reductions in inflation shortfalls could, however, not be found to be generated on the basis of different versions of averaging rules or make-up strategies. Our results turned out to be less conclusive than in the corresponding

[174] See Maih et al. (2021) for an optimal parameterisation of an asymmetrical policy rule in the presence of a lower bound constraint. For additional background material on asymmetric interest rate rules in representative agent models, see Work stream on the price stability objective (2021).

Federal Reserve study by Feiveson et al. (2020) and are therefore not presented or discussed in detail.

Chart 40
Symmetric vs. asymmetric inflation targeting – stochastic simulations



Sources: Ferrari et al. (2021) – Euro area HANK model; Fernández-Villaverde et al. (2021) – US HANK model.
Note: The bar charts show macroeconomic outcomes from stochastic simulations under both symmetric and asymmetric inflation targeting rules with ELB binding.

Dynamic heterogeneous agent models, while being more realistic than models with only one representative household, can be computationally complex and difficult to calibrate due to a lack of sufficiently granular quarterly time-series data. Computational challenges arise from having to keep track of the evolution in households' wealth or history of shocks. Recently, Kaplan et al. (2018) provided methods to calibrate HANK models that feature full heterogeneity. Fernández-Villaverde et al. (2021) use these insights to calibrate their model parameters. These are typically calibrated to quarterly frequency, but some of the data exist only at annual frequency in the United States and are particularly scarce for the euro area where only a triennial survey is available.[175] Recently Le Grand and Ragot (2017), among others, have proposed a method of keeping track of only a limited history of different types of households, thereby easing the computational burden and making it possible to solve the model to first order and estimate it with standard Bayesian methods. Den Haan et al. (2021) use these solution techniques, as does Ferrari et al. (2021) who also estimate their model on euro area data. Lack of euro area data at quarterly frequency, however, prevents the matching of consumption or asset holdings of households with different histories.[176] Challe et al. (2017) solve this issue by computing consumption of the 60% poorest households and using data for

[175] At euro area level an important data source is the Household Finance and Consumption Survey, but it is conducted only every three years and the first survey was run only in 2010. There are, however, national surveys which are higher in frequency and go further back in time.

[176] Blomhoff et al. (2019) use Norwegian administrative data to study savings behaviour. Due to income and wealth taxes, the data offers a complete panel of asset holdings by every Norwegian household.

these in the estimation.[177] Calibration of some structural parameters can also be more complex, if one allows for different deep parameters across different groups. Herman and Lozej (2021) use microdata to calibrate different worker betas.

5.3 Conclusions on implications of employment heterogeneity for monetary policy

Our policy analysis mainly serves to illustrate implications for understanding business cycle dynamics and the transmission and conduct of monetary policy when factoring in employment heterogeneity. However, it is still selective and model-specific, its findings are difficult to generalise and it may benefit from further validation – especially for the euro area. Heterogeneous-agent models are currently at the frontier of monetary policy research. Some of the models used in this report are still under development, especially when bringing them to bear on policy analysis. Their underlying structural parameters are not always estimated, but often calibrated. At the same time, for capturing evidence of inequality as a potential channel in the propagation of business cycle dynamics, heterogeneous agent models are more realistic.

Bearing in mind these important caveats, our model-based analysis suggests that the performance of alternative policy rules depends on the nature and size of economic shocks. Whether make-up strategies or rules assigning higher weight to employment or its dispersion (within or across countries) improve macroeconomic outcomes depends on the nature of shocks affecting economic developments. Specifically, the combination of the size of the shock and the level of the real equilibrium rate of interest is crucial for the propagation of ELB constraints.

In response to demand shocks structural models factoring in heterogeneity can strengthen the proposition (established so far in models with representative agents) that forceful easing strategies can improve the effectiveness of monetary policy – especially close to the ELB. Inflation shortfalls may be better mitigated when pursuing an asymmetric interest rate rule than when pursuing a symmetric inflation targeting approach. This result particularly prevails if the slump in demand is large enough for the ELB to become a binding constraint on monetary policy – an event which in the current environment of low real equilibrium interest rates is much more likely than in the decades preceding the global financial crisis.

In response to adverse supply shocks (mark-up shocks or inflationary technology shocks), our model-based exercises confirm conventional wisdom that monetary policy faces a short-term trade-off in stabilising employment and inflation. Monetary policy may be effectively attuned to reducing costs in job losses, in particular for low-income groups, or to lower regional dispersion in unemployment, but this approach can lead to costs in overshooting the inflation aim in the near term.

---

[177] Potentially data on different percentiles of the distribution could be added to the estimation to match the data better. Due to lack of data at euro area level, Ferrari et al. (2021) do not match disaggregated consumption levels. They do, however, calibrate the share of workers and firm owners.

Overall, stochastic simulations (subjecting the model economy to a range of widely differing historical shocks) can confirm that asymmetric rules improve inflation outcomes. Such approaches featuring more forceful easing when inflation is below target than when it is above target can mitigate inflation shortfalls, on account of the ELB constraint.

Notwithstanding the early development state of heterogeneous-agent models for policy analysis, sufficiently important microeconomic and macroeconomic empirical evidence, including for the euro area, has accrued to suggest that understanding fluctuations in aggregate demand and in the transmission of monetary policy requires factoring in heterogeneity. That inequality rises in downturns and falls in upturns, that rich households save at a higher rate out of their income than poor households, that poor households face higher and rising income risks in downturns, and that monetary policy is also transmitted through inequality can all be considered sufficiently robust empirical patterns. Accordingly, factoring employment and inequality into the conduct of monetary policy is important in understanding monetary policy transmission, especially in understanding amplifying transmission effects when monetary policy is constrained by the effective lower bound. Thereby, in economic downturns, monetary policy strategies attenuating employment inequalities may well contribute to reducing adverse transmission effects on account of the effective lower bound on interest rates.

Bibliography

Aaronson, S.R., Daly, M.C., Wascher, W. and Wilcox, D.W. (2019), “Okun Revisited: Who Benefits Most from a Strong Economy?”, *Brookings Papers on Economic Activity*, Spring, pp. 333-404.

Abbritti, M. and Consolo, A. (2021a), “Labour market skills, endogenous productivity and business cycles”, *Working Paper Series*, ECB, forthcoming.

Abbritti, M. and Consolo, A. (2021b), *Monetary policy and inequality: the role of skill heterogeneity*, ECB, mimeo.

Abbritti, M., Consolo, A. and Weber, S. (2021), Endogenous growth, downward wage rigidities and optimal inflation target, *Working Paper Series*, ECB, forthcoming.

Abbritti, M., Equiza-Goñi, J., Perez de Gracia, F. and Trani, T. (2020), “The effect of oil price shocks on economic activity: a local projections approach”, *Journal of Economics and Finance*, Vol. 44, pp. 708-723.

Acemoglu, D. and Restrepo, P. (2020), “Robots and Jobs: Evidence from US Labor Markets”, *Journal of Political Economy*, Vol. 128, No 6, pp. 2188-2244.

Acemoglu, D. and Restrepo, P. (2018), “The Race Between Man and Machine: Implications of Technology for Growth, Factor Shares, and Employment”, *American Economic Review*, Vol. 108, No 6, pp. 1488-1542.

Acemoglu, D. Lelarge, C. and Restrepo, P. (2020), “Competing with Robots: Firm-Level Evidence from France”, *AEA Papers and Proceedings*, Vol. 110, pp. 383-88.

Acharya, S. and Dogra, K. (2020), “Understanding HANK: Insights from a PRANK”, *Econometrica*, Vol. 88, No 3, pp. 1113-1158.

Acharya, S., Challe, E. and Dogra, K. (2020), “Optimal Monetary Policy According to HANK”, *Staff Reports*, No 916, Federal Reserve Bank of New York.

Adamopoulou, E. and Villanueva, E. (2020), “Wage determination and the bite of collective contracts in Italy and Spain: evidence from the metal working industry”, *Working Papers*, No 2036, Banco de España.

Adamopoulou, E., Bobbio, E., De Philippis, M. and Giorgi, F. (2019), “Reallocation and the role of firm composition effects on aggregate wage dynamics”, *IZA Journal of Labor Economics*, Vol. 8, No 1, pp. 1-24, IZA Institute of Labor Economics.

Adamopoulou, E., De Philippis, M., Sette, E. and Viviano, E. (2020), “The Long Run Earnings Effects of a Credit Market Disruption”, *IZA Discussion Paper*, No 13185, IZA Institute of Labor Economics.

Adams-Prassl A., Boneva, T., Golin, M. and Rauh, C. (2020), “Inequality in the Impact of the Coronavirus Shock: Evidence from Real Time Surveys”, *CEPR Discussion Paper*, No 14665, Centre for Economic Policy Research.

Adjemian, S. and Darracq Pariès, M. (2008), “Optimal monetary policy and the transmission of oil-supply shocks to the euro area under rational expectations”, *Working Paper Series*, No 962, ECB.

Aguilar, P. and Vázquez J. (2018), “Term structure and real-time learning”, Documentos de Trabajo, No 1803, Banco de España.

Aiyar, S. and Voigts, S. (2019), “The Negative Mean Output Gap”, *IMF Working Paper*, No 19/183, International Monetary Fund.

Ajello, A., Cairó, I., Cúrdia, V., Lubik, T.A. and Queralto, A. (2020), “Monetary Policy Tradeoffs and the Federal Reserve’s Dual Mandate”, *Finance and Economics Discussion Series*, No 2020-066, Board of Governors of the Federal Reserve System.

Akcigit, U. et al. (2021), “Rising Corporate Market Power: Emerging Policy Issues”, *Staff Discussion Notes*, No 2021/001, International Monetary Fund.

Alcantara-Ortega, J., Henrion, T. and Leythienne, D. (2020), *Wages determinants in the European Union*, European Commission.

Aleksynska, M. and Tritah, A. (2013), “Occupation-education mismatch of migrant workers in Europe: Context and policies”, *Economics of Education Review*, Vol. 36, pp. 229-244.

Alesina, A., Ardagna S., Nicoletti, G. and Schiantarelli, F. (2005), “Regulation and Investment”, *Journal of the European Economic Association*, Vol. 3, No 4, pp. 791-825.

Alfonso, R. (2015), “On the response of Italian wages to the unemployment rate”, *Questioni di Economia e Finanza (Occasional Papers)*, No 287, Banca d’Italia.

Alichi, A., Bizimana, O., Domit, S., Fernandez Corugedo, E., Laxton, D., Tanyeri, K., Wang, H. and Zhang, F. (2015), “Multivariate Filter Estimation of Potential Output for the Euro Area and the United States”, *IMF Working Paper*, No 15/253, International Monetary Fund.

Alon, T., Coskun, S., Doepke, M., Koll, D. and Tertilt, M. (2021), “From Mancession to Shecession: Women's Employment in Regular and Pandemic Recessions”, *NBER Working Paper*, No 28632, National Bureau of Economic Research.

Alstadsæter, A., Bratsberg, B., Eielsen, G., Kopczuk, W., Markussen, S., Raaum, O. and Røed, K. (2020), “The First Weeks of the Coronavirus Crisis: Who Got Hit, When and Why? Evidence from Norway”, *NBER Working Paper*, No 27131, National Bureau of Economic Research.

Altavilla, C., Brugnolini, L., Gürkaynak, R.S., Motto, R. and Ragusa, G. (2019), "Measuring euro area monetary policy", *Journal of Monetary Economics*, Vol. 108, pp. 162-179.

Álvarez, L.J. and Correa-López, M. (2020), "Inflation expectations in euro area Phillips curves", *Occasional Papers*, No 2018, Banco de España.

Alvargonzález, P., Pidkuyko, M. and Villanueva, E. (2020), "The financial position of the workers most affected by the pandemic: an analysis drawing on the Spanish Survey of Household Finances", *Economic Bulletin*, Issue 3/2020, Banco de España, pp. 1-15.

Amable, B. and Gatti, D. (2001), "The Impact of Product Market Competition on Employment and Wages", *IZA Discussion Paper*, No 276, IZA Institute of Labor Economics.

Amable, B., Demmou, L. and Gatti, D. (2011), "The effect of employment protection and product market regulation on labour market performance: substitution or complementarity?", *Applied Economics*, Vol. 43, No 4, pp. 449-464.

Amberg, N., Jansson, T., Klein, M. and Rogantini Picco, A. (2021), "Five Facts about the Distributional Income Effects of Monetary Policy", *Working Paper*, No 403, Sveriges Riksbank.

Amiti, M., Itskhoki, O. and Konings, J. (2019), "International Shocks, Variable Markups, and Domestic Prices". *The Review of Economic Studies*, Vol. 86, No 6, pp. 2356-2402.

Ampudia, M., Cooper, R., Le Blanc, J. and Zhu, G. (2018), "MPC Heterogeneity in Europe: Sources and Policy Implications". *NBER Working Paper*, No 25082, National Bureau of Economic Research.

Anderton, R. (Chairman) et al. (2015), "Comparisons and contrasts of the impact of the crisis on euro area labour markets", *Occasional Paper Series*, No 159, ECB.

Anderton, R. and Di Lupidio, B. (2019), "Effects of labour and product market regulation on worker flows: evidence for the euro area using micro data", *Working Paper Series*, No 2312, ECB.

Anderton, R., Botelho, V., Consolo, A., Dias da Silva, A., Foroni, C., Mohr, M. and Vivian, L. (2020), "The impact of the COVID-19 pandemic on the euro area labour market", *Economic Bulletin*, Issue 8, ECB.

Anderton, R., Hantzsche, A., Savsek, S. and Tóth, M. (2017), "Sectoral wage rigidities and labour and product market institutions in the euro area", *Open Economies Review*, Vol. 28, No. 5, pp. 923-965.

Andrés, J., Arce, Ó. and Burriel, P. (2021), "Market polarization and the Phillips curve", *Working Papers*, No 2106, Banco de España.

Angrist, J.D. and Kugler, A.D. (2003), “Protective or counter-productive? Labour market institutions and the effect of immigration on EU natives”, *The Economic Journal*, Vol. 113, No 488, pp. 302-331.

Arellano, M., Blundell, R. and Bonhomme, S. (2017), “Earnings and Consumption Dynamics: A Nonlinear Panel Data Framework”, *Econometrica*, Vol. 85, No 3, pp. 693-734.

Arpaia, A. and Mourre, G. (2009) “Institutions and performance in the euro area labour market: taking a fresh look at the evidence”, *Economic Papers*, No 391, European Commission.

Auer, S., Bernardini, M. and Cecioni, M. (2019), “Corporate Leverage and Monetary Policy Effectiveness in the Euro Area”, *Temi di discussione (Economic Working Papers)*, No 1258, Banca d’Italia.

Autor D., Levy, F. and Murnane, R.J. (2003), “The Skill Content of Recent Technological Change: An Empirical Exploration”, *The Quarterly Journal of Economics*, Vol. 118, No 4, pp. 1279-1333.

Autor, D.H., Dorn, D. and Hanson, G.H. (2013), “The China syndrome: Local labor market effects of import competition in the United States”, *American Economic Review*, Vol. 103, No 6, pp. 2121-68.

Autor, D.H., Dorn, D., Hanson, G.H. and Song, J. (2014), “Trade adjustment: Worker-level evidence”, *Quarterly Journal of Economics*, Vol. 129, No 4, pp. 1799-1860.

Bachmann R., Cim, M. and Green, C. (2018), “Long-Rrun Patterns of Labour Market Polarization: Evidence from German Micro Data”, *British Journal of Industrial Relations*, Vol. 57, No 2, pp. 350-376.

Ball, L. and Mankiw, G. (2002), “The NAIRU in Theory and Practice”, *Journal of Economic Perspectives*, Vol. 16, No 4, pp. 115-136.

Ball, L., Leigh, D. and Loungani, P. (2017), “Okun's Law: Fit at 50?”, *Journal of Money, Credit and Banking*, Vol. 49, No 7, pp. 1413-1441.

Bańbura, M. and Bobeica, E. (2020), “Does the Phillips curve help to forecast euro area inflation?”, *Working Paper Series*, No 2471, ECB.

Barnichon, R. and Mesters, G. (2018), “On the Demographic Adjustment of Unemployment”, The Review of Economics and Statistics, Vol. 100, No 2, pp. 219-231.

Barro, R. and Gordon, D. (1983), “Rules, discretion and reputation in a model of monetary policy”, *Journal of Monetary Economics*, Vol. 12, No 1, pp. 101-121.

Barth, E., Bryson, A., Davis, J.C. and Freeman, R. (2016), “It's Where You Work: Increases in the Dispersion of Earnings across Establishments and Individuals in the United States”, *Journal of Labor Economics*, Vol. 34, No S2, part 2, pp. 67-97.

Bassanini, A. and Duval, R. (2006), “The determinants of unemployment across OECD countries: reassessing the role of policies and institutions”, *OECD Economic Studies*, Vol. 1, No 42, pp. 7-86.

Basso, G., D'Amuri, F. and Peri, G. (2019) “Immigrants, Labor Market Dynamics and Adjustment to Shocks in the Euro Area”, *IMF Economic Review*, Vol. 67, No 3, pp. 528-572.

Basso, H. and Rachedi, O. (2021), *Automation and inflation*, Banco de España, mimeo.

Basu, S., Fernald, J.G. and Kimball, M.S. (2006), “Are Technology Improvements Contractionary?”, *American Economic Review*, Vol. 96, No 5, pp.1418-1448.

Bäurle, G., Lein-Rupprecht, S.M. and Steiner, E. (2018), “Employment adjustment and financial constraints: Evidence from firm-level data”. *WWZ Working Paper*, No 2018/07, University of Basel, Center of Business and Economics (WWZ).

Bayer, C., Luetticke, R., Pham-Dao, L. and Tjaden, V. (2019), “Precautionary Savings, Illiquid Assets, and the Aggregate Consequences of Shocks to Household Income Risk”, *Econometrica*, Vol. 87, No 1, pp. 255-290.

Bayoumi, T., Laxton, D. and Pesenti, P. (2004), “Benefits and spillovers of greater competition in Europe: a macroeconomic assessment”, *Working Paper Series*, No 341, ECB.

Beland, L.-P., Brodeur, A. and Wright, T. (2020), “COVID-19, Stay-At-Home Orders and Employment: Evidence from CPS Data”, *IZA Discussion Paper*, No 13282, IZA Institute of Labor Economics.

Benigno, G. and Fornaro, L. (2018), “Stagnation Traps”, *The Review of Economic Studies*, Vol. 85, Issue 3, pp. 1425-1470.

Benigno, P. and Ricci, L. (2011), “The inflation-output trade-off with downward wage rigidities”, *American Economic Review*, Vol. 101, No 4, pp. 1436-66.

Benmelech, E., Bergman, N.K. and Seru, A. (2011), “Financing Labor”, *NBER Working Paper*, No 17144, National Bureau of Economic Research.

Berger, H. and Danninger, S. (2007), “The Employment Effects of Labor and Product Market Deregulation and Their Implications for Structural Reform”, *IMF Staff Papers*, Vol. 54, No 3, International Monetary Fund, pp. 591-619.

Bernanke, B.S. and Gertler, M. (1995), “Inside the Black Box: The Credit Channel of Monetary Policy Transmission”, *Journal of Economic Perspectives*, Vol. 9, No 4, pp. 27-48.

Bernanke, B.S., Kiley, M.T. and Roberts, J.M. (2019), “Monetary Policy Strategies for a Low-Rate Environment”, *Finance and Economics Discussion Series*, No 2019-009, Board of Governors of the Federal Reserve System.

Berson, C., Viviano, E. and de Philippis, M. (2020), “Job-to-job flows and wage dynamics in France and Italy”, *Working Paper*, No 756, Banque de France.

Bhandari, A., Evans, D., Golosov, M. and Sargent, T.J. (2018), “Inequality, Business Cycles and Monetary-Fiscal Policy”, *NBER Working Paper*, No 24710, National Bureau of Economic Research.

Biewen, M. and Steffes, S. (2010), “Unemployment persistence: Is there evidence for stigma effects?”, *Economics Letters*, Vol. 106, No 3, pp. 188-190.

Bijnens, G., Hutchinson, J., Konings, J. and Saint Guilhem, A. (2021), “The interplay between green policy, electricity prices, financial constraints, and jobs: firm-level evidence”, *Working Paper Series*, No 2537, ECB.

Bijnens, G., Hutchinson, J., and Saint Guilhem, A. (2021), *The effect of financing conditions on labour demand and the impact of monetary policy firm-level evidence*, ECB, mimeo.

Bilbiie, F., Ghironi, F. and Melitz, M.J. (2012), “Endogenous Entry, Product Variety, and Business Cycles”, *Journal of Political Economy*, Vol. 120, No 2, pp. 304-345.

Bilbiie, F. (2019), Monetary Policy and Heterogeneity: An Analytical Framework. Paper presented at the ECB Money Macro Workshop.

Bilbiie, F. (2020), “The New Keynesian cross”, *Journal of Monetary Economics*, Vol. 114, pp. 90-108.

Bilgili, Ö., Huddleston, T. and Joki, A.-L. (2015), The Dynamics between Integration Policies and Outcomes: a Synthesis of the Literature, Barcelona Centre for International Affairs and the Migration Policy Group.

Biroli, P., Mourre G. and Turrini, A. (2010), “Adjustment in the Euro Area and Regulation of Product and Labour Markets: An Empirical Assessment”, *Economic Papers*, No 428, European Commission.

Bisin A., Patacchini, E., Verdier, T. and Zenou, Y. (2011), “Ethnic identity and labour market outcomes of immigrants in Europe”, *Economic Policy*, Vol. 26, No 65, pp. 57-92.

Blanchard, O. (2018), “Should We Reject the Natural Rate Hypothesis?”, *Journal of Economic Perspectives*, Vol. 32, No 1, pp. 97-120.

Blanchard, O. and Giavazzi, F. (2003), “Macroeconomic Effects of Regulation and Deregulation in Goods and Labor Markets”, *The Quarterly Journal of Economics*, Vol. 118, No 3, pp. 879-907.

Blanchard, O. and Galí., J. (2010), “Labor Markets and Monetary Policy: A New Keynesian Model with Unemployment”, *American Economic Journal: Macroeconomics*, Vol. 2, No 2, pp. 1-30.

Blanchard, O., Cerutti, E. and Summers, L. (2015), "Inflation and Activity – Two Explorations and their Monetary Policy Implications", *IMF Working Paper*, No 15/230, International Monetary Fund.

Blanchard, O., Jaumotte, F. and Loungani, P. (2014) "Labor market policies and IMF advice in advanced economies during the Great Recession", *IZA Journal of Labor Policy*, Vol. 3, No 2.

Blanchard, O. and Summers, L. (1986), "Hysteresis and the European Unemployment Problem", in Fischer, S. (ed.), *NBER Macroeconomics Annual 1986*, Vol. 1, MIT Press, pp. 15-90.

Blanchard, O. and Wolfers, J. (2000), "The role of shocks and institutions in the rise of European unemployment: the aggregate evidence", *The Economic Journal*, Vol. 110, No 462, pp. 1-33.

Blomhoff, H., Fagereng, A., Moll, B. and Natvik, G. (2019), "Saving Behavior Across the Wealth Distribution: The Importance of Capital Gains", *NBER Working Paper*, No 26588, National Bureau of Economic Research.

Blundell, R., Costa Dias, M., Joyce, R. and Xu, X. (2020), "COVID-19 and inequalities", *The IFS Deaton Review*, The Institute for Fiscal Studies.

Blundell, R., Graber, M. and Mogstad, M. (2015), "Labor income dynamics and the insurance from taxes, transfers, and the family", *Journal of Public Economics*, Vol. 127, pp. 58-73.

Board of Governors of the Federal Reserve System (2019), Minutes of the Federal Open Market Committee, 10-11 December.

Board of Governors of the Federal Reserve System (2020a), Statement on Longer-Run Goals and Monetary Policy Strategy.

Board of Governors of the Federal Reserve System (2020b), The Federal Reserve's Review of Its Monetary Policy Framework: A Roadmap.

Board of Governors of the Federal Reserve System (2021), Transcript of Chair Powell's Press Conference, April 28.

Bobeica, E. and Sokol, A. (2019), "Drivers of underlying inflation in the euro area over time: a Phillips curve perspective", *Economic Bulletin*, Issue 4, ECB.

Bobeica, E., Ciccarelli, M. and Vansteenkiste, I. (2019), "The link between labor cost and price inflation in the euro area", *Working Paper Series*, No 2235, ECB.

Böck, M., Zens, G. and Zörner, T.O. (2020), "The heterogeneous impact of monetary policy on the US labor market", *Journal of Economic Dynamics and Control*, Vol. 119(C), 1-22.

Bodenstein, M. and Zhao, J. (2019), “On Targeting Frameworks and Optimal Monetary Policy”, Journal of Money, *Credit and Banking*, Vol. 51, No 8, pp. 2077-2113.

Bodenstein, M., Hebden, J. and Winkler, F. (2019), “Learning and Misperception: Implications for Price-Level Targeting”, *Finance and Economics Discussion Series*, No 2019-078, Board of Governors of the Federal Reserve System.

Bodnár, K. (2018a), “Labour supply and employment growth”, Economic Bulletin, Issue 1, ECB.

Bodnár, K. (2018b), “Compositional changes behind the growth in euro area employment during the recovery”, *Economic Bulletin*, Issue 8, ECB.

Bodnár, K. and Nerlich, C. (2020), “Drivers of rising labour force participation – the role of pension reforms”, *Economic Bulletin*, Issue 5, ECB.

Boeri, T., Bruecker H., Fuchs-Schündeln, N. and Mayer T. (2011), “Short-time work benefits revisited: some lessons from the Great Recession”, *Economic Policy*, Vol. 26, No 68, pp. 697-765.

Boeri, T., Nicoletti, G. and Scarpetta, S. (2000), “Regulation and labour market performance”, in Galli, G. and Pelkmans, J. (eds.), *Regulatory reform and competitiveness in Europe*, Edward Elgar, Northampton, Massachusetts.

Bonam, D., Colciago, A. and Goy, G. (2021), *On the labor market stabilization properties of make-up strategies*, De Nederlandsche Bank, mimeo.

Bonthuis, B., Jarvis, V. and Vanhala, J. (2016), “Shifts in euro area Beveridge curves and their determinants”, IZA Journal of Labor Policy, Vol. 5, No 1, pp. 1-17.

Boppart, T. and Krusell, P. (2020), “Labor Supply in the Past, Present, and Future: a Balanced-Growth Perspective”, *Journal of Political Economy*, Vol. 128, No 1, pp. 118-157.

Bordon, A.R., Ebeke, C. and Shirono, K. (2016), “When Do Structural Reforms Work? On the Role of the Business Cycle and Macroeconomic Policies”, *IMF Working Paper*, No 16/62, International Monetary Fund.

Bosch, N. and van der Klaauw, B. (2009) “Analyzing Female Labor Supply: Evidence from a Dutch Tax Reform”, *IZA Discussion Paper*, No 4238, IZA Institute of Labor Economics.

Botelho, V. and Dias da Silva, A. (2019a), “Employment growth and GDP in the euro area”, *Economic Bulletin*, Issue 2, ECB.

Botelho, V. and Dias da Silva, A. (2019b), “Indicators of labour market conditions in the euro area”, *Economic Bulletin*, Issue 8, ECB.

Bovini, G. and Viviano, E. (2018), “The Italian “employment-rich” recovery: a closer look”, *Questioni di Economia e Finanza (Occasional Papers)*, No 461, Banca d’Italia.

Brand, C. and Schneider, J. (2020), *Implications of the decline in the natural rate of interest for monetary policy strategies: a semi-structural approach*, ECB, mimeo.

Brainard, W. (1967), “Uncertainty and the Effectiveness of Policy”, *American Economic Review*, Vol. 57, No 2, pp. 411-425.

Brandolini, A., Cipollone, P. and Viviano, E. (2006), “Does the ILO definition capture all unemployment?”, *Journal of the European Economic Association*, Vol. 4, No 1, pp. 153-179.

Brey, B. and Hertweck, M.S. (2016), “The extension of short-time work schemes during the Great Recession: A story of success?”, *Macroeconomic Dynamics*, Vol. 24, No 2, pp. 360-402.

Brinbaum, Y. (2018), “Incorporation of Immigrants and Second Generations into the French Labour Market: Changes between Generations and the Role of Human Capital and Origins”, *Social Inclusion*, Vol. 6, No 3, pp. 104-118.

Brinbaum, Y. and Guégnard, C. (2013), “Choices and Enrollments in French Secondary and Higher Education: Repercussions for Second-Generation Immigrants”, *Comparative Education Review*, Vol. 57, No 3, pp. 481-502.

Brinca, P., Duarte, J.B. and Faria-e-Castro, M. (2020), “Is the COVID-19 Pandemic a Supply or a Demand Shock?”, *Economic Synopses*, No 31, Federal Reserve Bank of St. Louis.

Broda, C. and Parker, J.A. (2014), “The Economic Stimulus Payments of 2008 and the aggregate demand for consumption”, *Journal of Monetary Economics*, Vol. 68, pp. S20-S36.

Broer, T., John, K. and Kurt, M. (2020), *The Curious Incidence of Shocks Along the Income Distribution*, Institute for International Economic Studies, Stockholm University, mimeo.

Brussevich M., Dabla-Norris, E. and Khalid, S. (2020), “Who will Bear the Brunt of Lockdown Policies? Evidence from Tele-workability Measures Across Countries”, *IMF Working Paper*, No 20/88, International Monetary Fund.

Bulligan, G. and Viviano, E. (2017), “Has the wage Phillips curve changed in the euro area?”, IZA Journal of Labor Policy, Vol. 6, No 1, pp. 1-22.

Bulligan, G., Guglielminetti, E. and Viviano, E. (2020), *Adjustments along the intensive margin and wages: Evidence from the euro area and the US*, mimeo.

Burggraeve, K., de Walque, G. and Zimmer, H. (2015), “The relationship between economic growth and employment”, *Economic Review*, Nationale Bank van België/Banque Nationale de Belgique, June, pp. 31-50.

Burnside, C. and Eichenbaum, M. (1996), “Factor-Hoarding and the Propagation of Business-Cycle Shocks”, *The American Economic Review*, Vol. 86, No 5, pp. 1154-1174.

Burnside, C., Eichenbaum, M. and Rebelo, S. (1993), “Labour hoarding and the business cycle”, *Journal of Political Economy*, Vol. 101, No 2, pp. 245-273.

Busetti, F., Caivano, M. and Delle Monache, D. (2021), “Domestic and global determinants of inflation: Evidence from expectile regression”, *Oxford Bulletin of Economics and Statistics*, forthcoming.

Busetti, F., Neri, S., Notarpietro, A. and Pisani, M. (2020), “Monetary policy strategies in the New Normal: A model-based analysis for the euro area”, *Temi di discussione,* No 1308, Banca d’Italia.

Buysse, K. and Saks, Y. (2020), “Drivers of Labour Force Participation in Belgium”, *Economic Review*, Nationale Bank van België/Banque Nationale de Belgique, June, pp. 111-128.

Byrne, D. and Zekaite, Z. (2020), “Non-linearity in the wage Phillips curve: Euro area analysis”, *Economics Letters*, Vol. 186.

Cacciatore, M., Duval, R. and Fiori, G. (2012), “Short-term gain or pain? A DSGE model-based analysis of the short-term effects of structural reforms in labour and product markets”, *OECD Economics Department Working Papers*, No 948, OECD Publishing.

Campbell, J.Y. (2006), “Household Finance”, *The Journal of Finance*, Vol. 61, No 4, pp. 1553-1604.

Campolmi, A. and Gnocchi, S. (2016), “Labor market participation, unemployment and monetary policy”, *Journal of Monetary Economics*, Vol. 79, pp.17-29.

Cantor, R. (1990), “Effects of leverage on corporate investment and hiring decisions”, *Quarterly Review*, Vol. 15, No 2, Federal Reserve Bank of New York, pp. 31-41.

Card, D. (2005), “Is the new immigration really so bad?”, *The Economic Journal*, Vol. 115, No 507, pp. 300-323.

Carta, F. and De Philippis, M. (2021), “The impact of the COVID-19 shock on labour income inequality: evidence from Italy”, *Questioni di Economia e Finanza (Occasional Papers)*, No 606, Banca d’Italia.

Carta, F. and Rizzica, L. (2018) “Early kindergarten, maternal labor supply and children's outcomes: evidence from Italy”, *Journal of Public Economics*, Vol. 158, pp. 79-102.

Casiraghi, M., Gaiotti, E., Rodano, L. and Secchi, A. (2018), “A ‘reverse Robin Hood’? The distributional implications of non-standard monetary policy for Italian households”, *Journal of International Money and Finance*, Vol. 85, Issue C, pp. 215-235.

Chalaux, T. and Guillemette, Y. (2019), “The OECD Potential Output Estimation Methodology”, *OECD Economics Department Working Papers*, No 1563, OECD Publishing.

Challe, E., Matheron, J., Ragot, X. and Rubio-Ramirez, J.F. (2017), "Precautionary saving and aggregate demand", *Quantitative Economics*, Vol. 8, No 2, pp. 435-478.

Challe, E. (2020), "Uninsured Unemployment Risk and Optimal Monetary Policy in a Zero-Liquidity Economy", *American Economic Journal: Macroeconomics*, Vol. 12, No 2, pp. 241-83.

Christiano, L.J. and Fitzgerald, T.J. (2003), "The Band Pass Filter", *International Economic Review*, Vol. 44, No 2, pp. 435-465.

Christoffel, K., Coenen, G. and Warne, A. (2008), "The New Area-Wide Model of the euro area: a micro-founded open-economy model for forecasting and policy analysis", *Working Paper Series*, No 944, ECB.

Ciccarelli, M. and Osbat, C. (2017), "Low inflation in the euro area: causes and consequences", *Occasional Paper Series*, No 181, ECB.

Clarida, R., Galí, J. and Gertler, M. (2000), "Monetary policy rules and macroeconomic stability: evidence and some theory", *The Quarterly Journal of Economics*, Vol. 115, No 1, pp. 147-180.

Cockx, B. (2016), "Do youths graduating in a recession incur permanent losses?" *IZA World of Labor*, IZA Institute of Labor Economics, Vol. 281, pp.1-11.

Cockx, B. and Ghirelli, C. (2016), "Scars of recessions in a rigid labor market", *Labour Economics*, Vol. 41, pp. 162-176.

Cockx, B. and Picchio, M. (2011), "Scarring Effects of Remaining Unemployed for Long-Term Unemployed School-Leavers", *Journal of the Royal Statistical Society Series A*, Vol. 176, No 4, pp. 951-980.

Coenen, G., Karadi, P., Schmidt, S. and Warne, A. (2018), "The New Area-Wide Model II: an extended version of the ECB's micro-founded model for forecasting and policy analysis with a financial sector", *Working Paper Series*, No 2200, ECB.

Coenen, G. and Warne, A. (2021), *The inflation-employment correlation pattern for the euro area based on NAWM II*, ECB, mimeo.

Cœuré, B. (2017), *Scars or scratches? Hysteresis in the euro area*, speech at the International Center for Monetary and Banking Studies, Geneva, 19 May.

Colonna, F. and Marcassa, S. (2015), "Taxation and female labor supply in Italy", *IZA Journal of Labor Policy*, Vol. 4, No 5, IZA Institute of Labor Economics, pp. 1-29.

Comin, D., Quintana, J., Schmitz, T. and Trigari, A. (2018), *A New Measure of Utilization-Adjusted Total Factor Productivity Growth for European Countries, mimeo*.

Consolo, A. and Dias da Silva, A. (2019), "The euro area labour market through the lens of the Beveridge curve", *Economic Bulletin*, Issue 4, ECB.

Conti, A. and Gigante, C. (2018), “Weakness in Italy's core inflation and the Phillips curve: the role of labour and financial indicators”, *Questioni di Economia e Finanza (Occasional Papers)*, No 466, Banca d’Italia.

Conti, A. and Nobili, A. (2019), “Wages and prices in the euro area: exploring the nexus”, *Questioni di Economia e Finanza (Occasional Papers)*, No 518, Banca d’Italia.

Conti, A., Guglielminetti, E. and Riggi, M. (2020), *The wage-employment nexus: A tale of persistence*, VoxEU.

Conti, A., Guglielminetti, E. and Riggi, M. (2019), “Labour productivity and the wageless recovery”, *Temi di discussione (Economic Working Papers)*, No 1257, Banca d'Italia.

Corrigan, O. (2013), “Conditionality of legal status and immigrant occupational attainment in Western Europe”, *Policy & Politics*, Vol. 43, No 2, pp. 181-202.

Costain, J., Nakov, A. and Petit, B. (2021), “Flattening of the Phillips curve with state-dependent prices and wages”, *The Economic Journal*, conditionally accepted for publication.

Costain, J., Nakov, A. and Petit, B. (2019), “Monetary policy implications of state-dependent prices and wages”, *Working Paper Series*, No 2272, ECB.

Crossley, T.F., Fisher, P., Low, H., Benzeval, M., Burton, J., Jäckle, A. and Read, B. (2020), “Briefing note COVID-19 survey: the economic effects”, *Understanding Society Working Paper Series*, No 10/2020, Institute for Social and Economic Research.

Crump, R.K., Eusepi, E., Giannoni, M. and Şahin, A. (2019), “A Unified Approach to Measuring u*”, *Brookings Papers on Economic Activity*, Spring, Brookings Institution, pp. 143-238.

Crump, R.K., Nekarda, C.J. and Petrosky-Nadeau, N. (2020), “Unemployment Rate Benchmarks”, *Finance and Economics Discussion Series*, No 2020-072, Board of Governors of the Federal Reserve System.

Cutuli, G. and Grotti, R. (2020), “Heterogeneity in unemployment dynamics:(Un) observed drivers of the longitudinal accumulation of risks”, *Research in Social Stratification and Mobility*, Vol. 67, No 100494.

D'Amuri, F., De Philippis, M., Guglielminetti, E. and Lo Bello, S. (2021), “Natural unemployment rate and activity rates: flow-based determinants and implications for price dynamics”, *Questioni di Economia e Finanza (Occasional Papers)*, No 599, Banca d’Italia.

Dauth W., Findeisen, S., Südekum, J. and Wößner, N., “The Adjustment of Labor Markets to Robots”, *Journal of the European Economic Association*, forthcoming.

Dauth, W., Findeisen, S. and Südekum, J. (2021), “Adjusting to Globalization in Germany”, *Journal of Labor Economics*, Vol. 39, No 1, pp. 263-302.

De Philippis, M. (2017), “The dynamics of the labour force participation rate: determinants and implications for the employment and unemployment rate”, *Questioni di Economia e Finanza (Occasional Papers)*, No 396, Banca d’Italia.

De Serres, A., Murtin, F. and De La Maisonneuve, C. (2012), “Policies to facilitate the return to work”, *Comparative Economic Studies*, Vol. 54, No 1, pp. 5-42.

De Sloover, F. and Saks, Y. (2018), “Does job polarisation imply wage polarisation?”, *Economic Review*, Nationale Bank van België/Banque Nationale de Belgique, September, pp. 79-90.

Debortoli, D., Kim, J., Lindé, J. and Nunes, R. (2019), “Designing a simple loss function for central banks: Does a dual mandate make sense?”, *The Economic Journal*, Vol. 129, No 621, pp. 2010-2038.

Del Negro, M., Lenza, M., Primiceri, G. and Tambalotti, A. (2020), “What's up with the Phillips Curve?”, *Working Paper Series*, No 2435, ECB.

Den Haan, W., Ferrari, A., Mazelis, F. and Ristiniemi, A. (2021), *Does Monetary Easing Hurt Savers? Evidence from a heterogeneous agent model with aging*, ECB, mimeo.

Deutsche Bundesbank (2018), “Wage growth in Germany: assessment and determinants of recent developments”, *Monthly Report*, April.

Deutsche Bundesbank (2019a), “The revision of the sub-index for package holidays and its impact on the HICP and core inflation”, *Monthly Report*, March.

Deutsche Bundesbank (2019b), “The impact of wages on prices in Germany: evidence from selected empirical analyses”, *Monthly Report*, September.

Di Giovanni, J., Levchenko, A.A. and Mejean, I. (2014), “Firms, destinations, and aggregate fluctuations”, *Econometrica*, Vol. 82, No 4, pp. 1303-1340.

Dickens, W.T., Goette, L., Groshen, E.L., Holden, S., Messina, J., Schweitzer, M.E., Turunen, J. and Ward, M.E. (2007), “How Wages Change: Micro Evidence from the International Wage Flexibility Project”, *Journal of Economic Perspectives*, Vol. 21, No 2, pp 195-214.

Diev, P., Kalantzis, Y. and Lalliard, A. (2019), “Why have strong wage dynamics not pushed up inflation in the euro area?”, *Banque de France Bulletin*, No 225, Banque de France.

Dossche, M. and Hartwig, J. (2019), “Household income risk over the business cycle”, *Economic Bulletin*, Issue 6, ECB.

Dupraz, S., Nakamura, E. and Steinsson, J. (2019), “A Plucking Model of Business Cycles”, *NBER Working Paper*, No 26351, National Bureau of Economic Research.

Dupraz, S., Le Bihan, H. and Matheron, J. (2020), *Stabilization properties of make-up strategies when agents have finite planning horizons*, Banque de France, mimeo.

Ebell, M. and Haefke, C. (2003), “Product market deregulation and labor market outcomes”, *IZA Discussion Paper*, No 957, IZA Institute of Labor Economics.

Elsby, M., Hobijn, B. and Şahin, A. (2013), “Unemployment dynamics in the OECD”, *The Review of Economics and Statistics*, Vol. 95, No 2, pp. 530-548.

Erceg, C., Henderson, D. and Levin, A. (2000), “Optimal monetary policy with staggered wage and price contracts?”, *Journal of Monetary Economics*, Vol. 46, No 2, pp. 281-313.

Eriksson, S. and Rooth, D. (2014), “Do employers use unemployment as a sorting criterion when hiring? Evidence from a field experiment”, *American Economic Review*, Vol. 104, No 3, pp. 1014-1039.

Eser, F., Karadi, P., Lane, P.R., Moretti, L. and Osbat, C. (2020), “The Phillips Curve at the ECB”, *Manchester School*, Vol. 88, Issue S1, University of Manchester, pp. 50-85.

Estrella, A. and Mishkin, F. (1999), “Rethinking the role of NAIRU in monetary policy: implications of model formulation and uncertainty”, in Taylor, J.B. (ed.), *Monetary Policy Rules*, University of Chicago Press, Chicago, pp. 405-436.

European Central Bank (2012), *Structural issues report: euro area labour markets and the crisis*.

European Central Bank (2014), “The Phillips curve relationship in the euro area”, *Monthly Bulletin*, July.

European Central Bank (2016) “Factors behind developments in average hours worked per person employed since 2008”, *Economic Bulletin*, Issue 6.

European Commission (2010), *Europe 2020: A strategy for smart, sustainable and inclusive growth*.

European Commission (2017), “The 2018 Ageing Report: Underlying Assumptions & Projection Methodologies”, *Institutional Paper*, No 065.

European Commission (2021), “The 2021 Ageing Report: Economic and Budgetary Projections for the EU Member States (2019-2070)”, *Institutional Paper*, No 148.

Fabiani, S. and Mestre, R. (2000), “Alternative measures of the NAIRU in the euro area: estimates and assessment”, *Working Paper Series*, No 17, ECB.

Fagereng, A., Guiso, L. and Pistaferri, L. (2018), “Portfolio Choices, Firm Shocks, and Uninsurable Wage Risk”, *The Review of Economic Studies*, Vol. 85, No 1, pp. 437-474.

Faia, E. (2008), “Optimal monetary policy rules with labor market frictions”, *Journal of Economic Dynamics and Control*, Vol. 32, No 5, pp. 1600-1621.

Faia, E. (2009), “Ramsey monetary policy with labor market frictions”, *Journal of Monetary Economics*, Vol. 56, No 4, pp. 570-581.

Faruquee, H., Laxton, D. and Muir, D. (2007), “Smooth landing or crash? Model-based scenarios of global current account rebalancing”, in Clarida, R.H. (ed.), *G7 Current Account Imbalances: Sustainability and Adjustment*, National Bureau of Economic Research, pp. 377-456.

Fazzari, S., Hubbard, R.G. and Petersen, B.C. (1987), “Financing constraints and corporate investment”, *NBER Working Paper*, No 2387, National Bureau of Economic Research.

Feiveson, L., Gornemann, N., Hotchkiss, J., Mertens, K. and Sim, J. (2020), “Distributional Considerations for Monetary Policy Strategy”, *Finance and Economics Discussion Series*, No 2020-073, Board of Governors of the Federal Reserve System.

Feldstein, M. (1978), “The Private and Social Costs of Unemployment”, *The American Economic Review*, Vol. 68, No 2, pp. 155-158.

Fernald, J. (2014), “A Quarterly, Utilization-Adjusted Series on Total Factor Productivity”, *Working Paper*, No 2012-19, Federal Reserve Bank of San Francisco.

Fernandes A.P., Ferreira, P. and Winters, L.A. (2014), “Firm entry deregulation, competition and returns to education and skill”, *European Economic Review*, Vol. 70, pp. 210-230.

Fernández-Villaverde, J., Marbet, F., Nuño, G. and Rachedi, O. (2021), *Inequality and the Zero Lower Bound*, Banco de España, mimeo.

Ferrari, A., Grasso, A. and Papetti, A. (2021), *Monetary policy strategy evaluations in an estimated HANK model for the euro area*, *Temi di Discussione (Economic Working Papers)*, Banca d'Italia, forthcoming.

Ferrero, G., Pietrunti, M. and Tiseno, A. (2019), “Benefits of gradualism or costs of inaction? Monetary policy in times of uncertainty”, *Temi di Discussione (Economic Working Papers)*, No 1205, Banca d'Italia.

Fiori, G., Nicoletti, G., Scarpetta, S. and Schiantarelli, F. (2007), “Employment Outcomes and the Interaction between Product and Labor Market Deregulation: Are they Substitutes or Complements?”, *IZA Discussion Paper*, No 2770, IZA Institute of Labor Economics.

Fiori, G., Nicoletti, G., Scarpetta, S. and Schiantarelli, F. (2012), “Employment effects of product and labour market reforms: are there synergies?”, *The Economic Journal*, Vol. 122, pp. 79-104.

Fisher, J. (2012), “On the Structural Interpretation of the Smets-Wouters ‘Risk Premium’ Shock”, *Journal of Money, Credit and Banking*, Vol. 47, pp. 511-516.

Forbes, K., Gagnon, J. and Collins, C. (2020), “Low inflation bends the Phillips curve around the world”, *Working Paper Series*, No 20-6, Peterson Institute for International Economics.

Friedman, M. (1964), “Monetary Studies of the National Bureau”, *The National Bureau Enters Its 45th Year*, National Bureau of Economic Research, pp. 7-25.

Friedman, M. (1968), “The role of monetary policy”, *American Economic Review*, Vol. 58, No 1, pp. 1-17.

Friedman, M. (1976), “Nobel lecture: Inflation and unemployment”, *Journal of Political Economy*, Vol. 85, No 3, pp. 451-472.

Friedman, M. (1993), “The ‘Plucking Model’ of Business Fluctuations Revisited”, *Economic Inquiry*, Vol. 31, No 2, pp. 171-177.

Furceri, D., Loungani, P., Ostry, J.D. and Pizzuto, P. (2020), “Will COVID-19 affect inequality? Evidence from past pandemics”, *Covid Economics*, Issue 12, pp. 138-157.

Gabaix, X. (2011), “The granular origins of aggregate fluctuations”, *Econometrica*, Vol. 79, No 3, pp. 733-772.

Gal, P. and Hijzen, A. (2016), “The short-term impact of product market reforms: a cross-country firm-level analysis”, *OECD Economics Department Working Papers*, No 1311, OECD Publishing.

Gal, P. and Theising, A. (2015), “The macroeconomic impact of structural policies on labour market outcomes in OECD countries: a reassessment”, *OECD Economics Department Working Papers*, No 1271, OECD Publishing.

Galí, J. (2008), *Monetary Policy, Inflation, and the Business Cycle: An Introduction to the New Keynesian Framework*, Princeton University Press.

Galí, J. (2010), “The Return of the Wage Phillips Curve”, *NBER Working Paper*, No 15758, National Bureau of Economic Research.

Galí, J., Smets, F. and Wouters, R. (2011), “Unemployment in an estimated New Keynesian model”, *NBER Macroeconomics Annual 2011*, Vol. 26, University of Chicago Press, pp. 329-360.

Ganong, P., Noel, P.J. and Vavra, J.S. (2020), “US Unemployment Insurance Replacement Rates During the Pandemic”, *NBER Working Paper*, No 27216, National Bureau of Economic Research.

Genre, V., Kohn, K. and Momferatou, D. (2009) “Understanding inter-industry wage structures in the euro area”, *Working Paper Series*, No 1022, ECB.

Gerke, R., Giesen, S. and Scheer, A. (2020), “The power of forward guidance in a quantitative TANK model”, *Economic Letters*, Vol. 186, pp. 108828.

Gertler, M., Huckfeldt, C. and Trigari, A. (2020), “Unemployment Fluctuations, Match Quality, and the Wage Cyclicality of New Hires”, *The Review of Economic Studies*, Vol. 87, No 4, pp.1876-1914.

Giannoni, M.P. (2002), “Does model uncertainty justify caution? Robust optimal monetary policy in a forward-looking model”, *Macroeconomic Dynamics*, Vol. 6, No 1, pp. 111-144.

Girardi, D., Meloni, W.P. and Stirati, A. (2020), “Reverse hysteresis? Persistent effects of autonomous demand expansions”, *Cambridge Journal of Economics*, Vol. 44, No 4, pp. 835-869.

Giroud, X. and Mueller, H.M. (2017), “Firm leverage, consumer demand, and employment losses during the Great Recession”, *The Quarterly Journal of Economics*, Vol. 132, No 1, pp. 271-316.

Golosov, M. and Lucas, R.E. (2007), “Menu Costs and Phillips Curves”, *Journal of Political Economy*, Vol. 115, No 2, pp. 171-199.

Gomes, S., Jacquinot, P. and Lozej, M. (2021), *Monetary policy and the euro area labour market*, European System of Central Banks, mimeo.

Gomes, S., Jacquinot, P. and Pisani, M. (2012), “The EAGLE. A model for policy analysis of interdependence in the euro area”, *Economic Modelling*, Vol. 29, No 5, pp. 1686-1714.

Goos, M. and Manning, A. (2007), “Lousy and Lovely Jobs: The Rising Polarization of Work in Britain”, *The Review of Economics and Statistics*, Vol. 89, No 1, pp. 118-133.

Goos, M., Manning, A. and Salomons, A. (2009), “Job Polarization in Europe”, *American Economic Review*, Vol. 99, No 2, pp.58-63.

Goos, M., Manning, A. and Salomons, A. (2014), “Explaining Job Polarization: Routine-Biased Technological Change and Offshoring”, *American Economic Review*, Vol. 104, No 8, pp. 2509-2526.

Gornemann, N., Keith, K. and Nakajima, Makoto. (2016), “Doves for the Rich, Hawks for the Poor? Distributional Consequences of Monetary Policy”, *International Finance Discussion Papers*, No 1167, Board of Governors of the Federal Reserve System.

Grasso, A. and Traficante, G. (2021), *Optimal robust monetary policy with parameter and output gap uncertainty*, Banca d'Italia, mimeo.

Gregg, P. (2001), “The impact of youth unemployment on adult unemployment in the NCDS”, *The Economic Journal*, Vol. 111, No 475, pp. 626-653.

Gregg, P. and Tominey, E. (2005), “The wage scar from male youth unemployment”, *Labour Economics*, Vol. 12, No 4, pp. 487-509.

Griffith, R., Harisson, R. and Macartney, G. (2007), “Product market reforms, labour market institutions and unemployment”, *The Economic Journal*, Vol. 117, No 519, pp. 142-166.

Gubler, M. and Hertweck, M.S. (2013), “Commodity price shocks and the business cycle: Structural evidence for the U.S.”, *Journal of International Money and Finance*, Vol. 37, pp. 324-352.

Guiso, L. and Sodini, P. (2013), “Household finance: An emerging field”, *in Handbook of the Economics of Finance*, Vol. 2, Elsevier, pp. 1397-1532.

Gumiel, J. and Hahn, E. (2018), “The role of wages in the pick-up of inflation”, *Economic Bulletin*, Issue 5, ECB.

Gunnella, V., Krustev, G. and Schuler, T. (2020) “Developments in the tourism sector during the COVID-19 pandemic”, *Economic Bulletin*, Issue 8, ECB.

Guvenen, F., Karahan, F., Ozkan, S. and Song, J. (2015), “What Do Data on Millions of U.S. Workers Reveal about Life-Cycle Earnings Risk?”, *NBER Working Paper*, No 20913 National Bureau of Economic Research.

Guvenen, F., Schulhofer-Wohl, S., Song, J. and Yogo, M. (2017), “Worker Betas: Five Facts about Systematic Earnings Risk”, *American Economic Review*, Vol. 107, No 5, pp. 398-403.

Haavio, M. and Laine, O. (2021), “Monetary policy rules and the effective lower bound in the euro area”, *Research Discussion Papers,* No 5-2021, Suomen Pankki – Finlands Bank.

Hagedorn, M., Luo, J., Manovskii, I. and Mitman, K. (2019), “Forward guidance”, *Journal of Monetary Economics*, Elsevier, Vol. 102(C), pp.1-23.

Hahn, E. (2019), “How are wage developments passed through to prices in the euro area? Evidence from a BVAR model”, *Applied Economics*, Vol. 53, No 22, pp. 1-19.

Hakkio, C.S. and Willis, J.L. (2013), “Assessing labor market conditions: the level of activity and the speed of improvement”, *Macro Bulletin*, Federal Reserve Bank of Kansas City, July, pp. 1-2.

Hakkio, C.S. and Willis, J.L. (2014), “Kansas City Fed's Labor Market Conditions Indicators (LMCI)”, *Macro Bulletin*, Federal Reserve Bank of Kansas City, August, pp.1-2.

Haltiwanger, J.C. and Spletzer, J.R. (2020), “Between firm changes in earnings inequality: the dominant role of industry effects”, *NBER Working Paper*, No 26786, National Bureau of Economic Research.

Hamermesh, D.S. (1993), *Labor Demand*, Princeton University Press.

Hamilton, J.D. (2021), *Supply, Demand, and Specialized Production*, University of California San Diego, manuscript.

Hartley, J.S. (2021), “Friedman's plucking model: New international evidence from Maddison Project data”, *Economics Letters*, Vol. 199.

Hauptmeier, S., Holm-Hadulla, F. and Nikalexi, K. (2020), “Monetary policy and regional inequality”, *Working Paper Series*, No 2385, ECB.

Hazell, J., Herreño, J., Nakamura, E. and Steinsson, J. (2020), “The slope of the Phillips curve: evidence from US states”, *NBER Working Paper*, No 28005, National Bureau of Economic Research.

Heathcote, J., Perri, F. and Violante, G.L. (2020), *The Rise of US Earnings Inequality: Does the Cycle Drive the Trend?*, Princeton University, mimeo.

Herman, U. and Lozej, M. (2021), *Who Gets Jobs Matters: Monetary Policy and the Labour Market*, ECB, mimeo.

High Council for Employment (2018), *Immigrants Born Outside the European Union on the Belgian Labour Market*, Report 2018, Brussels.

Hijzen, A., Kappeler, A., Pak, M. and Schwellnus, C. (2017), “Labour Market Resilience: The Role of Structural and Macroeconomic Policies”, *OECD Economics Department Working Papers*, No 1406, OECD Publishing.

Hodrick, R.J. and Prescott, E.C. (1997), “Postwar U.S. Business Cycles: An Empirical Investigation”, *Journal of Money, Credit, and Banking*, Vol. 29, No 1, pp. 1-16.

Hopenhayn, H.A. (1992), “Entry, Exit, and Firm Dynamics in Long Run Equilibrium”, *Econometrica*, Vol. 60, No 5, pp. 1127-1150.

Hotchkiss, J.L. and Moore, R.E. (2018), “Some Like It Hot: Assessing Longer-Term Labor Market Benefits from a High-Pressure Economy”, *Working Paper*, No 2018-1c, Federal Reserve Bank of Atlanta.

Hristov, A., Planas, C., Roeger, W. and Rossi, A. (2017), “NAWRU Estimation Using Structural Labour Market Indicators”, *European Economy Discussion Papers*, No 069, European Commission.

Hubmer, J. (2018), “The job ladder and its implications for earnings risk”, *Review of Economic Dynamics*, Vol. 29, pp. 172-194.

Hubmer, J. and Restrepo, P. (2021), “Not a typical firm: the joint dynamics of firms, labor shares, and capital-labor substitution”, *NBER Working Paper*, No 28579, National Bureau of Economic Research.

Huo, Z., Levchenko, A.A. and Pandalai-Nayar, N. (2020), “Utilization-adjusted TFP across countries: Measurement and implications for international co-movement”, *NBER Working Paper*, No 26803, National Bureau of Economic Research.

Hutchinson, J. and Xavier, A. (2006), “Comparing the Impact of Credit Constraints on the Growth of SMEs in a Transition Country with an Established Market Economy”, *Small Business Economics*, Vol. 27, No 2-3, pp. 169-179.

International Monetary Fund (2021), “Recessions and recoveries in labor markets: patterns, policies, and responses to the Covid-19 shock”, *World Economic Outlook*, April, pp. 63-80.

Jacquinot, P., Lozej, M. and Pisani, M. (2018), “Labour tax reforms, cross-country coordination, and the monetary policy stance in the euro area: a model-based approach”, *International Journal of Central Banking*, Vol. 14, No 3, pp. 65-140.

Jappelli, T. and Pistaferri, L. (2010), “The Consumption Response to Income Changes”, *Annual Review of Economics*, Vol. 2, No 1, pp. 479-506.

Jappelli, T. and Pistaferri, L. (2014), “Fiscal Policy and MPC Heterogeneity”, *American Economic Journal: Macroeconomics*, Vol. 6, No 4, pp. 107-136.

Jarociński, M. and Lenza, M. (2018): “An Inflation-Predicting Measure of the Output Gap in the Euro Area”, *Journal of Money, Credit and Banking*, Vol. 50, pp. 1189-1224.

Jean, S. and Nicoletti, G. (2004), “Regulation and Wage Premia”, *Research Paper*, No 2004/26, University of Nottingham.

Jordà, Ò., Singh, S.R. and Taylor, A.M. (2020), “The Long-Run Effects of Monetary Policy”, *Working Paper Series*, 2020-01, Federal Reserve Bank of San Francisco.

Jørgensen, P. and Lansing, K. (2021), *Anchored inflation expectations and the slope of the Phillips curve*, mimeo.

Joyce, R. and Xu, X. (2020), “Sector shutdowns during the coronavirus crisis: which workers are most exposed?”, *Briefing Note*, No BN278, Institute for Fiscal Studies.

Jung, P. and Kuhn, M. (2014), “Labour Market Institutions and Worker Flows: Comparing Germany and the US”, *The Economic Journal*, Vol. 124, No 581, pp. 1317-1342.

Jung, P. and Kuhn, M. (2019), “Earnings Losses and Labor Mobility Over the Life Cycle”, *Journal of the European Economic Association*, Vol. 17, No 3, pp. 678-724.

Juvonen, P. and Obstbaum, M. (2018), “A new method to measure structural unemployment via labour market flows”, *Bank of Finland Bulletin*, 5/2017, Suomen Pankki – Finlands Bank.

Juvonen, P. and Vanhala, J. (2021), *Excess unemployment index for the euro area*, mimeo.

Kahn, L. (2007), “The impact of employment protection mandates on demographic temporary employment patterns: International microeconomic evidence”, *The Economic Journal*, Vol. 117, No 521, pp. 333-356.

Kaplan, G. and Violante, G.L. (2014), “A Model of the Consumption Response to Fiscal Stimulus Payments”, *Econometrica*, Vol. 82, No 4, pp. 1199-1239.

Kaplan, G., Moll, B. and Violante, G.L. (2018), “Monetary Policy According to HANK”, *American Economic Review*, Vol. 108, No 3, pp. 697-743.

Karahan, F. and Ozkan, S. (2013), "On the persistence of income shocks over the life cycle: Evidence, theory, and implications", *Review of Economic Dynamics*, Vol. 16, No 3, pp. 452-476.

Karahan, F., Michaels, R., Pugsley, B., Şahin, A. and Schuh, R. (2017), "Do job-to-job transitions drive wage fluctuations over the business cycle?", *American Economic Review*, Vol. 107, No 5, pp. 353-57.

Koester, G. Lis, E. Nickel, C., Osbat, C. and Smets, F. (eds.) (2021), "Understanding low inflation in the euro area from 2013 to 2019: cyclical and structural drivers", *Occasional Paper Series*, No 280, ECB, September.

Kogan, I. (2006), "Labor Markets and Economic Incorporation among Recent Immigrants in Europe", *Social Forces*, Vol. 85, No 2, pp. 697-721.

Kouvavas, O., Kuik, F., Koester, G. and Nickel, C. (2019), "The effects of changes in composition of employment on euro area wage growth", *Economic Bulletin*, Issue 8, ECB.

Kozlowski, J., Veldkamp, L., and Venkateswaran, V. (2020), "The Tail That Wags the Economy: Beliefs and Persistent Stagnation", *Journal of Political Economy*, Vol. 128, No 8, pp. 2839-2879.

Krueger, A.B. and Mueller, A. (2011), "Job Search, Emotional Well-Being, and Job Finding in a Period of Mass Unemployment: Evidence from High-Frequency Longitudinal Data", *Brookings Papers on Economic Activity*, Spring, Brookings Institution, pp. 1-57.

Krueger, A.B., Cramer, J. and Cho, D. (2014), "Are the Long-Term Unemployed on the Margins of the Labor Market?", *Brookings Papers on Economic Activity*, Spring, Brookings Institution, pp. 229-299.

Kuhn, M. and Ploj, G. (2020) "Job Stability, Earnings Dynamics, and Life-Cycle Savings", *IZA Discussion Paper*, No 13887, IZA Institute of Labor Economics.

Lachowska, M., Mas, A. and Woodbury, S.A. (2020), "Sources of Displaced Workers' Long-Term Earnings Losses", *American Economic Review*, Vol. 110, No 10, pp. 3231-66.

Laxton, D., Meredith, G. and Rose, D. (1995), "Asymmetric Effects of Economic Activity on Inflation: Evidence and Policy Implications", *Staff Papers*, Vol. 42, No 2, pp. 344-374.

Le Grand, F., Alais, M.B. and Ragot, X. (2021), *Should monetary policy care about redistribution? Optimal fiscal and monetary policy with heterogeneous agents*, mimeo.

Le Grand, F. and Ragot, X. (2017), "Optimal fiscal policy with heterogeneous agents and aggregate shocks", *Meeting Papers*, No 969, Society for Economic Dynamics.

Lee, S., McCann, D. and Messenger, J.C. (2007), *Working Time Around the World: Trends in Working Hours, Laws and Policies in a Global Comparative Perspective*, Routledge; International Labour Organisation.

Lenza, M. and Primiceri, G.E. (2020), "How to estimate a VAR after March 2020", *Working Paper Series*, No 2461, ECB.

Lenza, M. and Slacalek, J. (2018), "How does monetary policy affect income and wealth inequality? Evidence from quantitative easing in the euro area", *Working Paper Series*, No 2190, ECB.

Liebig, T. and Widmaier, S. (2009), "Children of Immigrants in the Labour Markets of EU and OECD countries: An Overview", *OECD Social, Employment and Migration Working Papers*, No 97, OECD Publishing.

Lindé, J. and Trabandt, M. (2019), "Resolving the missing deflation puzzle", *CEPR Working Paper*, No 13690, Centre for Economic Policy Research.

Lindé, J. and Trabandt, M. (2018), "Should we use linearized models to calculate fiscal multipliers?", *Journal of Applied Econometrics*, Vol. 33, No 7, pp. 937-965.

Lippi, F. and Neri, S. (2007), "Information variables for monetary policy in an estimated structural model of the euro area", *Journal of Monetary Economics*, Vol. 54, No 4, pp. 1256-1270.

Lise, J. (2013), "On-the-Job Search and Precautionary Savings", *The Review of Economic Studies*, Vol. 80, No 3, pp. 1086-1113.

Lombardi, M.J., Riggi, M. and Viviano, E. (2020), "Bargaining power and the Phillips curve: a micro-macro analysis", *Temi di Discussione (Economic Working Papers)*, No 1302, Banca d'Italia.

Lydon, R. and Simmons, M. (2020) "The ins and outs of the gender unemployment gap in the OECD", *Research Technical Paper*, Vol. 2020, No 10, Central Bank of Ireland.

Maih, J., Mazelis, F., Motto, R. and Ristiniemi, A. (2021), "Asymmetric monetary policy rules for the euro area and the US", *Working Paper Series*, No 2587, ECB, September.

Mäki-Fränti, P., Silvo, A., Gulan, A. and Kilponen J. (2021), *Monetary policy and inequality: the Finnish case*, Bank of Finland Research Discussion, Suomen Pankki – Finlands Bank, forthcoming.

Manning, A. (2010), "Feature: the integration of immigrants and their children in Europe: introduction", *The Economic Journal*, Vol. 120, No 542, pp. 1-3.

Manning, N., (1994), "Are higher long-term unemployment rates associated with lower earnings?", *Oxford Bulletin of Economics and Statistics*, Vol. 56, No 4, pp. 383-397.

Marotzke, P., Anderton, R., Bairrao, A., Berson, C. and Tóth, P. (2020), "Asymmetric wage adjustment and employment in European firms", *The B.E. Journal of Macroeconomics*, Vol. 20, No 2.

Martin, R., Munyan, T. and Wilson, B.A. (2015), "Potential Output and Recessions: Are We Fooling Ourselves?", *International Finance Discussion Papers*, No 1145, Board of Governors of the Federal Reserve System.

Mazelis, F., Motto, R. and Ristiniemi, A. (2021), *The price stability framework: quantitative evaluation of key policy parameters and approaches*, ECB, mimeo.

McKay, A, Nakamura, E. and Steinsson, J. (2016), "The Power of Forward Guidance Revisited", *American Economic Review*, Vol. 106, No 10, pp. 3133-58.

McKinsey & Company (2017), *Digitally-enabled automation and artificial intelligence: shaping the future of work in Europe's digital front-runners*.

McLeay, M. and Tenreyro, S. (2019), "Optimal inflation and the identification of the Phillips curve", *NBER Macroeconomics Annual 2019*, Vol. 34, University of Chicago Press, pp. 199-255.

Mongey, S., Pilossoph, L. and Weinberg, A. (2020), "Which workers bear the burden of social distancing policies?", *Covid Economics*, Issue 12, pp. 69-86.

Moscarini, G., and Postel-Vinay, F. (2012), "The Contribution of Large and Small Employers to Job Creation in Times of High and Low Unemployment", *American Economic Review*, Vol. 102, No 6, pp. 2509-2539.

Mukoyama, T. and Şahin, A. (2006), "Costs of business cycles for unskilled workers", *Journal of Monetary Economics*, Vol. 53, No 8, pp. 2179-2193.

Nickel, C., Bobeica, E., Koester, G., Lis, E. and Porqueddu, M. (eds.) (2019), "Understanding low wage growth in the euro area and European countries", *Occasional Paper Series*, No 232, ECB.

Nickell, S.J. (1986), "Dynamic models of labour demand", in Ashenfelter, O. and Layard, R. (eds.), *Handbook of Labor Economics*, 2nd edn., Vol. 1, Elsevier, pp. 473-522.

Nickell, S.J. (1987), "Why is wage inflation in Britain so high?", *Oxford Bulletin of Economics and Statistics*, Vol. 49, No 1, pp. 103-128.

Nicoletti G., Bassanini A., Jean S., Ernst E., Santiago P. and Swaim P. (2001), "Product and labour market interactions in OECD countries", *OECD Economics Department Working Papers*, No 312, OECD Publishing.

Nicoletti, G. and Scarpetta, S. (2005), "Product market reforms and employment in OECD countries", *OECD Economics Department Working Papers*, No 472, OECD Publishing.

Nilsen, Ø.A. and Reiso, K.H. (2011), “Scarring Effects of Unemployment”, *IZA Discussion Paper*, No 6198, IZA Institute of Labor Economics.

Nittai, B., Matsa, D.A. and Weber, M. (2021), *Heterogeneous Labor Market Effects of Monetary Policy*, Northwestern University, mimeo.

Nuño, G. and Thomas, C. (2020), “Optimal Monetary Policy with Heterogeneous Agents”, *CESifo Working Paper*, No 8670.

Organisation for Economic Co-operation and Development (2010), *OECD Employment Outlook 2010: Moving beyond the Jobs Crisis*.

Organisation for Economic Co-operation and Development (2016), “Short-term labour market effects of structural reforms: Pain before the gain?”, *OECD Employment Outlook 2016*.

Organisation for Economic Co-operation and Development (2019), *OECD Employment Outlook 2019: The Future of Work*.

Orlandi, F. (2012), “Structural unemployment and its determinants in the EU countries”, *Economic Papers*, No 455, European Commission.

Orphanides, A. (2002), “Monetary-policy rules and the Great Inflation”, *American Economic Review*, Vol. 92, No 2, pp. 115-120.

Orphanides, A. (2004), “Monetary policy rules, macroeconomic stability, and inflation: A view from the trenches”, *Journal of Money, Credit and Banking*, Vol. 36, No 2, pp. 151-175.

Orphanides, A. and van Norden, S. (2002), “The unreliability of output-gap estimates in real time”, *The Review of Economics and Statistics*, Vol. 84, No 4, pp. 569-583.

Patterson, C. (2020), *The most exposed workers in the coronavirus recession are also key consumers: Making sure they get help is key to fighting the recession*, Washington Center for Equitable Growth.

Penalver, A. and Siena, D. (2021), *The deflationary bias of the ZLB and the Fed's strategic response*, Banque de France, mimeo.

Piracha, M. and Vadean, F. (2012), “Migrant Educational Mismatch and the Labour Market”, *IZA Discussion Paper*, No 6414, IZA Institute of Labor Economics.

Piton, C. and Rycx, F. (2019), “Unemployment Impact of Product and Labor Market Regulation: Evidence from European Countries”, *IZA Journal of Labor Policy*, Vol. 9, No 1, IZA Institute of Labor Economics, pp. 1-32.

Piton, C. and Rycx, F. (2020), “The heterogenous employment outcomes of first- and second-generation immigrants in Belgium”, *Working Paper Research*, No 381, Nationale Bank van België/Banque Nationale de Belgique.

Portes, A. and Rumbaut, R. (2001), *Legacies: The Story of the Immigrant Second Generation*, University of California Press, Berkeley.

Powell, J. (2020), “New Economic Challenges and the Fed's Monetary Policy Review”, remarks at *Navigating the Decade Ahead: Implications for Monetary Policy*, an economic policy symposium sponsored by the Federal Reserve Bank of Kansas City, Jackson Hole.

Pries, M.J. (2008), “Worker heterogeneity and labor market volatility in matching models”, *Review of Economic Dynamics*, Vol. 11, No 3, pp.664-678.

Quintini, G. and Venn, D. (2013), “Back to Work: Re-employment, Earnings and Skill Use after Job Displacement”, *OECD Report*, No VS/2011/0352.

Ramskogler, P. (2021), “Labour market hierarchies and the macro-economy – Do labour market dualities affect wage growth in Europe?”, *Structural Change and Economic Dynamics*, Elsevier, Vol. 56, pp. 154-165.

Riggi, M. and Santoro, S. (2015), “On the Slope and the Persistence of the Italian Phillips Curve”, *International Journal of Central Banking*, Vol. 11, No 2, pp. 157-197.

Roberts, J.M. (2006), “Monetary Policy and Inflation Dynamics”, *International Journal of Central Banking*, Vol. 2, No 3, pp. 193-230.

Rogerson, R. (1997), “Theory Ahead of Language in the Economics of Unemployment”, *Journal of Economic Perspectives*, Vol. 11, No 1, pp. 73-92.

Rudebusch, G.D. and Williams, J.C. (2016), “A wedge in the dual mandate: Monetary policy and long-term unemployment”, *Journal of Macroeconomics*, Vol. 47, Part A, pp. 5-18.

Santoro, S. and Viviano, E. (2021), *Optimal trend inflation, misallocation and the pass-through of labour costs to prices*, Banca d’Italia, mimeo.

Scarpetta, S., Sonnet, A. and Manfredi, T. (2010), “Rising Youth Unemployment During the Crisis: How to Prevent Negative Long-Term Consequences on a Generation?”, *OECD Social, Employment and Migration Working Papers*, No 106, OECD Publishing.

Schiantarelli, F. (2010), “Product Market Regulation and Macroeconomic Performance: A Review of Cross Country Evidence”, in Loayza, N. and Serven, L. (eds.), *The Microeconomic Underpinning of Growth*, The World Bank.

Schmieder, J., von Wachter, T. and Heining, J. (2021), *The Costs of Job Displacement over the Business Cycle and Its Sources: Evidence from Germany, mimeo*.

Shimer, R. (2012), “Reassessing the ins and outs of unemployment”, *Review of Economic Dynamics*, Vol. 15, No 2, pp. 127-148.

Slacalek, J., Tristani, O. and Violante, G. (2020), “Household balance sheet channels of monetary policy: A back of the envelope calculation for the euro area”, *Journal of Economic Dynamics and Control*, Vol. 115, pp. 1-30.

Smets, F. (2003), “Maintaining price stability: how long is the medium term?”, *Journal of Monetary Economics*, Vol. 50, No 6, pp. 1293-1309.

Smets, F. and Wouters, R. (2002), “An estimated stochastic dynamic general equilibrium model of the euro area”, *Working Paper Series*, No 171, ECB.

Smets, F., Warne, A. and Wouters, R. (2014), “Professional forecasters and real-time forecasting with a DSGE model”, *International Journal of Forecasting*, Vol. 30, No 4, pp. 981-995.

Smit, S., Tacke, T., Lund, S., Manyika, J. and Thiel, L. (2020), “The future of work in Europe: automation, workforce transitions and the shifting geography of employment”, *Discussion Paper*, McKinsey Global Institute, June.

Söderström, U. (2002), “Monetary policy with uncertain parameters”, *Scandinavian Journal of Economics*, Vol. 104, No 1, pp. 125-145.

Sondermann, D. (2016), “Towards more resilient economies: the role of well-functioning economic structures”, *Working Paper Series*, No 1984, ECB.

Sondermann, D. (ed.), Consolo, A., Gunnella, V. Koester, G., Lambrias, K., López-Garcia, P., Nerlich, C., Petroulakis, F., Saiz, L. and Serafini R. (2019), “Economic Structures 20 years into the euro”, *Occasional Paper Series*, No 224, ECB.

Song, J., Price, D., Guvenen, F., Bloom, N., Von Wachter, T. (2018), “Firming up inequality”, *Quarterly Journal of Economics*, Vol. 134, pp. 1-50.

Spitzer, M. and Schmöller, M. (2020), “Endogenous TFP, business cycle persistence and the productivity slowdown in the euro area”, *Working Paper Series*, No 2401, ECB.

Stansbury, A. and Summers, L.H. (2020), “The declining worker power hypothesis: An explanation for the recent evolution of the American economy”, *Brookings Papers on Economic Activity*, Spring, Brookings Institution, pp. 1-77.

Steiner, V. (2017), “The labor market for older workers in Germany”, *Journal for Labour Market Research*, Vol. 50, No 1, pp. 1-14.

Storesletten, K., Telmer, C.I. and Yaron, A. (2004), “Cyclical Dynamics in Idiosyncratic Labor Market Risk”, *Journal of Political Economy*, Vol. 112, No 3, pp. 695-717.

Svensson, L. and Woodford, M. (2003), “Indicator variables for optimal policy”, *Journal of Monetary Economics*, Vol. 50, No 3, pp. 691-720.

Syverson, C. (2011), “What determines productivity”, *Journal of Economic Literature*, Vol. 49, No 2, pp. 326-365.

Szörfi, B. and Tóth, M. (2018), “Measures of slack in the euro area”, *Economic Bulletin*, Issue 3, ECB.

Thévenon, O. (2013), “Drivers of Female Labour Force Participation in the OECD”, *OECD Social, Employment and Migration Working Papers*, No 145, OECD Publishing.

Thomas, C. (2008), “Search and matching frictions and optimal monetary policy”, *Journal of Monetary Economics*, Vol. 55, No 5, pp. 936-956.

Tóth, M. (2018), *A dynamic factor model for backcasting labour market series and extracting a common cyclical component*, ECB, mimeo.

Tóth, M. (2021), “A multivariate unobserved components model to estimate potential output in the euro area: a production function-based approach”, *Working Paper Series*, No 2523, ECB.

Tumino, A. (2015), “The scarring effect of unemployment from the early '90s to the Great Recession”, *ISER Working Paper Series*, No 2015-05, Institute for Social and Economic Research.

Utar, H. (2018), “Workers beneath the floodgates: low-wage import competition and workers’ adjustment”, *Review of Economics and Statistics*, Vol. 100, No 4, pp. 631-647.

Valletta, R.G., Bengali, L. and van der List, C. (2020), “Cyclical and Market Determinants of Involuntary Part-Time Employment”, *Journal of Labor Economics*, Vol. 38, No 1, pp. 67-93.

Walsh, C. (2014), “Multiple Objectives and Central Bank Tradeoffs under Flexible Inflation Targeting”, *Working Paper Series*, No 5097, CESifo.

Walsh, C. (2019), “Alternatives to Inflation Targeting in Low Interest Rate Environments”, *Monetary and Economic Studies*, Vol. 37, Institute for Monetary and Economic Studies, Bank of Japan, pp. 41-70.

Watson, M.W. (2014), “Inflation persistence, the NAIRU, and the Great Recession”, *American Economic Review*, Vol. 104, No 5, pp. 31-36.

Werning, I. (2015), “Incomplete Markets and Aggregate Demand”, NBER Working Paper, No 21448, National Bureau of Economic Research.

Wolcott, E.L. (2021), “Employment inequality: Why do the low-skilled work less now?” *Journal of Monetary Economics*, forthcoming.

Woodford, M. (2003), *Interest and Prices*, Princeton University Press.

Work stream on the price stability objective (2021), “The ECB’s price stability framework: past experience, and current and future challenges”, *Occasional Paper Series*, No 269, ECB, September.

Yellen, J. (2014), *What the Federal Reserve is doing to promote a stronger job market*, speech at the National Interagency Community Reinvestment Conference, Chicago, Illinois, 31 March.

Zhutova, A. (2021), *Inflation and employment: trade-off considerations for monetary policy through the lens of EA-BDF*, Banque de France, mimeo.

Annex 1

In order to document the cyclical sensitivity of labour market outcomes for different demographic groups, Okun's Law-type regressions of the following form are estimated:

$$\Delta u_{g,t} = \alpha_0 + \alpha_1 \cdot \Delta y_t + \varepsilon_t \quad [1]$$

where in this case $\Delta x_t = x_t - x_{t-4}$; $u_{g,t}$ may refer to either the unemployment rate or the participation rate for a specific demographic group g (determined by gender: female or male; age: young (15-24), prime (25-54) or old (55-74[178]); or education level: up to lower secondary education, higher secondary education or tertiary education[179]); y_t is output (measured as ln(GDP)); and ε_t is the usual error term. The regressions are estimated at a quarterly frequency over the period Q1 1997 to Q4 2019 for gender and age groups, and the period Q1 2005 to Q4 2019 for education groups. To analyse whether cyclical sensitivities changed over the period during and after the global financial crisis (GFC), i.e. Q1 2008 to Q4 2019, equation [1] is extended with an additional regressor, namely $\alpha_2 \cdot D_t^{GFC} \cdot \Delta y_t$, where the term D_t^{GFC} is a dummy variable which equals one for the period Q1 2008 to Q4 2019, and otherwise equals zero. The data for unemployment is from the Labour Force Survey, whereas the GDP data is from national accounts.

To examine whether the cyclical sensitivity differs between periods of economic expansion and contraction, the following regression is estimated for each group:

$$\Delta u_{g,t} = \alpha_0 + \alpha_1 \cdot \Delta y_t + \alpha_2 \cdot D_t^{exp} \cdot \Delta y_t + \varepsilon_t \quad [2]$$

where the term D_t^{exp} is a dummy variable which equals one for expansionary periods and zero otherwise. An expansionary period is defined by the condition $\Delta y_t \geq 0$. Table A1.2 reports these estimation results.

Table A1.3 reports the estimate of $\alpha_0/|\alpha_1|$ for each demographic group from Table A1.1, which can be interpreted as the minimum level of output growth needed to reduce the unemployment rate according to the labour force and labour productivity growth.

[178] The age group is 55-64 for the participation rate.

[179] Corresponding with International Standard Classification of Education 2011 levels 0-2, 3-4, and 5-8 respectively.

Table A1.1

Estimation results for equation [1]

(specification in year-on-year differences)

Characteristics:	ΔUnemployment rate Constant	ΔY	ΔY*GFC	ΔParticipation rate Constant	ΔY	ΔY*GFC
Female	0.002	-0.304		0.006	-0.006	
	(0.001)**	(0.032)***		(0.000)***	(0.009)	
Male	0.005	-0.413		0.000	0.031	
	(0.001)***	(0.026)***		(0.000)***	(0.009)***	
p-val. Female = Male		0.000			0.001	
GFC:						
Female	0.002	-0.314	0.018	0.005	0.056	-0.107
	(0.001)**	(0.034)***	(0.044)	(0.000)***	(0.015)***	(0.018)***
Male	0.004	-0.339	-0.129	0.000	0.040	-0.016
	(0.001)***	(0.0297)***	(0.041)***	(0.000)	(0.012)***	(0.015)
p-val. Female = Male		0.199	0.000		0.218	0.000
Lower secondary ed.	0.009	-0.617		0.006	0.378	
	(0.001)***	(0.058)***		(0.001)***	(0.031)***	
Upper secondary ed.	0.002	-0.345		-0.001	0.281	
	(0.001)**	(0.033)***		(0.001)	(0.031)***	
Tertiary ed.	0.002	-0.235		0.000	0.206	
	(0.001)***	(0.031)***		(0.001)	(0.030)***	
p-val. Lower sec. = Tertiary		0.000			0.000	
p-val. Upper sec. = Tertiary		0.000			0.000	
GFC:						
Lower secondary ed.	0.008	-0.464	-0.195	-0.006	0.357	0.026
	(0.002)***	(0.052)***	(0.076)**	(0.001)***	(0.031)***	(0.046)
Upper secondary ed.	0.002	-0.379	0.044	-0.001	0.369	-0.112
	(0.001)***	(0.029)***	(0.034)	(0.001)*	(0.026)***	(0.035)***
Tertiary ed.	0.002	-0.259	0.031	0.000	0.244	-0.049
	(0.001)***	(0.023)***	(0.030)	(0.001)	(0.029)***	(0.036)
p-val. Lower sec. = Tertiary		0.000	0.000		0.001	0.056
p-val. Upper sec. = Tertiary		0.000	0.513		0.000	0.005
Young (15-24)	0.008	-0.782		-0.003	0.118	
	(0.001)***	(0.037)***		(0.001)***	(0.020)***	
Prime (25-54)	0.004	-0.343		0.002	0.020	
	(0.001)***	(0.027)***		(0.000)***	(0.007)***	
Old (55-74)	0.001	-0.194		-0.003	0.210	
	(0.001)**	(0.024)***		(0.001)***	(0.048)***	
p-val. Young = Prime		0.000			0.000	
p-val. Old = Prime		0.000			0.000	
GFC:						
Young (15-24)	0.008	-0.683	-0.171	-0.004	0.190	-0.125
	(0.001)***	(0.048)***	(0.072)**	(0.001)***	(0.030)***	(0.041)***
Prime (25-54)	0.004	-0.302	-0.071	0.002	0.069	-0.085
	(0.001)***	(0.031)***	(0.042)*	(0.000)***	(0.013)***	(0.015)***
Old (55-74)	0.001	-0.193	-0.002	-0.003	0.167	0.077
	(0.001)**	(0.028)***	(0.034)	(0.001)**	(0.095)*	(0.118)
p-val. Young = Prime		0.000	0.013		0.000	0.313
p-val. Old = Prime		0.000	0.003		0.000	0.000

Sources: Authors' estimates using data from Eurostat.
Notes: Robust standard errors in parentheses; * p < 0.10, ** p < 0.05, *** p < 0.01. Sample period is 1997q1-2019q4 for gender and age; 2005q1-2019q4 for education. The estimation for older workers was based on a trend-adjusted participation series. GFC refers to the period 2008:q1-2019:q4.

Table A1.2

Estimation results for equation [2]

(specification in year-on-year differences)

Characteristics:	ΔUnemployment rate Constant	ΔY	ΔY*Boom	ΔParticipation rate Constant	ΔY	ΔY*Boom
Female	0.003	-0.216	-0.166	0.006	-0.014	0.016
	(0.001)***	(0.044)***	(0.069)**	(0.000)***	(0.014)	(0.023)
Male	0.005	-0.426	0.024	0.000	0.030	0.003
	(0.001)***	(0.056)***	(0.076)	(0.000)*	(0.013)**	(0.015)
p-val. Female = Male		0.000	0.000		0.000	0.501
Lower secondary ed.	0.011	-0.520	-0.215	-0.006	0.336	0.113
	(0.003)***	(0.093)***	(0.183)	(0.001)***	(0.043)***	(0.067)*
Upper secondary ed.	0.004	-0.283	-0.139	0.002	0.244	0.098
	(0.001)***	(0.054)***	(0.082)*	(0.001)**	(0.038)***	(0.053)*
Tertiary ed.	0.004	-0.141	-0.208	-0.001	0.175	0.083
	(0.001)***	(0.042)***	(0.068)***	(0.001)	(0.037)***	(0.048)*
p-val. Lower sec. = Tertiary		0.000	0.958		0.000	0.501
p-val. Upper sec. = Tertiary		0.000	0.039		0.000	0.588
Young (15-24)	0.008	-0.772	-0.018	-0.004	0.070	0.095
	(0.002)***	(0.073)***	(0.111)	(0.001)***	(0.033)**	(0.050)*
Prime (25-54)	0.004	-0.313	-0.057	0.002	0.007	0.027
	(0.001)***	(0.050)***	(0.073)	(0.000)***	(0.011)	(0.018)
Old (55-74)	0.002	-0.147	-0.089	-0.002	0.321	-0.224
	(0.001)***	(0.038)***	(0.059)	(0.001)*	(0.087)***	(0.128)*
p-val. Young = Prime		0.000	0.539		0.042	0.125
p-val. Old = Prime		0.000	0.452		0.115	0.010

Sources: Authors' estimates using data from Eurostat.
Notes: Robust standard errors in parentheses; * p < 0.10, ** p < 0.05, *** p < 0.01. Sample period is 1997q1-2019q4 for gender and age; 2005q1-2019q4 for education. The estimation for older workers was based on a trend-adjusted participation series. Boom referes to periods with Δy≥0.

Table A1.3

Estimated threshold GDP growth rates (α0/α1)

Charaoteristios:	all sample	up to 2007:Q4	2008:Q1-2019:Q4
Female	0.66	0.64	0.68
	***	***	***
Male	1.21	1.18	0.86
	***	***	***
Lower secondary ed.	1.46	1.72	1.21
	***	***	***
Upper secondary ed.	0.58	0.53	0.60
	***	***	***
Tertiary ed.	0.85	0.77	0.88
	***	***	***
Young (15-24)	1.02	1.17	0.94
	***	***	***
Prime (25-54)	1.17	1.32	1.07
	***	***	***
Old (55-74)	0.52	0.52	0.51
	**	**	**

Source: authors' calculations.
Note: * p < 0.10, ** p < 0.05, *** p < 0.01.

Table A1.4

Estimated long-run growth rates based on a linear trend model

(estimated coefficients and percentages)

	Coefficient for the linear trend	Implied long-run growth
1970-2008	0.00578	2.33
1999-2008	0.00491	1.98
1999-2019	0.00274	1.10

Source: Abbritti et al. (2021c).

Table A1.5

Model simulations (averages) for the unemployment rate and output growth

(percentage rates or percentage points)

Model variation	UR	Δy	$y^{j}_{t=100} - y^{Ex}_{t=100}$
Benchmark			
Exogenous growth	9.19	1.20	0.0
Endogenous growth	9.15	1.18	-2.27
Baseline			
Endogenous growth & DWR	9.55	1.14	-5.79

Source: Abbritti et al. (2021c).
Note: The last column shows how the combination of shocks leads to lower output and higher unemployment in a model with endogenous growth and downward wage rigidity (DWR) (fifth row).

Annex 2

A.2.1 Models and interest rate rules used in the model-based simulations of make-up strategies

Table A2.1 lists the suite of macroeconomic models for the euro area economy used in the comparative simulation exercise concerning the stabilisation performance of alternative make-up strategies, the findings of which are presented in the main body of this report. In general, the models differ in terms of specification, the set of variables covered and the empirical approaches employed. They comprise structural dynamic stochastic general equilibrium (DSGE) and semi-structural models, closed and open-economy models (in a small open economy or in a multi-country set-up), models with a rich set of financial frictions and, possibly, a banking sector, and a few models that allow for deviations from the strong "rational expectations" assumption typically maintained for structural models. As regards the labour market set-up, the models all follow the New Keynesian approach according to which nominal wage rigidities are the primary source of labour market frictions, while only two of them model unemployment based on the extension of the New Keynesian approach outlined by Galí, Smets and Wouters (2011).

Table A2.1

The suite of models used in the simulations

Model	Empirical approach	Documentation
ECB – NAWM	Estimated, with sample period Q1 1985 to Q4 2014	Coenen et al. (2018)
ECB –SSM (without labour market variables)	Estimated, with sample period Q3 1970 to Q1 2020	Brand and Schneider (2020)
ECB – MMR	Estimated, with sample period Q1 1995 to Q1 2020	Mazelis et al. (2021)
BBk – TANK	Estimated, with sample period Q1 1999 to Q4 2014	Gerke et al. (2020)
BdE – ELMo	Estimated, with sample period Q1 1999 to Q4 2018	Aguilar and Vázquez (2018)
BdF – GSW model with finite planning horizon	Estimated, with sample period Q2 1995 to Q2 2014	Dupraz et al. (2020)
BdF – GSW model with infinite planning horizon		
Bd'I – SW model	Calibrated for inflation and real GDP, with sample period Q4 1999 to Q4 2014	Busetti et al. (2020)
BoF – GSW model with financial sector	Estimated, with sample period Q1 1999 to Q2 2014	Haavio and Laine (2021)
BoL – Non-linear SW model	Estimated, with sample period Q1 1999 to Q2 2014	

Complementing the analysis based on the above suite of models, additional simulations were conducted by Bonam et al. (2021) using a New Keynesian model with two features that ensure rich supply-side dynamics, namely search and matching (SAM) frictions in the labour market and frictional entry and exit of firms in the goods market, as presented in Bilbiie et al. (2012). Firm dynamics imply additional margins of variation in job creation and destruction compared with those implied by SAM frictions.

In conducting the stochastic simulations, the models are exposed repeatedly to random sequences of shocks that have been either estimated or calibrated so that the simulated variables of interest broadly match the variability of the historical data. For a given interest rate rule, the simulations are carried out around the models' non-stochastic steady state with an annual inflation rate of 2% and an annualised equilibrium real interest rate of 0.5%, taking into account the ELB constraint at -0.5%. The outcomes of the stochastic simulations are used to obtain the probability distributions of the annual inflation rate, alternative measures of goods and labour market slack (the output gap, the employment gap and, for the models with a GSW extension, the unemployment gap)[180], and the annualised short-term nominal interest rate. The relevant statistics for assessing the performance of the alternative interest rate rules are then calculated from these distributions.

Table A2.2 reports the numerical specifications of the alternative interest rate feedback rules that are used to represent the alternative make-up strategies considered in the comparative simulation exercise, along with the specification of an inertial Taylor-type rule (shown in the first row of the table), which is representative of the standard inflation-targeting approach and is used as a benchmark for assessing the performance of the make-up rules. This benchmark rule differs from the Taylor (1999) rule only in that it allows for a different feedback coefficient on deviations of annual inflation from target, with a view to better matching the volatility of inflation.

Table A2.2

Specification of the interest rate rules used in the simulations

Inflation targeting (benchmark)	$R_t = 0.85R_{t-1} + 0.15\left(r^* + \bar{\pi}_t^{(4)} + y_t^{gap} + \varphi\left(\bar{\pi}_t^{(4)} - \pi^*\right)\right)$
Average inflation targeting (four-year window)	$R_t = 0.85R_{t-1} + 0.15\left(r^* + \bar{\pi}_t^{(4)} + y_t^{gap} + 4\left(\bar{\pi}_t^{(16)} - \pi^*\right)\right)$
Average inflation targeting (eight-year window)	$R_t = 0.85R_{t-1} + 0.15\left(r^* + \bar{\pi}_t^{(4)} + y_t^{gap} + 8\left(\bar{\pi}_t^{(32)} - \pi^*\right)\right)$
Price level targeting	$R_t = 0.85R_{t-1} + 0.15\left(r^* + \bar{\pi}_t^{(4)} + y_t^{gap} + (p_t - p_t^*)\right)$

Notes: r^* denotes the annualised long-run equilibrium real interest rate, R_t is the annualised short-term nominal interest rate, $\bar{\pi}_t^{(4T)}$ is the annualised average inflation rate over the past T years (equal to the annual inflation rate for T = 1), π^* is the inflation target and y_t^{gap} is the output gap. For some models, the coefficient φ is chosen with a degree of flexibility to match the variability of historical inflation data; for other models it is set equal to 0.5, as in the inertial Tayler (1999) rule. In the price level targeting rule, p_t is the (log-)price level and $p_t^* = p_{t-1}^* + \pi^*$ is the price level target path.

For the average inflation targeting rules, results are not available for every model, yet the coverage of models is deemed sufficient to show the respective boxplots. However, it should be noted that the limited model coverage for these rules partly explains the heterogeneity in the boxplots, especially for the ranges of the normalised standard deviations.

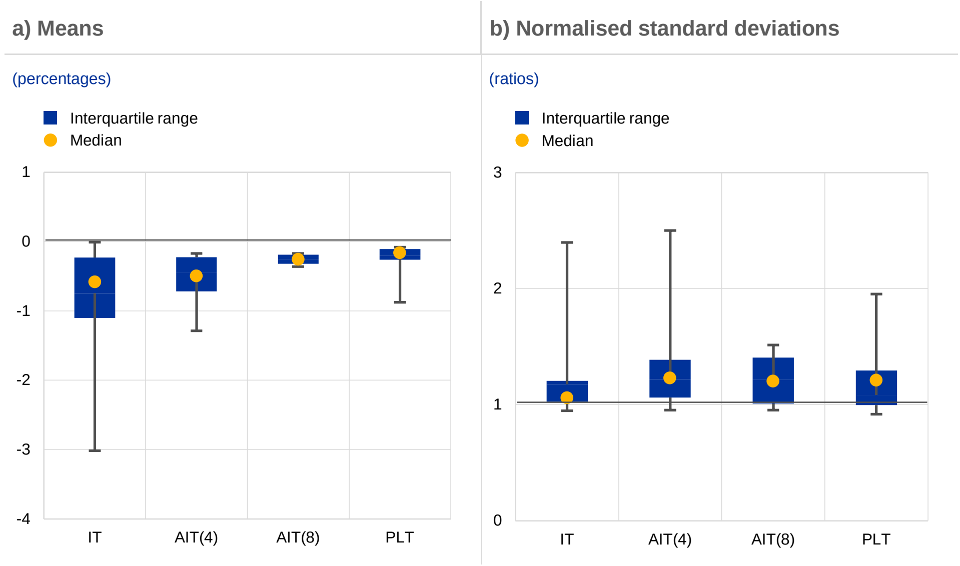
[180] Employment is measured in terms of total employment or hours worked and reported in deviation from the models' respective steady state values. Similarly, unemployment is reported in deviation from the models' steady state unemployment rate.

A.2.2 Additional results of the model-based simulations of make-up strategies

Chart A2.1 shows additional results of the comparative model-based simulation exercise concerning the stabilisation performance of alternative make-up strategies.

Chart A2.1

The implications of make-up strategies for output stabilisation



Source: Eurosystem staff calculations based on simulations with a suite of macroeconomic models. See Table A2.1 in this annex for details.
Notes: This chart depicts boxplots of the means and the standard deviations for the probability distributions of the output gap that are obtained by carrying out stochastic simulations around the models' non-stochastic steady state with an annual inflation rate of 2% and an annualised equilibrium real interest rate set at 0.5%. The simulations are conducted for alternative make-up strategies, notably average inflation targeting (AIT) with a four or an eight-year averaging window, and price level targeting (PLT), taking into account the effective lower bound (ELB) constraint. Inflation targeting (IT) serves as the benchmark strategy for assessing the effectiveness of the make-up strategies. See Table A2.2 in this annex for details. The standard deviations for the individual models are normalised by the standard deviations obtained under the IT strategy, without taking into account the ELB constraint. Output is measured in terms of real GDP and reported in terms of deviation from the models' respective steady state values.

Annex 3

A.3.1 Overview of models for policy simulations featuring heterogeneity

Table A3.1

Overview of model analysis

Author	Type of analysis and parameterisation	Main sources of heterogeneity and definition of unemployment gap	Main features of transmission of shocks	Main implications for monetary policy
Abbritti and Consolo (021b)	TANK model with labour market skill heterogeneity and endogenous growth. The model is calibrated to match the first and second moments of euro area macroeconomic time series as well as the historical incidence of hitting the effective lower bound.	Incomplete markets, aggregate risk shocks, hand-to-mouth consumers and labour market heterogeneity with low-and high-skilled workers. The unemployment gap is defined as the difference between observed unemployment and its steady state value.	The model features an endogenous growth mechanism via investment which increases the persistence of business cycle fluctuations. The search and matching framework and skill heterogeneity also contribute to business cycle amplification effects. The model has an asymmetric impact on certain aggregate shocks because of the wage dynamic of low-skilled workers. Compared to its RANK representation, the TANK (high and low-skilled workers) model generates a flattening of the Phillips curve and more persistent effects on unemployment, mostly driven by low-skilled workers. The model also matches key stylised facts on the wage premium, with high-skilled wages being more severely affected by negative demand shocks. The TANK version of the model also enriches the transmission mechanism of shocks via inequality effects among agents. Compared with the RANK representation, in which consumption inequality works only via the different MPCs of low and high-skilled workers, the TANK representation includes quantitatively important channels via labour income effects driven by both wages and employment dynamics for the two types of workers.	The asymmetric nature of the model combined with the endogenous growth mechanism would call for monetary policy strategies that can accommodate make-up motives. The optimal inflation rate in this class of models is not close to zero. A Taylor rule including the unemployment rate tends to reduce the incidence of the ZLB as well as output and unemployment volatility and hysteresis. However, the average inflation rate (stochastic steady state) from the model simulations is higher than 2%. Monetary policy make-up strategies tend to perform better than Taylor rules as history dependence tends to (i) reduce the incidence of the ZLB, (ii) stabilise the macroeconomy and (iii) achieve the inflation target of 2%. From an inequality/heterogeneity perspective, make-up strategies result in lower unemployment fluctuations for low-skilled workers. Hence, accommodative monetary policy which makes up for past losses in the inflation target helps also to reduce low-skilled unemployment, consumption and labour market inequality.
den Haan et al. (2021)	Calibrated HANK model with ageing. The calibration of structural parameters is in line with euro area business cycle literature, with equal shares of young workers, experienced workers, and retirees. Labour market characteristics follow stylised facts in the literature, mainly based on the US economy.	Individual uninsurable income risk from unemployment, income risk from ageing and borrowing constraints. The unemployment gap is defined as the difference between observed unemployment and its steady state value.	In the model, households save for two different reasons: on the one hand, they are subject to unemployment risk (and borrowing constraints) and save to smooth consumption; on the other hand, they need to save to ensure consumption in the retirement phase when they lose their labour income. When households retire, their savings are transformed into an annuity linked to the long-term sovereign bond rate. Thus, monetary policy has an effect via multiple channels: 1. substitution effects for all households caused by lowering the marginal rate of transformation of actual consumption into future consumption (as in any New Keynesian model); 2. an income effect for more indebted households that see a reduction in their interest expenses (as in many other HANK models); 3. a wealth effect for households close to retirement that goes in the opposite direction to channels 1 and 2.	While persistent monetary policy easing strategies can have adverse partial-equilibrium effects on returns to retirement savings, the positive employment effects of such policies dominate in general equilibrium. Once general equilibrium effects are taken into account, all cohorts benefit from low interest rates through higher labour income, with the poorest households benefiting most and inequality declining.

Fernández-Villaverde et al. (2021)	Calibrated and partially estimated heterogeneous agent New Keynesian (HANK) model. The calibration strategy aims to match selected stylised facts found in the literature on US business cycles and inequality.	Individual uninsurable income risk and aggregate preference risk. While households are subject to idiosyncratic shocks that determine the efficiency unit of hours supplied by each household, there are no unemployed households and therefore no unemployment gap measure exists.	The presence of idiosyncratic risk reduces the real interest rate in the deterministic steady state of the HANK economy. Precautionary savings reduce the central bank's room for manoeuvre, as they alter the zero lower bound (ZLB) frequency, and consequently affect the behaviour of macroeconomic variables in the stochastic steady state (SSS). The interaction of aggregate uncertainty with wealth heterogeneity further increases precautionary savings in the SSS, and thus exacerbates the downward force on the real interest rate vis-à-vis the representative agent New Keynesian (RANK) economy. As ZLB events disproportionately affect wealth-poor agents, the presence of aggregate uncertainty and the possibility of the occurrence of large recessions in which the policy rate is constrained leads households – especially those at the bottom of the wealth distribution – to increase their precautionary savings (or equivalently, reduce their borrowing positions).	The level of real interest rates in standard New Keynesian models is determined by structural parameters, with the choice of monetary policy having no impact on the long-run value. In contrast, this model features precautionary savings that lead to an equilibrium level for the real rate which depends on households' expectations about the costs of experiencing a ZLB event. Since the monetary authority can alter the frequency of the ZLB spells by modifying its dynamic behaviour in response to macroeconomic fluctuations, the choice of monetary policy strategy ends up affecting households' precautionary savings and, eventually, the level of real interest rates.
Ferrari et al. (2021)	Estimated HANK model with search frictions on the labour market. The model is estimated based on reconstructed series of labour market data, with some parameters calibrated externally. Labour market parameters are taken from the literature on labour markets and business cycles in the euro area, while for parameters of the New Keynesian model the main reference is the New Area-Wide Model (NAWM) II.	Individual uninsurable income risk (unemployment) and borrowing constraint. The unemployment gap is defined as the difference between observed unemployment and its steady state value.	At the micro level the model has two main features: 1. the existence of uninsurable unemployment risk induces precautionary savings from all households as compared with a RANK model; 2. the existence of a borrowing constraint further amplifies the heterogeneity of marginal propensities to consume out of income. At the aggregate level the existence of a frictional labour market with precautionary savings amplifies business cycle fluctuations. Indeed, an adverse demand shock determines a feedback loop whereby aggregate demand is lowered more than in a RANK model: as households increase precautionary savings, firms reduce vacancy postings, thus lowering the probability of becoming employed for households, who, in turn, raise precautionary savings further.	The deflationary bias and the heightened volatility implied by the lower bound are further amplified by the existence of heterogeneity. As a result, average inflation reached by an inflation targeting central bank is lower than in the RANK representation. The model also offers insights on the effects of different policy strategies on inequality: by lowering the incidence of the lower bound, make-up strategies reduce the average share and volatility of borrowing-constrained (poorer) households.
Herman and Lozej (2021)	Calibrated HANK model with search frictions on the labour market. The calibration of the labour market aims to match stylised facts on employment risk dispersion over the business cycle in the euro area economy. Some parameters on idiosyncratic income risk and the amount of liquid wealth are taken from the literature.	Individual uninsurable income risk (wage changes and unemployment). The unemployment gap is defined as the difference between observed unemployment and its steady state value.	Uninsurable idiosyncratic income risk generates higher marginal propensities to consume out of income for poor agents, who have a particularly strong income channel and a very weak intertemporal substitution channel. Labour markets are segmented, with more volatile employment prospects for low-wage households than for high-wage households. A stronger reaction of poor agents' labour income to monetary policy shocks leads to amplification of monetary policy effects: when poor agents obtain employment after monetary easing (consistent with poor agents' higher worker betas in the data), most of their income is spent, which means that aggregate demand responds strongly. This leads to amplification effects, as stronger aggregate demand requires a stronger hiring response, which again leads to relatively more employment of poor agents. The responses in the model without the differences across labour market segments are more attenuated, because a greater proportion of new jobs is obtained by richer households with lower marginal propensities to consume.	When worker betas of poor households are higher than those of rich households, monetary policy has stronger effects on aggregate demand than in a model with homogeneous labour markets. This applies to standard monetary policy as well as to forward guidance. Monetary policy effects are more persistent than in standard RANK models because of persistent changes in the wealth distribution.

Jacquinot et al. (2018)	Calibrated global dynamic stochastic general equilibrium (DSGE) model with most parameters similar to those in the standard euro area and global economy (EAGLE) model, but with regional labour markets calibrated to mimic stylised facts regarding regional labour market characteristics, such as matching probabilities, unemployment rates, and wage rigidities in various regions.	Multi-country model with country-specific search and matching frictions in the labour market. The unemployment gap is defined as the difference between observed unemployment and its steady state value.	This is a global, multi-country representative agent model where two countries form a monetary union. The model features equilibrium unemployment with search and matching frictions. Sources of heterogeneity between countries are due to different nominal and real rigidities as well as labour market institutions, which lead each country to respond differently to a common shock. Important features of the model are a common euro area-wide monetary policy and spillovers across countries through trade linkages. While policy transmission is mainly explained by the standard intertemporal substitution channel, its manifestation in each country is significantly affected by nominal and real rigidities, including labour market frictions.	Short-run labour market dynamics can be significantly affected by the monetary policy stance. When policy is accommodative, the price of labour services increases as firms satisfy higher aggregate demand and demand more labour to augment production. A higher price of labour services leads to higher profits of labour agencies that intermediate between firms and households, as wages do not adjust instantaneously. The value of having a worker for a labour agency increases, which leads to more vacancy postings. As a result, employment increases and unemployment decreases. A higher job-finding probability for workers and higher wages imply that the value of being in an employment relationship increases, while the value of being unemployed also increases because the prospects of finding a job improve. Because the value of unemployment is a threat point in wage bargaining (as workers' outside option has more value), they can achieve higher wages in the bargaining process.

A.3.2 Protocol for counterfactual monetary policy simulations with models featuring heterogeneity

This section of the annex presents protocols for running simulations with models featuring heterogeneity. The first part presents specifications for calculating impulse response functions (IRFs) to monetary policy easing, demand, and supply shocks. The second part presents specifications for running simulations with an ELB constraint.

Impulse response functions

The purpose of the IRFs is to illustrate differences in the transmission of monetary policy shocks to different groups of society, and how the transmission differs between HANK and RANK models. Furthermore, the exercises should illustrate how the presence of the ELB affects the results in a HANK model.

IRFs to a monetary policy shock

Specification of the exercise:

- Calibrated to a 100-basis point decline in interest rate
- Where possible, the RANK version of the model should be calibrated in the same way

Rule:

- Benchmark rule

IRFs to an adverse demand shock

Specification of the exercise:

- Calibrated to an ELB duration of four quarters
- The ELB should be set 300 basis points below the model steady state nominal interest rate rather than at a specific level
- Where possible, the exercise should also be done with a corresponding RANK version of the model

Rules (make-up strategies as far as feasible):

- Benchmark interest rate rule
- Average inflation targeting over four years

IRFs to an inflationary technology shock

Specification of the exercise:

- Calibrated to a 100-basis point increase in inflation above the target of 2%

Rule:

- Benchmark interest rate rule, with two versions:
  - Benchmark rule with zero weight on unemployment gap
  - Benchmark rule with weight on unemployment gap (see equations below)

Simulation exercises

Specification of the exercise:

- The simulations should be run with and without an ELB.
- The ELB should be set 300 basis points below the model's steady state nominal interest rate rather than at a specific level.
- It is left up to the teams to specify the number of simulations. A typical example is running 1000 simulations for 150 periods and dropping the first 50 periods as burn-in.

Rules:

- Benchmark interest rate rule
- Asymmetric interest rate rule

Interest rate rules

The annual inflation target in all the rules should be set at 2%.

Benchmark inertial Taylor (1999) rule

$$R_t \;= 0.85R_{t-1} + 0.15\left(r^* + \bar{\pi}_t^{(4)} + 2u_t^{gap} + 0.5\left(\bar{\pi}_t^{(4)} - \pi^*\right)\right)$$

where R_t is the annualised nominal interest rate, r^* is the annualised long-run equilibrium real interest rate, $\bar{\pi}_t^{(4)}$ is the annual price inflation rate ($\bar{\pi}_t^{(4)} = \sum_{i=1}^{4} \pi_{t-i+1}$), π^* is the annual inflation target and u_t^{gap} is the unemployment gap.

Asymmetric inflation targeting rule

$$R_t \;= 0.85R_{t-1} + 0.15\left(r^* + \bar{\pi}_t^{(4)} + 2u_t^{gap} + 0.5\left(\bar{\pi}_t^{(4)} - \pi^*\right) + I_{\left[\bar{\pi}_t^{(4)} < \pi^*\right]}\varphi\left(\bar{\pi}_t^{(4)} - \pi^*\right)\right)$$

where R_t is the annualised nominal interest rate, r^* is the annualised long-run equilibrium real interest rate, $\bar{\pi}_t^{(4)}$ is the annual price inflation rate ($\bar{\pi}_t^{(4)} = \sum_{i=1}^{4} \pi_{t-i+1}$), π^* is the annual inflation target and u_t^{gap} is the unemployment gap.

The weight on the annual inflation shortfall should be set to φ = 0.5. The inflation target should be set at 2.0%.

Average inflation targeting

In the case of average inflation targeting, it is proposed to consider an averaging window of four years. The numerical specification of the rules can be written as

$$R_t \;= 0.85R_{t-1} + 0.15\left(r^* + \bar{\pi}_t^{(4)} + 2u_t^{gap} + \mathrm{T}\left(\bar{\pi}_t^{(4T)} - \pi^*\right)\right)$$

where in this case, T is the averaging window (four), and $\bar{\pi}_t^{(4\mathrm{T})}$ is the annualised average inflation rate over the past T years.

Postal address 60640 Frankfurt am Main, Germany
Telephone +49 69 1344 0
Website www.ecb.europa.eu

This paper can be downloaded without charge from the ECB website, from the Social Science Research Network electronic library or from RePEc: Research Papers in Economics. Information on all of the papers published in the ECB Occasional Paper Series can be found on the ECB's website.

PDF ISBN 978-92-899-4829-6, ISSN 1725-6534, doi: 10.2866/04288, QB-AQ-21-018-EN-N