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The need for an inflation buffer in the ECB's price stability objective – the role of nominal rigidities and inflation differentials

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Abstract

The existence of nominal rigidities and inflation differentials between countries offers two of the main rationales for an inflation buffer in a monetary union where monetary policy is oriented towards an area-wide inflation objective. Evidence accumulated since 2003 suggests that nominal rigidities remain a prevalent feature of the euro area, with some differences as regards prices and wages. Price setting may have become more flexible and there is no evidence for any especially strong downward rigidities in price setting. At the same time, persistent downward nominal wage rigidity (DWR) provides a strong argument for a positive inflation buffer to "grease the wheels" of the euro area economy – also in order to avoid the risk of macroeconomic adjustments being managed in terms of quantities (unemployment) rather than prices when DWR is binding and particularly when productivity growth is low. Inflation differentials across euro area countries have tended to be small but persistent. For inflation dispersion in the euro area, the across countries has been more important than across regions, confirming that an inflation buffer might be especially important in a monetary union of different countries. Overall, inflation differentials were due to the rise of economic and financial imbalances in the first decade of the euro and the subsequent need for adjustment. Balassa-Samuelson effects which were highlighted in the 2003 strategy review were only a minor factor. By and large, the ECB's inflation objective seems to have provided a sufficient margin to prevent countries from having to live with prolonged periods of excessively low inflation rates in the period 1999-2019. There were some exceptions in the second decade of the euro (from 2009-2019), when inflation in the euro area was, overall, substantially lower than during the first decade.

JEL codes: E31, E52, E24.

Keywords: Monetary policy strategy review, HICP inflation, nominal rigidities, inflation differentials.

Executive summary

This paper discusses two of the main rationales for an inflation buffer in a monetary union where monetary policy is oriented towards an area-wide inflation objective: nominal rigidities and inflation differentials. While the 2003 strategy review focused mainly on the conceptual aspects of these nominal rigidities and inflation differentials as arguments for a positive inflation buffer, considerable empirical evidence has been gathered since then. Each of the factors provides a standalone rationale for an inflation buffer, although the two can also interact.

Evidence accumulated since 2003 suggests that nominal rigidities remain a prevalent feature of the euro area, but with some differences as regards prices and wage rigidities.

Price setting may have become more flexible and there is no evidence of any especially strong downward rigidities. Based on the evidence obtained from the Inflation Persistence Network, the ECB Corporate Telephone Survey and the PRIce-Setting Microdata Analysis Network (PRISMA), consumer prices, on average, remain unchanged for several quarters. However, there is significant sectoral heterogeneity around this average, with more frequent changes for energy and unprocessed food and less frequent ones for non-energy industrial goods and services. Since the last strategy review, the frequency of price changes appears to have increased substantially for non-energy industrial goods, although not as much for services. While the share of decreases in overall price changes remains lower than the share of increases, the average size of the decreases tends to be somewhat larger. Overall, there is no evidence for strong downward price rigidities in the euro area. Nevertheless, given that relative prices of goods tend to decrease over the life cycle of the product, the overall frequency of price changes may still be relatively low, which would suggest a need for a positive inflation buffer to minimise misallocations over time.

Nominal wage rigidities across euro area countries have remained high compared with the most flexible advanced OECD economies, and evidence gathered during the sovereign debt crisis suggests that downward nominal wage rigidities (DWRs) remain prevalent. The Wage Dynamic Network (WDN) finds that wage contracts in the euro area are staggered and sticky, and DWR is found to be important across euro area countries. Nominal wages are often frozen during a crisis, but very rarely cut. Adjustments thus led to nominal wage changes clustering at zero. At the same time, the WDN results point to adjustments in firms' wage bills during the financial and sovereign debt crises via other labour market margins such as variable pay, more flexible types of contract and hours worked. Structural policies implemented to support economic resilience and higher economic growth have contributed to increasing labour market flexibility, but may have made DWR more binding.

DWR provides a strong argument for a positive inflation buffer to support the euro area economy. The high costs associated with unemployment following the need for rebalancing after the financial and sovereign debt crises emphasise the risk of

macroeconomic adjustments being managed in terms of quantities (unemployment) rather than prices when DWR is binding. This risk can be moderated by a positive inflation buffer.

The argument for a positive inflation buffer is reinforced in a persistent low-inflation and low-productivity environment with DWR. In such an environment nominal wage growth is likely to be low, leaving very little room for nominal adjustments if DWR prevails, and hence increasing the risk of an adjustment in terms of quantities. Limited adjustment to real wages in such an environment has an impact on firms' profitability, with persistently negative effects on hiring and investment and hysteresis effects on output and unemployment. The effect on output and unemployment is also related to the joint degree of flexibility in prices and wages. If prices become more flexible than wages, the protracted adjustment in real wages could lead to hysteresis effects on output and unemployment.

Average inflation differentials have been relatively small across euro area countries, with an average standard deviation of below 1 percentage point. The difference between the highest average and lowest average for both HICP and HICPX (HICP excluding energy and food) inflation was a mere 0.7 percentage points in the euro area 12 countries in the period 1999-2019 and 1.6 percentage points for all 19 euro area countries. While cyclical developments played a key role in inflation dispersion in the euro area, a substantial part of this can be linked to dispersion in more persistent inflation trends. It is the dimension across countries that has been key rather than across regions, confirming that an inflation buffer may be especially important in a monetary union of different countries. Overall, inflation dispersion across euro area countries has been only slightly higher than, for example, across US regions.

By and large, the ECB's inflation objective seems to have provided a margin which was sufficient to prevent countries from having to live with excessively low or even negative inflation rates in the period 1999-2019. In the first decade following the launch of the euro the 2% headline inflation buffer was enough to prevent countries from having to live with negative inflation rates for prolonged periods of time. During the second decade – from 2009 to 2019 – the picture changed and episodes of negative HICP headline rates and even negative HICPX rates occurred in the aftermath of the financial and sovereign debt crises. Correcting for the upward effects of indirect taxes expands and prolongs most of these periods of negative HICPX inflation. The periods of negative inflation observed in individual countries emerged in an environment of low inflation for the euro area as a whole. A simple counterfactual analysis suggests that periods with negative inflation rates in euro area countries during the second decade of the euro would have been less pronounced, but would not have been completely avoided, if the euro-area wide inflation objective of "close to, but below 2%" had been met. These episodes underline how important the inflation buffer is in the face of asymmetric shocks, implying both negative and positive deviations from the inflation target across countries.

Inflation differentials have remained persistent and only changed sign in many countries between the first and second decades due to the build-up and subsequent

partial correction of imbalances. In the first decade of the euro, inflation differentials were in line with convergence in price levels, but were only in a few countries accompanied by a lasting convergence in income levels. The Balassa-Samuelson argument discussed prominently in the 2003 strategy review does not seem to have been the key driver of the inflation differentials actually observed. These were mainly a by-product of unsustainable growth in lower income economies which, in the presence of high nominal wage growth and comparatively weak productivity dynamics, led to a loss of competitiveness and high current account deficits in some cases. In the second decade of the euro, the need to unwind these unsustainable imbalances and regain competitiveness led to a reversal of inflation differentials. Countries with lower price levels recorded lower-than-average inflation rates, but this was typically at a high cost in terms of unemployment. Structural differences in the composition of consumption baskets across euro area countries played only a limited role in inflation differentials in the euro area.

Inflation differentials that imply negative inflation rates for some countries are particularly harmful if they are combined with high DWR. An inflation buffer limits the risk of long-lasting adjustment processes from asymmetric shocks (or from common shocks that affect euro area countries asymmetrically) leading to deflationary outcomes.

It should be noted that the different reasons for an inflation buffer – e.g. nominal rigidities and inflation differentials – cannot simply be added up to calculate the appropriate size of the buffer. This requires a holistic assessment of the different rationales for the buffer, including the possibility of a systematically positive error in the measurement of inflation, and the importance of reducing the likelihood of nominal interest rates reaching the effective lower bound (see Work stream on inflation measurement, 2021; Work stream on the price stability objective, 2021).

1 Introduction

There are several important rationales for including an inflation buffer in the formulation of the euro area price stability objective. The 2003 strategy review[1] covered four main aspects: i) accounting for a (possible) systematically positive error in the measurement of inflation; ii) reducing the likelihood of nominal interest rates reaching the effective lower bound, iii) facilitating the real adjustment (in particular that of real wages) to shocks in the presence of DWR; and iv) avoiding protracted periods of deflation and high adjustment costs (also linked to nominal rigidities) in countries with sustained negative inflation differentials.

The analyses conducted as part of the 2020-21 strategy review confirm the fact that the rationales applied in the 2003 strategy review are still valid. The inflation measurement work stream concluded that a positive bias still exists in the measurement of HICP and that there is no clear evidence that this bias has declined significantly since the last strategy review (see Work stream on inflation measurement, 2021). The price stability objective work stream confirmed the value of an inflation buffer over the medium term to avoid situations in which the nominal interest rate is constrained by the effective lower bound (see Work stream on the price stability objective, 2021). This is even more relevant in the context of a substantial decline in the equilibrium real interest rate since the 2003 strategy review and the prolonged period of low inflation the euro area experienced from 2013 to 2019 (before the launch of the ECB's strategy review), during which nominal policy interest rates were close to the effective lower bound (see Koester et al., 2021).

This paper focuses on two of the main rationales for an inflation buffer: nominal rigidities and inflation differentials. Each of these factors provides a standalone rationale for an inflation buffer, although the two can also interact.

Nominal rigidities can result in price adjustments not being sufficiently rapid to facilitate efficient resource allocation. They play a decisive role in determining the effects of different shocks on the economy. To the extent that nominal rigidities make prices sticky and allow prices and wages to react only sluggishly to demand or cost shocks, they create inefficiencies and welfare costs. If prices move smoothly, central banks are better able to steer inflation without creating undesired variability in output and employment.[2] Structural reforms can play an important role in reducing nominal rigidities[3]– and thereby support the working of monetary policy – although nominal rigidities can be seen as unavoidable to some extent and should be taken into consideration in any review of monetary policy strategy.

The existence of nominal rigidities can be an important argument for a positive inflation buffer. In monetary economic models, price adjustment costs and the resulting nominal rigidities are usually seen as calling for an optimal inflation target of

1 See Issing, O. (ed.) (2003).

2 See, for example, Altissimo et al. (2006); European Central Bank (2005); European Central Bank (2016); Druant et al. (2012).

3 See, for example, Masuch et al. (2018).

around zero[4] – which should minimise the welfare costs of sticky prices (Work stream on the price stability objective, 2021). But there are also three strands of argument in support of a positive inflation buffer based on nominal rigidities.

First, a positive inflation buffer might be needed when firms are hesitant to cut prices in practice. This could be because of a desire to increase profit margins, DWR (see below), or for any other reason. In this case a positive inflation buffer would facilitate adjustments of (relative) prices without any need for outright cuts, thereby helping to avoid allocative inefficiencies.

Second, sticky prices might call for a positive inflation buffer if the relative prices of products decline over their life cycle. In this case infrequent price adjustments would require a positive inflation buffer to minimise price and quantity misalignments.[5]

Third, a positive inflation buffer is especially important in the case of DWR, to ensure that adjustments to negative shocks do not need to be made largely through employment losses (i.e. quantities).[6] A positive inflation target "greases the wheels" of the labour market in response to both common and asymmetric shocks by facilitating relative real wage adjustments across countries or regions. It plays an especially important role in a monetary union as country-specific shocks cannot be cushioned by exchange rate adjustments or by national monetary policy. This effect is relevant from both a cyclical and a long-run perspective. New Keynesian models with an endogenous productivity growth mechanism featuring price stickiness and DWR provide a rationale for breaking the long-run monetary policy neutrality hypothesis and making the equilibrium rate of unemployment a function of the target rate of price inflation.[7] In an environment with persistently low inflation and productivity growth, DWR may become more binding and may lead to a persistently higher unemployment rate and lower output growth following an adverse demand shock.

Inflation differentials are a normal feature of any currency union and can arise for many reasons, including temporary and structural factors. A single monetary policy cannot address such differentials, in exactly the same way that in an individual country monetary policy cannot reduce inflation differentials across sectors, regions or cities. However, the size and persistence of inflation differentials across countries can have important implications for setting the optimal inflation target in a monetary union and for a positive inflation buffer. An inflation buffer helps to prevent a situation arising where some countries or regions have to live with excessively low or even negative inflation rates while others experience higher rates. This risk is more pronounced in periods of persistently low inflation – e.g. in the euro area from 2013 to the start of the pandemic (see Koester et al., 2021).

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4 See, for an overview, Schmitt-Grohe and Uribe (2010).

5 See Adam et al. (2021).

6 See also Kim and Ruge-Murcia (2009).

7 While standard New Keynesian models with symmetric price and wage stickiness show no long-run trade-off between inflation and unemployment, Tobin (1972) and Akerlof et al. (1996a) provide a rationale based on DWR for breaking the long-run monetary policy neutrality hypothesis which is based on asymmetric wage rigidity. See Section 2.3 for further analysis.

Downward nominal rigidities and inflation differentials are closely linked, reflecting potentially substantial adjustment costs and the extent to which an inflation buffer is needed. Nominal rigidities can be an important cause of inflation differentials. In the case of asymmetric shocks nominal rigidities can prevent smooth adjustment in the countries hit by the shock and can then lead – depending on the extent of the rigidities – to persistent inflation differentials. Based on cross-country differences in the level of nominal rigidities, common shocks can also lead to inflation differentials across countries, as the adjustment processes will be smoother in countries with a lower level of nominal rigidities. In such cases an inflation buffer can ensure that the inflation differentials caused by processes of adjusting to shocks do not imply negative inflation rates for individual countries. At the same time, the presence of sizeable and persistent differences in average inflation between different countries in the euro area could exacerbate the cost of downward nominal rigidities in countries with inflation rates which are lower than the euro area average if a part of the adjustment needs to take place via quantities instead of prices. In addition, some countries could be pushed into periods of protracted deflation.

This paper takes stock of changes in nominal rigidities and inflation differentials as well as their interlinkages. It discusses the implications of a need for an inflation buffer in the euro area. Chapter 2 reviews changes in the degree of price and wage rigidity in the euro area, focusing in particular on the role of DWR. Chapter 3 discusses changes in inflation differentials and their drivers. Chapter 4 concludes.

2 Nominal rigidities in the euro area and their implications for an inflation buffer

The 2003 ECB strategy review focused mainly on the conceptual aspects of nominal rigidities. Since 2003, considerable empirical evidence has been gathered on changes in nominal rigidities. This is based, for example, on the Eurosystem Inflation Persistence Network (IPN), the Wage Dynamics Network (WDN) and the PRIce-Setting Microdata Analysis Network (PRISMA). The evidence on price and wage rigidities is discussed in Sections 2.1 and 2.2 respectively. Moreover, advances in research have shown how important an inflation buffer is in the presence of downward nominal rigidities. Section 2.3 includes a model-based analysis of a general equilibrium model, including a currency union version, with downward nominal wage rigidity (DWR).[8]

2.1 Evidence on the changes in price rigidities in the euro area based on studies using micro data

Price stickiness can provide strong arguments for a positive inflation buffer. Key aspects to assess are how sticky prices are (i.e. how (in)frequently they change) and whether there is any evidence that firms – for whatever reason– are hesitant to cut prices.[9]

The IPN conducted an in-depth study of inflation persistence and price stickiness in the euro area.[10] Based on a broad set of macro data and micro data, the IPN analysed the presence, characteristics and determinants of price rigidities.

The IPN found a moderate degree of inflation persistence in the euro area, albeit with significant sectoral heterogeneity. Prices in sectors that produce items for private consumption (which are included in the CPI) were found, on average, to be unchanged for several quarters (see Chart 1). Price changes were more frequent in the energy and unprocessed food sector, while non-energy industrial goods and services demonstrated a higher degree of price stickiness. Price decreases were found to be relatively frequent, albeit to a lesser extent for services.

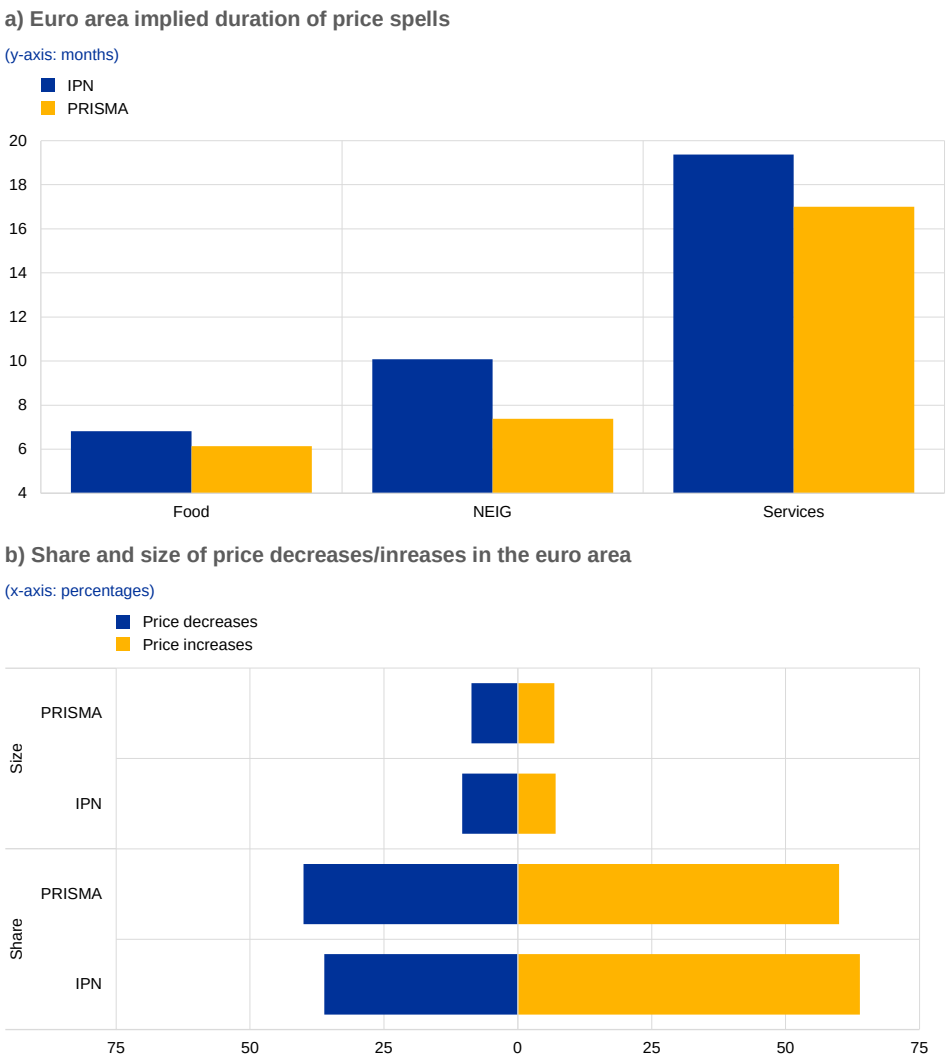
8 Throughout this paper DWR stands for downward nominal wage rigidities as the focus is on the nominal lower bound constraint of wage agreements – which reflects the reluctance to propose and agree on nominal wage cuts in wage bargaining.

9 Frequency of adjustment is even more important as a measure of stickiness in the absence of selection effects, which is supported by recent analyses of micro data (see Karadi et a. 2021).

10 See, for example, Altissimo et al. (2006); European Central Bank (2005).

Chart 1

Nominal rigidities in the euro area – IPN versus PRISMA results



Sources: Gautier et al. (2021): PRISMA update of IPN results; Dhyne et al. (2006): IPN results.
Note: For details of PRISMA data see Box 1.

More recently, a study using micro data underlying euro area CPIs within PRISMA indicates that price setting may have become more flexible. An increase in the flexibility of prices (in terms of more frequent adjustments)[11] was observed, especially in non-energy industrial goods as well as food products, although less so in services (see Chart 1 and, for details, Box 1). In addition, the average size of price increases and decreases is slightly larger, based on PRISMA data. The share of decreases in price changes also increased slightly. The frequency of price changes is now similar to that of the United States, while average price changes are much greater in the United States, even when price changes due to sales or promotions are excluded (for details see Box 1).

11 Such an increase in price flexibility is suggested when comparing PRISMA and IPN data, which rely, in principle, on comparable data sources. Nonetheless it should be kept in mind that differences in coverage and methodology – particularly methodology related to sales – may make IPN and PRISMA numbers difficult to compare.

A survey of firms confirms that prices usually remain unchanged for several quarters. In 2019 the ECB carried out a survey of leading euro area firms of their price-setting behaviour (see Box 2 for details). Most retailers said that they reviewed prices on a monthly, weekly or even daily basis, depending on their range of products. They also tended to change prices frequently. In the manufacturing sector, price reviews were typically carried out monthly, although prices usually only changed on a quarterly, semi-annual or annual basis. Meanwhile, excluding retail trade and transport (where prices are driven in part by the fuel element), firms in most other services sectors said they typically reviewed and changed prices annually.

Overall, studies of micro data suggest that nominal price rigidities remain a prevalent feature of the euro area, but they do not provide evidence in support of especially strong downward price rigidities. While the share of price decreases in overall price changes has remained lower than the share of price increases in PRISMA and IPN analyses, the average size of the price decreases tends to be somewhat larger, especially in the latest PRISMA analysis. Lower inflation tends to result from a larger number of price cuts, while the size of these price cuts does not move with inflation (see Box 1).

Studies which include the frequency of price changes based on PRISMA data and address the fact that, for example, the relative prices of goods tends to decrease over their life cycle suggest that a substantial positive inflation buffer would be needed to minimise misallocations over time. Adam et al. (2021) estimate that the positive inflation buffer needed to account for these effects of price stickiness might be well above 1% in the euro area.

Box 1

Insights from the PRISMA research network into consumer price nominal rigidities in the euro area

This box summarises the paper produced by Gautier et al. (2021). It presents the results for the degree of nominal rigidities in consumer prices based on CPI micro data for the euro area within PRISMA. The study complements the evidence on price rigidity for the euro area provided by the IPN.[12] PRISMA has analysed about 130 million individual price quotes underlying the HICP of 11 countries, which together represent nearly 90% of the euro area HICP aggregate. Gautier et al. (2021) expand previous evidence to include the most recent period of persistently low inflation. They also cover a much larger share of the euro area HICP (60%) in terms of products.[13]

In the euro area, only 12% of consumer prices change in a given month

Two-thirds of all price changes are increases. Country differences are very limited but sectoral heterogeneity is much more pronounced (6% of services prices are modified each month versus

12 Summarised in Dhyne et al. (2006).

13 The common sample covers 166 COICOP-5 groups (available to at least three of the four largest euro area country price data sets), implying a much larger share of the total euro area HICP basket than for the IPN analysis (which focused on 50 products covering a maximum of 14% of the HICP).

30% of unprocessed food prices; see Table A).[14] A cross-sectoral analysis shows that the higher the share of imported energy and raw materials input and the lower the share of labour, the more frequently prices change. Excluding price changes arising from sales and temporary promotions lowers the share of price changes to about 8.5%. By contrast, the data show that US price changes are more frequent than those of the euro area. However, excluding sales and promotions, which account for about 4 percentage points of the frequency of price changes in the United States, the difference is smaller, reflecting more frequent sales in the US rather than more frequent changes in regular (non-sales) prices. This is important for the nexus between nominal price rigidities and monetary policy transmission, as research shows that regular prices respond to monetary policy shocks while sales do not.

Typical price changes are fairly large: the median price increase is 11% and the median price decrease is 15%. As with frequencies, we find a low level of heterogeneity across countries and more pronounced differences across broad sectors. Accounting for sales, both the median price increase and the median price decrease are lower (8% and 10% respectively). Moreover, the price change distribution is quite dispersed, as both very small and very large price changes are not uncommon: 10% of all price changes (absolute values and excluding) are below 1.9% and 10% are higher than 18%. In comparison with US data,[15] price changes are, on average, much larger in the United States even when changes due to sales or promotions are excluded. In summary, while the frequency of price changes excluding sales is similar in the United States and the euro area, price changes are larger in the United States.

Table A

Frequency and size of consumer price changes in the euro area

(percentages)

All numbers in percentages	Frequency of price changes		Fraction of price increases		Average size of price increases		Average size of price decreases	
	Incl. sales	Excl. sales	Incl. sales	Excl. sales	Incl. sales	Excl. sales	Incl. sales	Excl. sales
Total	12.3	8.4	64.3	69.8	11.3	8.3	14.5	10.1
Unprocessed food	31.2	23.2	54.5	58.4	16.1	12.5	18.1	13.1
Processed food	14.9	10.1	57.7	63.1	10.9	7.4	12.6	7.8
NEIG	12.5	6.2	48.6	61.1	15.7	10.0	20.4	12.5
Services	6.2	5.8	84.7	84.4	6.4	6.3	9.1	8.2
US – total	19.3	10.0	62.0	71.2	17.8	10.6	21.6	13.4

Source: Gautier et al. (2021).

Comparing results across time: an update of IPN and new time series evidence

A comparison of the PRISMA and IPN results poses a number of challenges relating to coverage in respect of countries, products and methodology. A detailed comparative exercise was conducted by focusing on exactly the same 50 products[16] in a smaller number of countries (Belgium, Germany, France, Italy and Austria). The IPN results for the period 1996-2003 were compared with those using PRISMA data for a common sample over the period 2011-17. The main result is that – except

14 More detailed results on heterogeneity across sectors and across countries can be found in Gautier et al. (2021).

15 For evidence on the United States, see Nakamura and Steinsson (2008).

16 Although some products are not available in some countries.

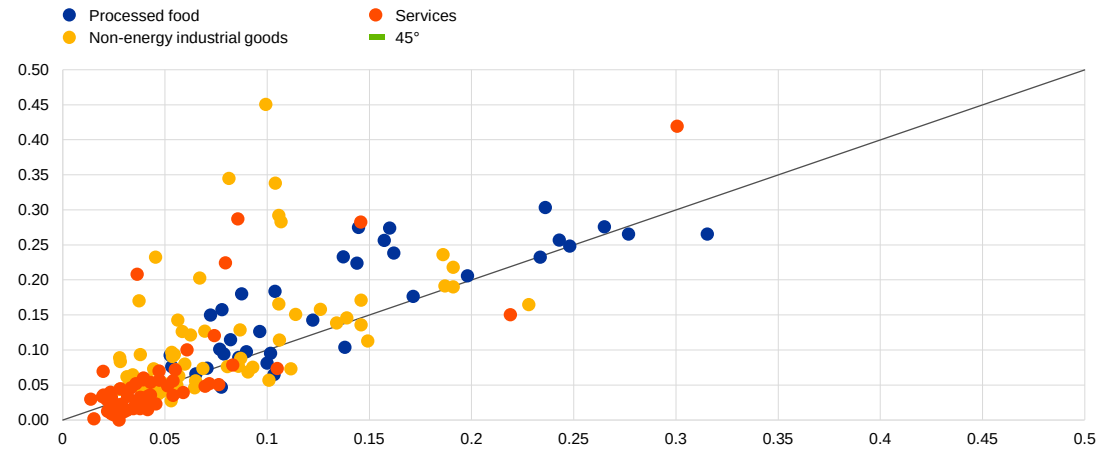
in France – the prices of these products have become more flexible, particularly in Germany and Austria and especially for non-energy industrial goods (see Chart A).[17]

Chart A

Frequency of price changes: a comparison of IPN (x-axis) and PRISMA (y-axis) results

Each dot corresponds to a product category

(percentages)



Source: Gautier et al. (2021).

Over the last 10 to 15 years, we have been able to rely on the full dataset of micro prices for each country.[18] There appears to be no significant trend for the frequency of price changes for the euro area as a whole. However, price changes are more frequent in certain countries, in particular Austria and, more recently, Germany. Since 2013, persistently low inflation in the euro area has been associated with slightly less frequent price increases in several countries, whereas the size of price adjustments has remained more or less the same. Inflation is obtained from the aggregation of millions of individual price adjustments – increases occur either because stores update their prices more frequently or because they adjust their prices by larger amounts. In the euro area, variations in inflation are associated with variations in the size of price changes, mainly because of changes in the relative frequency of price increases and decreases. Specifically, lower inflation is associated with a higher number of price cuts, while the typical size of these decreases does not move with inflation. Similarly, an exercise based on monetary policy, oil supply, global demand and VAT shocks shows that their effects on inflation tend to occur as a result of the changing frequencies rather than the size of price increases and decreases. Overall, these results provide crucial evidence on the role played by nominal rigidities in shaping price adjustment and inflation dynamics.

17 This exercise makes it possible to compare statistics over a long period of time, but its relevance is subject to certain caveats related to the small set of products analysed and to the fact that it can only be replicated for a few countries.

18 The time period covered by each country dataset varies from one country to another but in most cases includes the last 10 to 15 years.

Box 2

Evidence on the changes in price rigidities in the euro area based on the ECB's corporate telephone survey

Firms' price-setting strategies are crucial pointers which show how flexibly prices adjust to shocks and therefore, implicitly, the effect of monetary policy on inflation. Surveys are a useful tool for collating evidence in this regard. Surveys can provide an overview of how firms set prices, including some specific dimensions. Do firms discriminate across geographical markets, either by type of customer or by sales platform? How often do they typically review their prices? What factors do firms take into account when setting prices? What aspects of price-setting behaviour are likely to give rise to sluggish price adjustment?

In 2019, the ECB carried out a survey of leading euro area firms' price-setting behaviour.[19] The survey drew on elements of the seminal work done by Blinder (1994) for the United States as well as evidence collated in the context of the Eurosystem's IPN (Fabiani et al., 2005), while also gathering more qualitative information regarding the various dimensions of price setting. The 58 firms that replied to the survey had global sales which were equivalent to around 2% of euro area output. Roughly a third of these firms sell directly to consumers while two-thirds sell to other businesses.

According to these firms, the frequency with which prices are reviewed and changed varies significantly across sectors. Most retailers said they reviewed prices on a monthly, weekly or even daily basis, depending on their range of products. They also tended to change prices frequently. In the manufacturing sector price reviews were typically carried out monthly, although prices usually only changed on a quarterly, semi-annual or annual basis. Meanwhile, excluding retail trade and transport (where prices are driven in part by the fuel element), firms in most other service sectors said that they typically reviewed prices annually.

The surveyed firms' pricing strategies were consistent with a range of theories concerning "sticky prices". Firms were presented with a number of statements, each of which related to a different theory of sticky prices, in line with Blinder's original survey (see the table below). Chart A plots the scores of the responses against the scores (and rankings) presented in Blinder's survey, as well as against the results of the survey undertaken by the IPN in 2005. For firms overall, the roles played by cost-based pricing, contracts (either explicit or implicit) and coordination failure would appear to be the main causes of price stickiness. For more consumer-oriented firms, an understanding that customers expect prices to remain roughly the same (implicit contracts) and the targeting of psychological price thresholds are likely to be important causes of sluggish price adjustment.

19 See European Central Bank (2019).

Table A

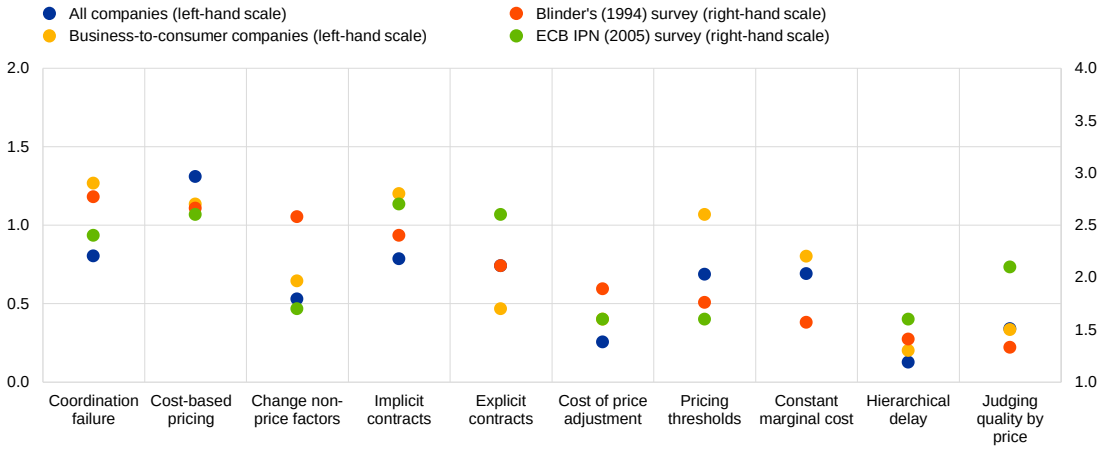
Theories concerning “sticky prices” and related survey statements

Theory	Survey statement
Coordination failure	We are hesitant to change prices for fear that our competitors will not follow suit.
Cost-based pricing	We raise prices when we incur cost increases.
Changes to non-price factors	We prefer to vary other elements of our products or services (e.g. warranty, delivery lag or customer service) rather than change prices.
Implicit contracts	We understand that our customers expect prices to remain roughly the same regardless of the economic environment.
Explicit contracts	We have contracts that limit our ability to change prices as costs change.
Cost of price adjustment	It is costly for us to change prices.
Pricing thresholds	We target price points that better influence pricing behaviour.
Constant marginal cost	Our costs do not change much as we increase production and we try to maintain a steady profit.
Hierarchical delays	Delays within our organisation slow down pricing decisions.
Judging quality by price	We do not reduce prices as our customers may take view as a reduction in the quality of our products or services.

Chart A

Price-setting behaviour and possible causes of sluggish price adjustment

(average score of responses)



Source: ECB calculations.
Notes: For this ECB survey: 0 = unimportant; 1 = important; 2 = very important. For Blinder’s (1994) survey and the Eurosystem’s IPN (2005) survey: 1 = totally unimportant; 2 = of minor importance; 3 = moderately important; 4 = very important. Theories are ordered according to their scoring (highest to lowest) in Blinder’s (1994) survey. The "constant marginal cost" theory was not tested in the Eurosystem’s IPN (2005) survey.

With regard to how increases in average selling prices are achieved, firms place an emphasis on the introduction of new products with a higher value content (see Chart B).[20] Half of the respondents considered the introduction of new products with a higher value content to be “very important” and a further third said that it was “important” for raising average selling prices. Overall, introducing new products was regarded as being (slightly) more important than increasing the prices of existing products – this was particularly the case for businesses selling directly to consumers. Based on what firms said about the way their price-setting behaviour had changed over the past five to ten years, there appears to be an increasing focus on adding value targeted at

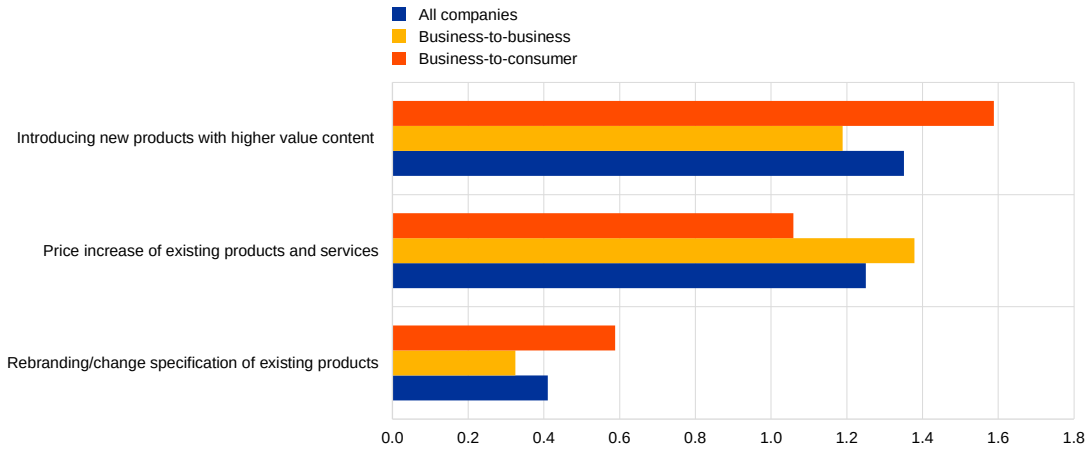
[20] The impact on inflation depends on how prices for these new products are linked to existing prices and to what extent there is a “quality adjustment” of prices (see also Work stream on inflation measurement, 2021).

specific customers in response to increasing global competition and greater price transparency driven by the internet.

Chart B

How increases in average selling prices are achieved

(average score of responses: 0 = not important; 1 = important; 2 = very important)



Source: ECB calculations.

2.2 Nominal wage rigidities – evidence from the Wage Dynamics Network

With regard to wage rigidities, the frequency of wage changes and DWR are key factors assessed in the Eurosystem's Wage Dynamic Network (WDN).[21] The WDN carried out three surveys between 2007 and 2013 that provided new empirical evidence on nominal rigidities, with a focus on wages. This information has served to complement the results from the IPN by shedding light on the underlying factors leading to DWR.

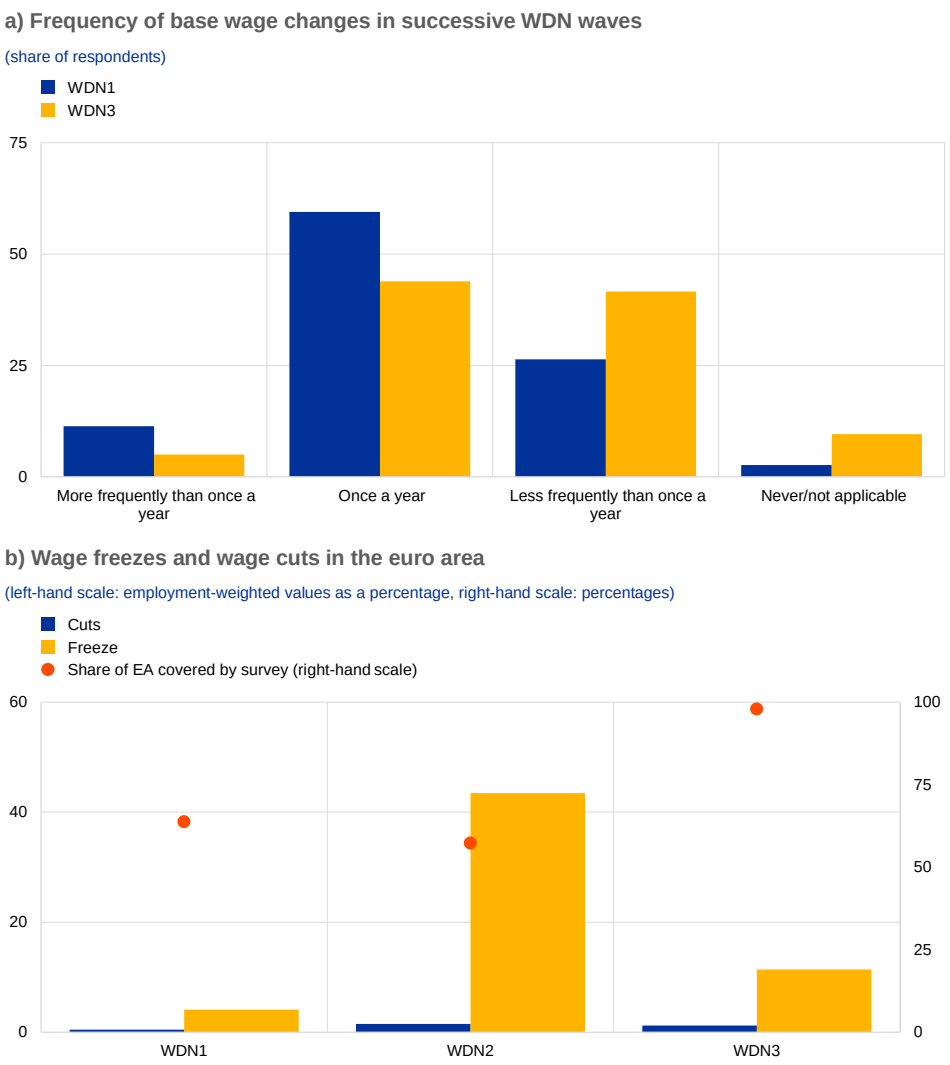
EU firms typically adjust wages once a year. On average, during the period 2010-13, their wages changed every 17 months (see Chart 2, panel a). This frequency was lower than it had been during the pre-crisis period (2002-07), when the estimated duration of the wage spell (the number of months for which wages remain unchanged) was 15 months. This lower frequency seen during the period 2010-13 seems to be at least partially attributable to firms' resistance to lower base wages, i.e. to the prevalence of DWR. However, these aggregate numbers mask a greater degree of cross-country heterogeneity. Over the period 2010-13, 44% of firms adjusted wages once a year (compared with 60% in 2007), while 41% adjusted wages less frequently (compared with 26% in 2007).[22]

21 This section is based on evidence from the WDN as presented in European Central Bank (2016) and benefitted from contributions of Ana Lamo.

22 See Branten et al. (2018).

Chart 2

Results of the Wage Dynamics Network (WDN)



Source: panel a: Druant et al. (2012) for WDN1 and Branten et al. (2018) for WDN3; authors' calculations on the basis of WDN1 and WDN3. Panel b: WDN surveys (i.e. first cluster: Messina and Rõõm, (2009), second cluster: Fabiani et al., 2015, third cluster: Branten et al., 2018) and Eurostat for employment data to calculate "Share of euro area covered by survey".
Notes: Figures in panel a are weighted to reflect overall employment and rescaled to exclude non-responses. During WDN1, the countries covered by the survey amounted to ~60% of the euro area. During WDN3, the countries covered by the survey amounted to ~100% of the euro area. Cuts and freezes in panel b are employment-weighted and rescaled, excluding "do not know" answers.

The average length of a wage spell matches the typical length of labour contracts negotiated (between one and two years) and is longer than the average duration of prices (about 9.5 months). The survey evidence is confirmed by the analysis of micro data in those few countries for which quarterly wage data are available. Wages change less often when collective bargaining coverage is high and employment protection is strong, and more often when bargaining takes place at firm level and there is a formal or informal inflation indexation scheme.

The frequency of wage changes is mostly driven by national institutions, whereas the frequency of price changes is mostly driven by sectoral differences, including the extent of competition. There is strong evidence of time-dependence in wage-setting. In the WDN survey covering the period 2007-08,

over 60% of euro area firms reported wage changes in a particular month (mostly January – one-third of wage changes take place in January, with an additional, smaller peak in July). As a result, wage changes are more synchronised than price changes, although the timing of wage changes is characterised by a mix of staggering (also driven by collective agreements) and synchronisation.[23]

The WDN surveys show that DWR is prevalent in euro area countries. Nominal base wage cuts are extremely rare among euro area firms, as was the case even in the period 2010-13, despite the length and intensity of the crisis (see Chart 2, panel b). Meanwhile, the percentage of firms reporting that they had frozen base wages increased dramatically during the crisis, reaching a peak in 2008-09 (WDN2), before declining over the period 2010-13. Nevertheless, there is evidence that the percentage fell substantially in the case of very strong negative shocks. This was the case in Estonia in the period 2008-09 and Greece and Cyprus in the period 2010-13. In spite of downward base wage rigidity, employee compensation decreased during the crisis as a result of adjustments to benefits and bonuses, changes in workforce composition and adjustments to the number of hours worked per person. About 23% of euro area firms reported that wages of new hires in the period 2010-13 were lower than the wages of similar existing workers in a given firm (compared with 13% in 2007).

The recent reforms that improved labour market flexibility and equality may also have made DWR more binding. During the global financial crisis, firms reduced wages and located them closer to the minimum level stipulated in collective agreements.[24] In addition, in some countries the level of minimum wages increased relative to average wages. These two factors, which bring wages closer to their lower bound, may lead to larger output losses in the case of future adverse shocks, given that DWR may become more binding.

Overall, the WDN offers no evidence that wage stickiness might have decreased. DWR persists in the euro area, which has important implications for the need to maintain a positive inflation buffer. Wage rigidities and their effects on unit labour costs can be particularly harmful in an environment of low productivity growth in which there is little scope to reduce costs by means of productivity increases, e.g. via innovation (see Work stream on digitalisation, 2012; Work stream on productivity, innovation and technological progress, 2021).

[23] Druant et al. (2012).

[24] See Masuch et al. (2018); Fagan and Messina (2009).

2.3 Model based analysis on a currency union with downward wage rigidity

2.3.1 Rationale and related literature

The presence of DWR may have contributed to persistently lower growth following the global financial crisis and means that macroeconomic models should be revisited. International evidence on DWR, especially for job stayers, is usually measured in terms of a high incidence of wage freezes and a lack of nominal wage cuts (which is taken as evidence of downward rigidity in nominal wages). For the US economy, a recent study[25] finds that DWR is even more pervasive than previous measurements had indicated, with nominal base wages declining for only 2% of job stayers. The same study also finds that the flexibility of new hire base wages is similar to that for existing workers. This implies that there are persistent effects on unemployment as comparatively high real wages depress hiring and increase unemployment duration, with negative and persistent effects on output. For instance, according to Yellen (2014) and Daly and Hobijn (2014), DWR provide an explanation for the limited adjustment of prices and persistent output losses stemming from the global financial crisis. This has led to a call to revisit the economists' toolbox, including a review of whether the monetary policy framework and the central bank inflation target are still appropriate (Yellen, 2016) in an environment of persistent output losses and persistent low inflation such as that which followed the great financial crisis.

DWR affects both the output-inflation trade-off and the choice of central bank inflation objective. Akerlof et al. (1996a) provide preliminary evidence, mostly based on survey data, for the role of DWR. As a consequence of DWR, an economy with a zero steady-state inflation rate may hamper relative wage adjustments across firms and sectors, which limits the natural rate of job turnover and reallocation in that economy. If aggregate price inflation or labour productivity growth is close to zero, firms that need to adjust their relative wages after an adverse shock can only do that by cutting nominal wages. Benigno and Ricci (2010) emphasise the role of DWR and their model shows a sizeable long-run inflation-output trade-off. The inflation-output trade-off curve is almost vertical at high inflation rates and flattens at low inflation rates. In line with Akerlof et al. (1996a), this implies that achieving an inflation target closer to zero implies progressively larger output costs. Following Gordon (1996), the introduction of DWR into a model creates a permanent long-term trade-off between output and inflation, with persistent effects if aggregate shocks make DWR binding. The persistence effect on output induced by DWR following an aggregate demand shock is in line with recent models with endogenous growth (see Benigno and Fornaro, 2018). The adjustment is further accentuated in a currency union as the asymmetric adjustment influences not only domestic but also between-country relative prices changes, which ultimately affect the aggregate inflation rate. Fahr and

[25] See Grisgby et al. (2021). For an international comparative study on DWR coordinated by the International Wage Flexibility Project, see Dickens et al. (2007).

Smets (2010) show that in a currency union, a region characterised by DWR adjusts with a persistent loss of competitiveness.

DWR provides a rationale for a positive inflation buffer. New Keynesian DSGE models with exogenous growth that embed DWR find that the optimal inflation rate is positive, and usually below 2%. The dynamic stochastic general equilibrium (DSGE) model discussed in Section 2.3.2 provides a point estimate for the optimal inflation rate of about 1.2%, with a confidence band ranging from 0.2% to 1.6%.[26] DWR leads to a non-vertical Phillips curve in the long run and introduces an exploitable monetary policy trade-off for low levels of inflation.[27] The extent of the long-run trade-off depends on the level of macroeconomic uncertainty as the higher the aggregate risk, the flatter the long-run Phillips curve.[28] The introduction of the zero lower bound (ZLB) on the monetary policy rate in a broadly similar DSGE model with DWR produces, however, a lower optimal inflation rate. The intuition behind this result is that wage rigidities – both in terms of symmetric wage stickiness and downward wage rigidity – limit the adjustment of marginal downward labour costs in the case of a large adverse shock. Wage rigidities thus help to limit the frequency and the persistence of the ZLB on the monetary policy rate by keeping marginal costs higher than they would otherwise be. In this class of DSGE models with exogenous growth and DWR, the introduction of the ZLB leads to a lower optimal inflation rate (ranging from 1.2% to 0.3%).[29]

The DSGE models with DWR discussed above lack two important features: an equilibrium unemployment rate and an endogenous growth mechanism. Both features are necessary to account for episodes like the great financial crisis, in which both unemployment and output displayed hysteresis. In models with exogenous growth and DWR, the implied output gap is, on average, negative and displays a violation of the natural rate hypothesis as business cycle fluctuations resemble those implied by the plucking theory.[30] Also, in a model with endogenous growth, a central bank following an inflation-targeting framework and featuring a ZLB suffers from output hysteresis bias as the monetary policy strategy in this setting does not allow catch-up for history-dependent losses related to large past output losses. An additional issue is the type of wage stickiness in an economy with search and matching unemployment. In this environment, it is often assumed that new hires receive wages that are linked to those of incumbent workers. In this case, real wages do not adjust enough after a recessionary shock and positive inflation is needed to

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26 Optimal inflation is determined in a model with a government that maximises households' welfare under commitment (i.e. the Ramsey policy). The model also accounts for the costs of price distortions stemming from a positive inflation rate in equilibrium (see Kim and Ruge-Murcia, 2009).

27 In the case of the work done by Kim and Ruge-Murcia (2009), this implies that if the inflation target moves from zero or a negative figure to 1.2%, monetary policy can improve welfare.

28 See Benigno and Ricci (2011).

29 As will be discussed later, this result hinges crucially on the assumption of exogenous growth. Once this is relaxed, the optimal inflation rate increases when DWR and ZLB are both in play (see Coibion et al., 2012; Amano and Gnocchi, 2021).

30 See Dupraz et al. (2019). In the plucking theory of business cycle fluctuations, fluctuations are not symmetric around a trend, but instead recessions represent a fall below the economy's full potential. Hence, output is on average below potential.

avoid trapping the economy in an inefficient low-employment and low-vacancy state.[31]

DSGE models featuring DWR with an endogenous growth mechanism and unemployment support a symmetric inflation buffer of around 2%. A DSGE model with DWR featuring search and matching unemployment and endogenous productivity growth (see Work stream on price stability objective, 2021) is better able to account for the fallout from the global financial crisis.[32] In this framework, the results for the optimal inflation target and the long-run monetary policy trade-off differ from comparable models with exogenous growth dynamics, as mentioned above. From a welfare perspective, there is an optimal rate of inflation which balances out the welfare costs of price inflation distortions and hysteresis effects on output and unemployment. Under a standard calibration of such a model, the derived optimal inflation rate under an inflation-targeting regime is higher than 2%, providing support for a symmetric inflation target. Also, this model shows that a price-level-targeting framework or an inflation-targeting regime augmented by a stronger response to unemployment provides a welfare improvement, as it accounts for the history and the shock dependence of the model. This also provides a rationale for monetary policy acting more forcefully when at the ZLB, to limit the hysteresis effects of large aggregate demand shocks.[33]

The results for the optimal inflation rate remain robust when a DSGE model with endogenous growth and DWR also features a ZLB. At the ZLB, our baseline model with endogenous growth and search and matching frictions (as discussed in Section 2.3.2) provides a new perspective on how symmetric wage rigidity and (asymmetric) DWR interact in New Keynesian models compared with models featuring exogenous growth. In models with exogenous growth and no search and matching unemployment,[34] the limited adjustment in wages helps to reduce downward pressures on marginal labour costs and price inflation. This reduces the likelihood of hitting the ZLB and helps monetary policy to fine tune the business cycle in the presence of adverse aggregate demand shocks. However, in our model with endogenous growth and search and matching unemployment, the higher real wage dampens job creation by negatively affecting the hiring rate. This leads to larger hysteresis effects on unemployment. Also, limited wage adjustments in the presence of adverse shocks affect the firms' profitability channel as well as the value of R&D and future productivity growth. Overall wage rigidity and DWR therefore lead to larger and more persistent effects on unemployment and output growth. However, the welfare effects and the implications for the optimal inflation rate in the economy differ for these two types of wage rigidity. While higher (symmetric) wage rigidity decreases the optimal inflation rate in the economy because it increases the costs of price distortions compensating for the costs stemming from lower output growth, a higher level of (asymmetric) DWR calls for a higher optimal inflation rate to minimise the costs of higher unemployment and lower permanent output growth.

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31 See Carlsson and Westermark (2016).

32 See Abbritti et al. (2021), Anzoategui et al. (2019) and Hall (2011).

33 See also Acharya et al. (2021).

34 See Coibion et al. (2012); Galì (2013); Amano and Gnocchi (2021); Billi and Galì (2020).

2.3.2 Model-based analysis of the role of downward wage rigidities for a positive inflation buffer

A general equilibrium model is used to gain a better understanding of the role of price and wage rigidities in the transmission of economic shocks and monetary policy. Previous sections have reviewed the evidence for nominal price and wage rigidities. This subsection presents the results obtained from a model of a currency union featuring DWR with product and labour market frictions and endogenous growth through R&D accumulation. A general equilibrium model can provide a holistic framework which can be used to capture (i) the importance of nominal rigidities measured in the data for the transmission of shocks, (ii) the interplay of nominal rigidities and the medium-term inflation objective, and (iii) how the medium-term inflation objective interacts with the adjustment in relative prices between and within countries in a currency union. For details of the model see Abbritti et al. (2021).

DWR calls for a positive inflation buffer to limit output and employment losses as well as to avoid a prolonged period of negative price inflation. In a two-country model with a currency union, the steady-state inflation rate for an economy may have important effects on output and employment fluctuations, depending on whether or not DWR is present. Abbritti et al. (2021) develop a model with DWR and endogenous growth. By calibrating this model across different levels of steady-state inflation they demonstrate that even if the central bank is able to control the long-term inflation rate and inflation expectations are well anchored, the hysteresis effects on output and unemployment may lead to significant short-term negative price inflation if a central bank does not target a positive inflation rate.[35] Following a symmetric adverse risk premium shock[36] to the currency union of a magnitude that seeks to proxy the increase in credit risk during the great financial crisis,[37] Chart 3 compares the responses from a model without DWR (and steady-state inflation at 2%, blue line) with different models featuring DWR and steady-state inflation ranging from 0% to 3%. For steady-state inflation of 2% the model with and without DWR produces qualitatively similar responses for the main macro variables. The results change if DWR is associated with lower steady-state inflation rates, as this leads to (i) a higher and more persistent unemployment rate (panel d) as real wages cannot adjust downwards (panel e), (ii) lower GDP growth (panel a) with lower long-term endogenous productivity growth (panel f), especially in the case of inflation closer to zero, and (iii) price inflation remaining longer in negative territory (panel b) especially for levels of steady-state inflation below 1%.

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35 See also Abbritti and Consolo (2020) for a description of the currency union model. With an exogenous positive steady-state inflation rate and operating under the assumption of rational expectations, the central bank is expected to converge towards its inflation objective and agents do not internalise temporary deviations from the inflation target.

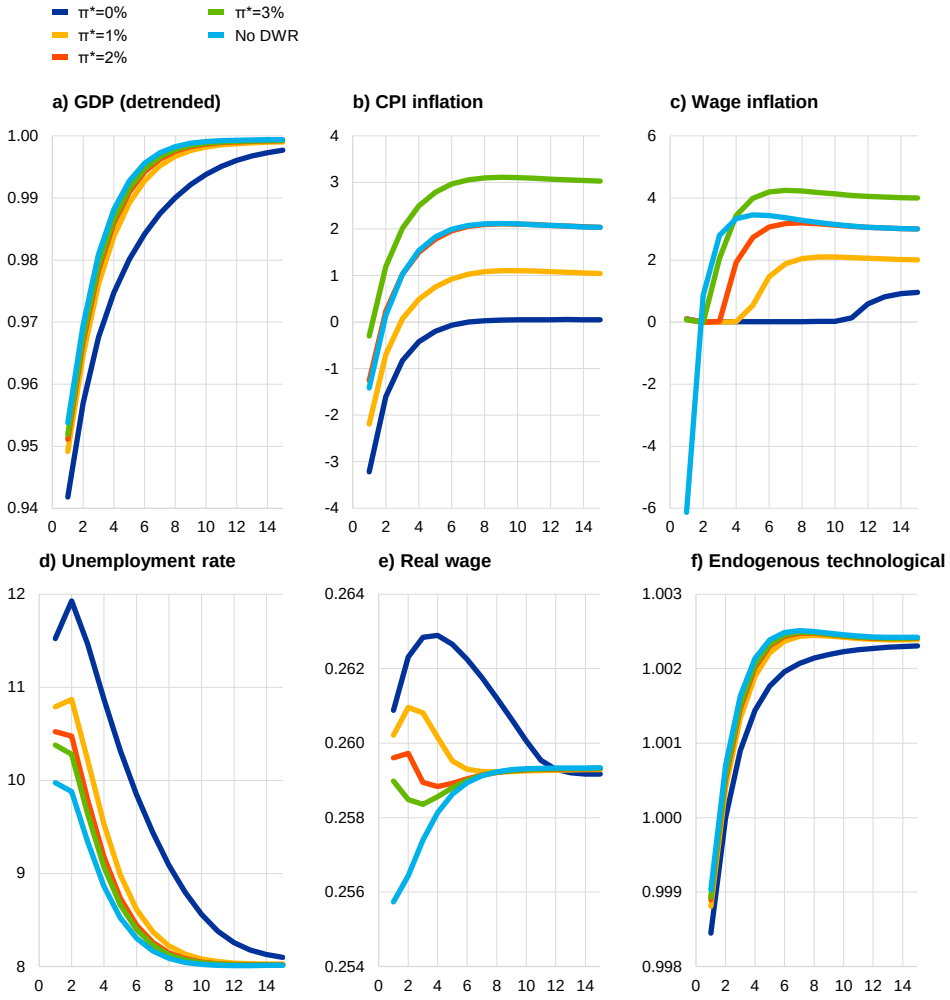
36 See Fisher (2015); Smets and Wouters (2007).

37 See Gilchrist and Mojon (2018).

Chart 3

Macro effects of DWR at different steady-state inflation rates

(percentage deviations from steady-state values; panel (d) percentage)



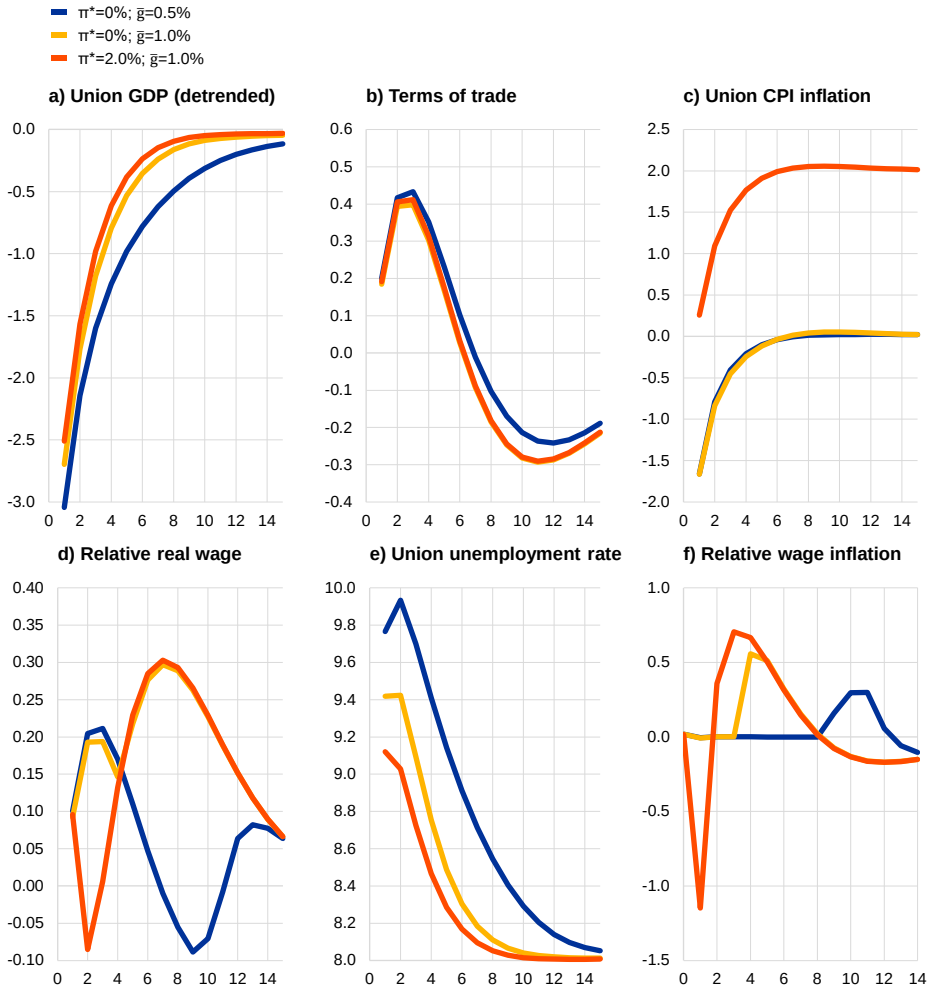
Source: Abbritti et al. (2021).
Notes: π^* refers to the inflation target. Panel d: measures for the y-axis are in percentage only. Model's impulse response functions to a risk premium shock across different calibrations for the steady-state inflation. The volatility and persistent of the risk premium shocks are close to the parameters used in Coibion et al. (2012), Anzoategui et al. (2019) and Andrade et al. (2021).

DWR also continues to play an important role if an adverse asymmetric shock hits only one of the two countries in the currency union. Chart 4 shows output, inflation and unemployment for the currency union in response to an asymmetric risk premium shock in the home country. As expected, the magnitude of the effects on the currency union variables is smaller, but the importance of DWR and productivity growth in supporting the adjustment mechanism and its persistence remains unchanged. Fahr and Smets (2010) find that such an asymmetric shock leads to a loss of competitiveness in the home country as real wages cannot fully adjust (see Chart 4) and they increase in response to an adverse asymmetric shock.

Chart 4

DWR in a currency union under an asymmetric risk premium shock

(percentage deviations from steady-state values; panel (d) percentage)



Source: Abbritti and Consolo (2020).
Notes: π^* and $\bar{g}$ refer to the inflation target and the steady-state growth rate of the economy, respectively. Model's impulse response functions to an asymmetric risk premium shock across different calibrations for the steady-state inflation rate and output growth. The volatility and persistent of the risk premium shocks are close to the parameters used in Coibion et al. (2012), Anzoategui et al. (2019) and Andrade et al. (2021).

The analysis of the effects of DWR under a risk premium shock is robust to changes in the degree of price flexibility and is also robust in the case of wage indexation. A model with lower price rigidity has lower aggregate effects on output and unemployment following a risk premium shock. Nevertheless, Chart 5 shows that by reducing the average frequency of price changes from 9 to 6 months,[38] the effect on the unemployment rate remains greater when there is an asymmetric nominal rigidity such as DWR. However, the partial indexation of wages to prices does not significantly affect the results (see Chart 6) as indexation introduces two effects which tend to balance each other out: (i) as wages become more flexible, the unemployment rate increases more for a given adverse shock as DWR becomes

[38] This change is made in order to match the Calvo parameter for the US economy following Smets and Wouters (2007). However, we do not account for other factors which tend to increase overall price stickiness, such as strategic complementarities among price setters.

more binding, and (ii) the lower adjustment costs of wages tend to reduce the increase in the unemployment rate deriving from an adverse shock.

Chart 5

DWR under different assumptions for price rigidity

(panel (a) percentage deviations from steady-state values; panel (b) percentage)

Source: Abbritti et al. (2021).
Notes: π^* and $\bar{g}$ refer to the inflation target and the steady-state growth rate of the economy, respectively. Model's impulse response functions to a risk premium shock across different calibrations for the degree of price rigidity.

Chart 6

DWR with different degrees of wage indexation

(panel (a) percentage deviations from steady-state values; panel (b) percentage)

Source: Abbritti et al. (2021).
Notes: π^* and $\bar{g}$ refer to the inflation target and the steady-state growth rate of the economy, respectively. Model's impulse response functions to a risk premium shock across different calibrations of wage indexation. The volatility and persistent of the risk premium shocks are close to the parameters used in Coibion et al. (2012), Anzoategui et al. (2019) and Andrade et al. (2021).

There is evidence of a long-term slowdown in productivity growth; this has implications for the medium-term inflation objective of monetary policy.

Blanchard et al. (2015) and Summers (2016), among others, offer a discussion of low productivity trends in the context of the secular stagnation hypothesis and the implications for macroeconomic policies (see Work stream on productivity, innovation and technological progress, 2021). As the equilibrium level of nominal wages depends both on price inflation and long-term productivity growth, a secular downward trend in productivity may increase the probability of hitting the lower bound on wages. Table 1 shows productivity and per capita output growth over the last few decades in the euro area for three subsample periods covering 1995 to 2020.[39] By and large, the underlying trends of real per capita growth have halved since the 2003 ECB strategy review. Table 2, column 3 shows different steady-state wage inflation calibrations – these are related to the historical values shown in Table 1. The only difference is in the last row of Table 2. Row d shows that steady-state inflation of 2.9% would be needed to pin down the same long-term nominal wage growth, given the slowdown in long-term growth from 1.9% to 0.8%. This would ensure a buffer for nominal wages and it would limit the frequency of hitting the lower bound of wage inflation in the presence of adverse shocks similar to those prevailing during the global financial crisis.

Table 1

Key macroeconomic variables

(average annual growth rates, percentages)

Sample period	Real potential growth	Labour productivity (per capita)	Labour productivity (per hour)	Population growth	Real potential growth per capita	HICP inflation
1995-2002	2.2	1.1	1.5	0.4	1.9	1.8
2003-2020	1.1	0.5	0.7	0.3	0.8	1.5
2010-2020	1.0	0.4	0.9	0.2	0.8	1.3

Sources: Eurostat and Eurosystem calculations.

Table 2

Model calibration of long-term nominal wage growth

(annual growth rates, percentages)

Cases	(1) Trend growth	(2) Inflation	(3) Nominal wage growth
a. Historical long-term values prevailing before 2003 strategy review	1.9	1.8	3.7
b. With lower growth	0.8	1.8	2.6
c. With lower inflation	0.8	1.3	2.1
d. Calibration to match nominal wage growth as in (a)	0.8	2.9	3.7

Source: Abbritti et al. (2021).

The "grease-the-wheel" effect of a positive inflation rate is also associated with the economy's long-term productivity growth rate. As is standard for macro models, nominal wage growth is linked to price inflation and productivity growth.[40]

39 The Abbritti et al. (2021) model features endogenous productivity through R&D accumulation. Long-term growth and endogenous productivity are therefore strongly interlinked.

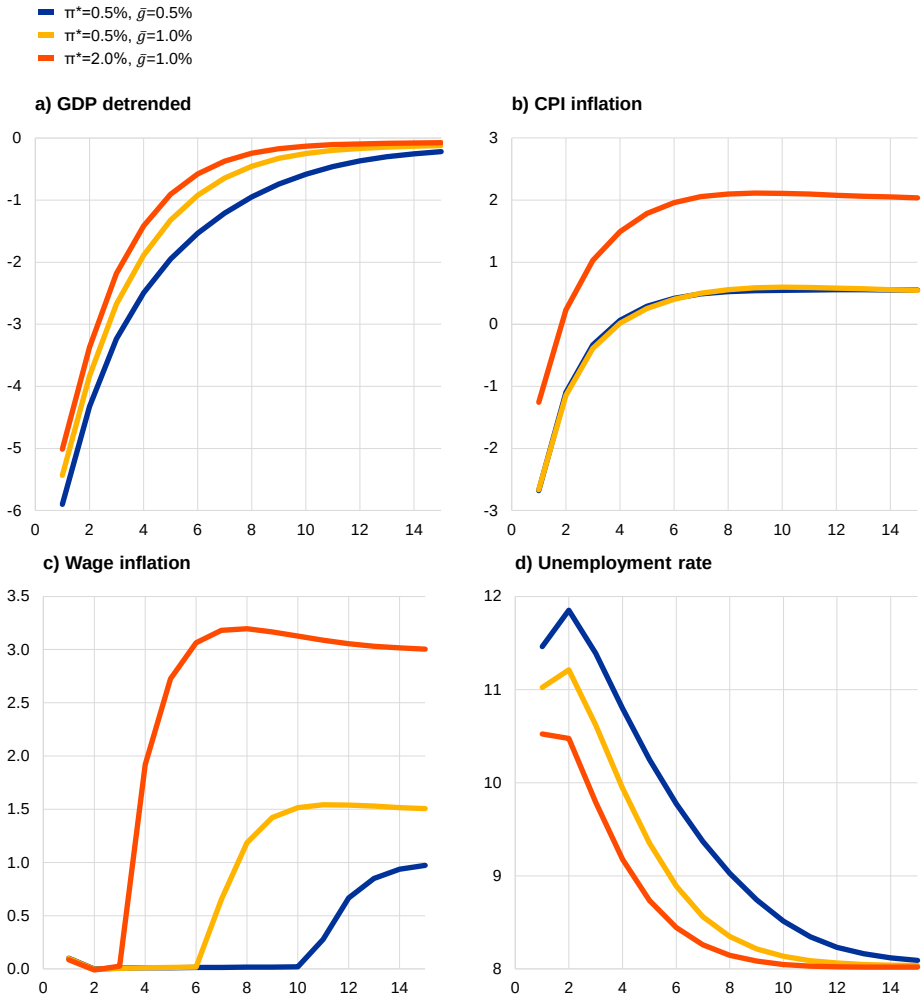
40 A relationship of this type between wage inflation, price inflation and productivity growth may feature additional factors related to labour market frictions and the wage bargaining process (see Abbritti and Consolo, 2020).

As such, nominal wages are more likely to hit the zero (wage inflation) lower bound if productivity growth is very low. Akerlof et al. (1996a) point out that the lower the trend productivity growth, the larger the amount of inflation required for a relative wage adjustment in the labour market. Chart 7 compares the adjustment mechanism under DWR with different combinations of average productivity growth and steady-state inflation rates in the model. The model shows that under DWR, the short-term adjustment effect of real GDP and unemployment in response to an adverse shock is amplified by lower trend productivity growth.

Chart 7

The impact of DWR in a low-productivity growth environment

(percentage; panel (a) percentage deviations from steady-state values)



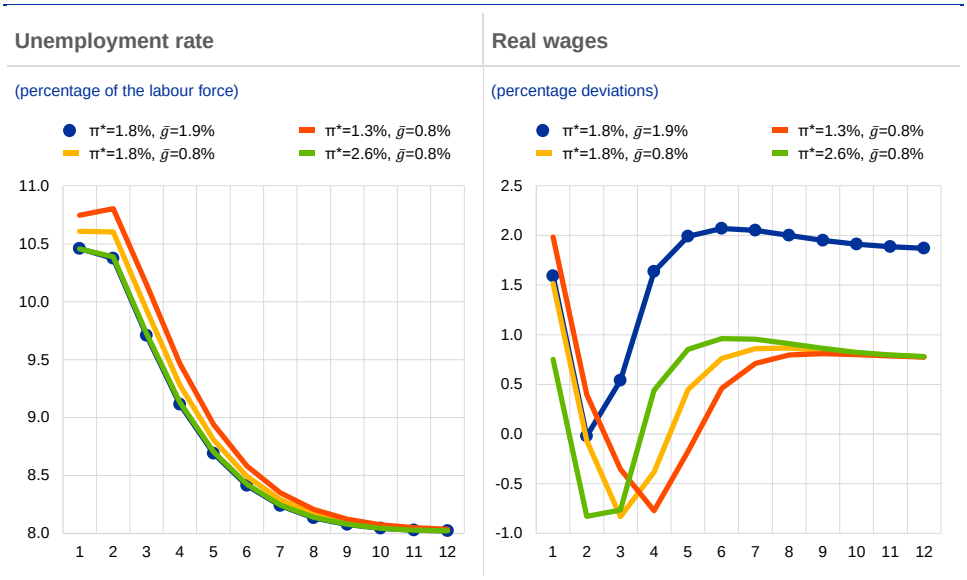
Source: Abbritti et al. (2021).
Notes: π^* and $\bar{g}$ refer to the inflation target and the steady-state growth rate of the economy, respectively. Model's impulse response functions to a risk premium shock across different calibrations for the steady-state inflation rate and output growth. The volatility and persistent of the risk premium shocks are close to the parameters used in Coibion et al. (2012), Anzoategui et al. (2019) and Andrade et al. (2021).

The decline in productivity growth since 2003 has given rise to a greater trade-off between inflation and output, reinforcing the case for increasing the size of the buffer. Notably, quantitative analysis based on matching the business cycle response of the unemployment rate to the situation prevailing at the time of the 2003

strategy review would require a steady-state inflation rate of 2.6%. Chart 8 (left panel) shows the impulse response of the unemployment rate to different pairings of inflation and productivity growth based on Table 2. However, from a business cycle perspective, steady-state inflation does not need to rise to 2.9% (as in Table 2, row d) because changes to structural parameters (such as long-term growth or steady-state inflation) also affect the shock propagation mechanism. In this case, a lowering of steady-state inflation would lead to a flattening of the Phillips curve in the model, limiting the negative effects on nominal wages. Chart 8 (right panel) shows that the key underlying mechanism is the adjustment of real wages, which tend to increase rather than decrease when DWR is binding (with steady-state inflation equal to 1.3%). As such, the unemployment rate remains above its equilibrium value for longer, and the overall economic adjustment is prolonged because of pent-up real wage deflation. Chart 8 shows that for higher inflation (at 2.6%) the real wage adjustment is faster (and employment losses lower; see Chart 8).

Chart 8

Unemployment rate (left panel) and real wages (right panel)



Source: Abbritti et al. (2021).
Note: π^* and $\bar{g}$ refer to the inflation target and the steady-state growth rate of the economy, respectively. The charts present impulse response functions for the unemployment rate and real wages for a risk premium shock across different steady-state inflation rates, "pi", and output growth, "g". The volatility and persistent of the risk premium shocks are close to the parameters used in Coibion et al. (2012), Anzoategui et al. (2019) and Andrade et al. (2021).

Summing up the model-based analysis, the argument in favour of a positive inflation buffer is reinforced in a persistent low-inflation, low-productivity environment in the presence of DWR. In such an environment the long-run monetary policy trade-off between output and inflation becomes more relevant. A positive inflation buffer is therefore needed to support the economy[41] and allow the relative price and wage changes to take place without large and persistent changes in unemployment and output.[42] From a welfare perspective, a positive inflation buffer

41 See Tobin (1972).

42 Empirically, negative (basic) wage changes are not observed across job stayers. Acharya et al. (2021) provide a model with unemployment hysteresis based on skill depreciation. When monetary policy is constrained by the ZLB, large shocks reduce hiring to the point where the economy recovers slowly and there is a risk of falling into a permanent unemployment trap.

balances the costs arising from price distortions and as well as the costs related to output and unemployment hysteresis.[43] In a monetary union, the rationale for a positive inflation buffer is reinforced by the need to ensure that the necessary price and wage adjustments take place across countries without incurring severe and long-lasting asymmetric recession.

[43] For a more detailed analysis of this trade-off, see Abbritti et al. (2021). Garga and Singh (2021) show that in a model with endogenous growth, when interest rates are at the ZLB, the optimal monetary policy response is a commitment to keeping interest rates low for longer in order to support the recovery, the aim being to return close to the pre-recession productivity growth trend.

3 Evidence on inflation differentials in the euro area

The 2003 strategy review indicated that an inflation buffer was needed to account for structural factors such as the expected catch-up effects in countries starting from lower price levels. A buffer was seen as a way to avoid higher inflation rates resulting from Balassa-Samuelson effects in countries starting from low price levels would - to reach the euro area inflation target - require negative inflation in countries starting from higher price levels (which could have high economic costs because of nominal wage rigidities).[44]

This chapter reviews changes in inflation differentials in the euro area since 1999 to assess whether the inflation target of below but close to 2% has provided a sufficient margin to prevent some countries or regions having to live with excessively low or even negative inflation rates. Section 3.1 reviews what has happened to inflation dispersion and inflation differentials in the euro area, including compared to the United States and among regions of euro area countries. Section 3.2 evaluates whether the 2% buffer has proven sufficient to prevent long periods of excessively low or even negative inflation in the countries of the euro area, taking into account special factors like increases in indirect taxes and performing counterfactual exercises. Section 3.3 discusses the drivers of structural inflation differentials in the euro area (specifically price level convergence, structural changes in consumption baskets and the build-up and correction of macroeconomic imbalances) and their implications in light of the review of the ECB's monetary policy strategy.[45] One important aspect is the interaction between downward nominal rigidities and inflation differentials. This can lead to substantial adjustment costs, for example in the context of rebalancing, and reinforces the need for a positive inflation buffer as discussed in Chapter 2.

3.1 Changes in inflation and inflation differentials in the euro area – an overview

Inflation in the euro area differed markedly between the first decade of the euro and the period thereafter. After an adjustment phase during the run-up to the euro (the Maastricht Treaty stipulated that price convergence was a compulsory requirement for adopting the single currency), headline inflation fluctuated around the ECB's target of close to but below 2% over most of the period 1999 to 2008 (see Chart 9a). Since the great financial crisis, both headline and underlying inflation have remained substantially below pre-crisis averages. HICP headline inflation averaged 2.2% from 1999 to 2008, compared to only 1.2% from 2009 to the first half of 2021

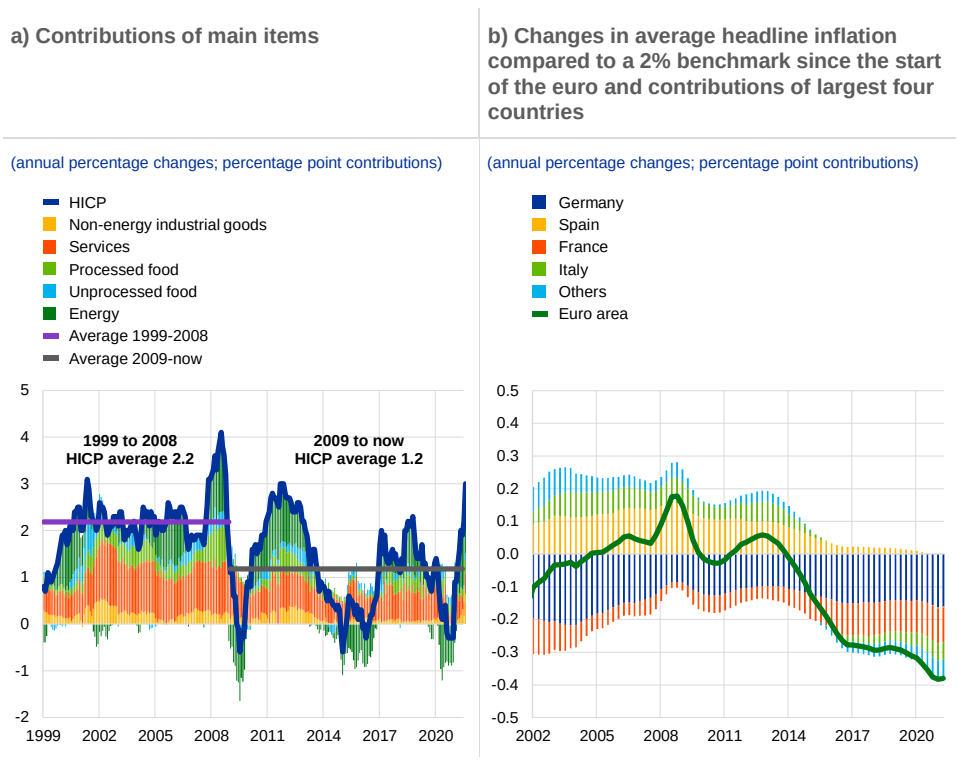
44 See Issing, O. (ed.) (2003), part 4.

45 For a more extensive discussion of temporary and structural drivers of inflation differentials see ECB (2003), ECB (2005) and ECB (2012).

(the average over the full period from 1999 to the first half of 2021 was 1.6%). Around half of the lower average headline inflation was directly attributable to lower inflation rates in the volatile energy and food components, which are strongly affected by global trends. The other half resulted from the more domestically determined HICP excluding energy and food inflation (HICPX), which declined substantially from an average of 1.6% in 1999-2008 to 1.1% in 2009-mid 2021.[46]

Chart 9

Contributions of main items and countries to changes in headline inflation in the euro area



Sources: Eurostat and ECB calculations.
Note: Latest observations: a) June 2021 and b) second quarter 2021.

Average headline inflation in the euro area since the start of euro equalled close to 2% until 2013, but then fell substantially to 1.6% at the end of the sample (Chart 9b). The contribution of the four largest euro area countries to changes in average headline inflation since 1999 shows that while Germany and France have tended to record rates below the 2% target since the start of EMU, in Spain and Italy it was generally above 2% until around 2013. These positive and negative differentials largely cancelled each other out, keeping average inflation in the euro area around 2%. When inflation in Italy and Spain also fell below 2% from 2013 on, average euro area inflation since the start of the euro decreased; to around 1.7% in 2017, and then further to 1.6% in 2021.

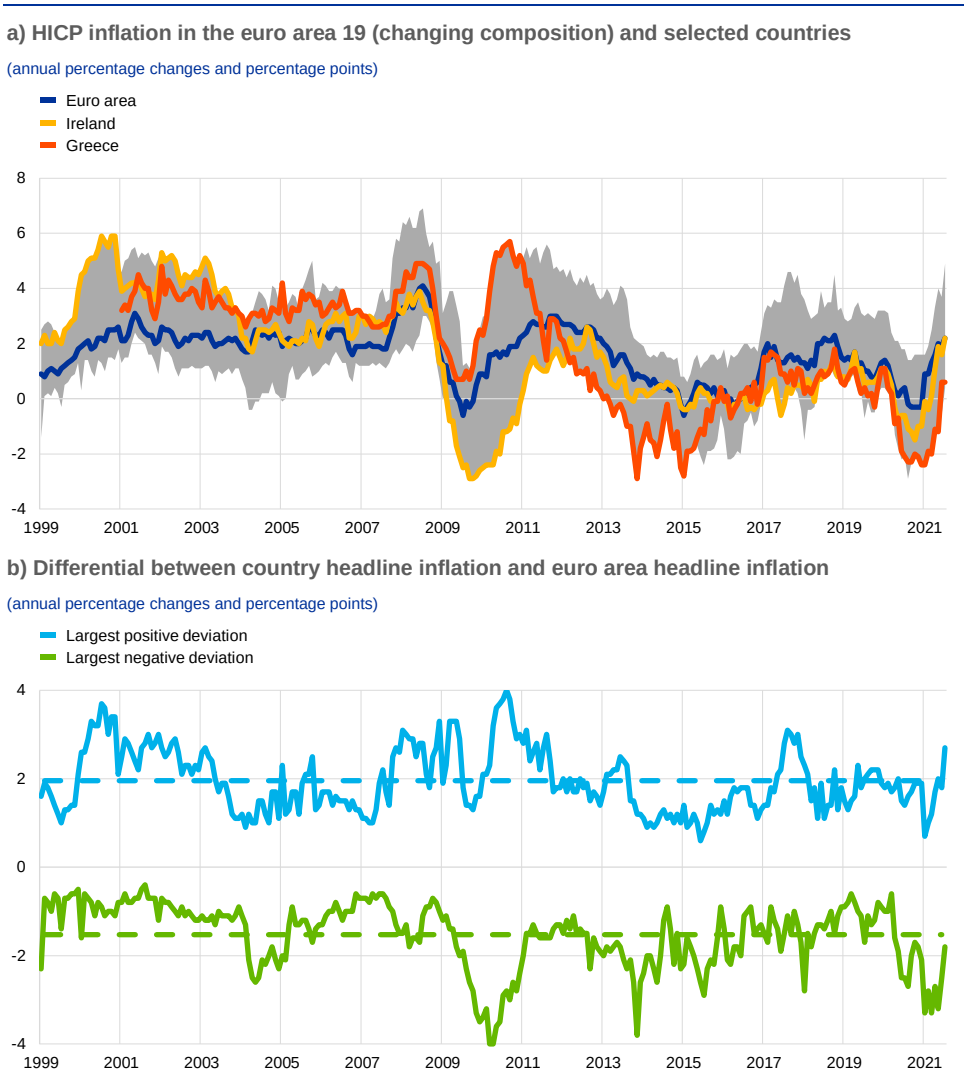
While the relative position compared to average euro area inflation has changed in some countries, the overall pattern of higher and more stable

[46] See also the discussion in Koester et al. (2021).

inflation in the first decade was very similar across countries (see Chart 10a). The range of euro area countries' (changing composition) HICP inflation rates has on average been 3.5 percentage points, with the upper end being on average 2 percentage points above average euro area headline inflation and the lower end on average 1.5 percentage points below (see Chart 10b). Variation in the upper and lower end of the range relative to the average, and hence the size of the range, has been quite limited over time, with the exception of the global financial crisis. In the period from 2009 to 2011 the range of inflation rates reached a peak of 7 percentage points (twice its average). This was the result of both a higher than usual positive deviation in inflation rates in some countries (especially Greece) and higher than usual negative deviation in others (especially Ireland – see Chart 10a).

Chart 10

Headline inflation in the euro area and across euro area countries



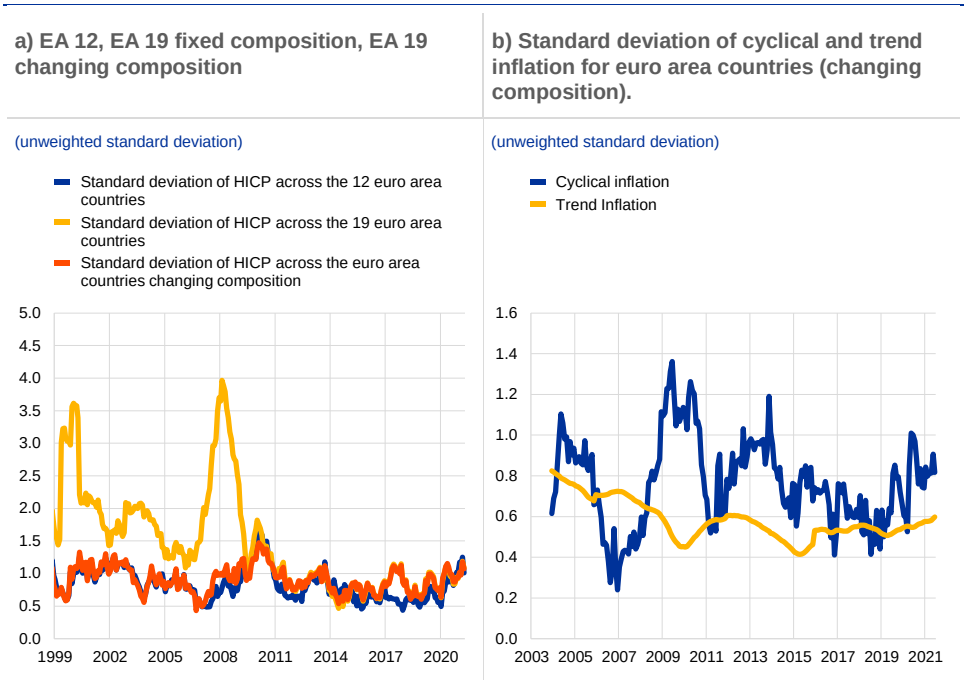
Source: Eurostat and ECB calculations.
Note: Latest observation: July 2021.

The resulting inflation dispersion in the euro area has been relatively limited overall. The process towards accession exerted a clear disciplining effect on the

convergence of inflation rates among countries joining. The standard deviation of inflation rates across early euro area members (EA12) dropped from about 5 percentage points in 1990 (the outset of stage 1 of EMU), to around 2.5 percentage points in 1994 (the start of stage 2). It has hovered around 0.9 percentage points in the euro area (changing composition) since 1999 (see Chart 12a). A similar process of nominal convergence can also be seen, though with some delay and a major upsurge in inflation differentials during the pre-crisis years, for the whole sample of the current 19 euro area countries (EA19) in fixed composition, bearing in mind that the seven "new" euro area members adopted the euro between 2007 (Slovenia) and 2015 (Lithuania). Dispersion then increased in 2020 and the first half of 2021 due to factors related to the pandemic (see Box 3).

Chart 11

Dispersion in inflation rates – cycle and trend



Source: Eurostat and ECB calculations.
Notes: Monthly data. Latest observations: June 2021. Trend inflation for each country is calculated as a five-year moving average; cyclical inflation is calculated as the difference between headline inflation and trend inflation.

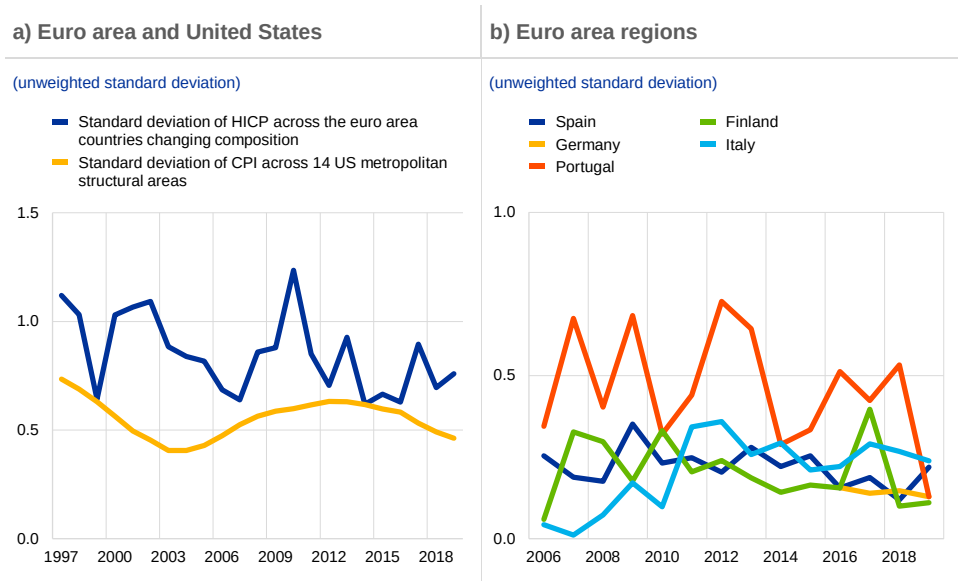
While cyclical developments played a key role in inflation dispersion, a substantial part can also be linked to a dispersion in trend inflation. As illustrated in Chart 11b, changes in inflation dispersion can be largely attributed to changes in cyclical inflation rates, taking a five-year moving average as a proxy for trend headline inflation in each euro area country. However the standard deviation of this trend headline inflation has fluctuated around 0.5 – indicating that a substantial part of the inflation dispersion between euro area countries can be attributed to differentials in the more persistent inflation developments.

Inflation dispersion across euro area countries has been slightly higher than that across US regions. Overall inflation dispersion in the euro area has been reasonable stable. The fact that it has been only slightly higher than across regions of the United States is remarkable, given that one might expect larger differences in

a currency union with both national business cycles and, for example, largely national fiscal and economic policies too (see Chart 12a).

Chart 12

Inflation rate dispersion – a comparison of the euro area and the United States, and across regions in euro area countries



Source: Eurostat and ECB calculations, Haver for US data.
Note: Annual data: latest observation: 2019.

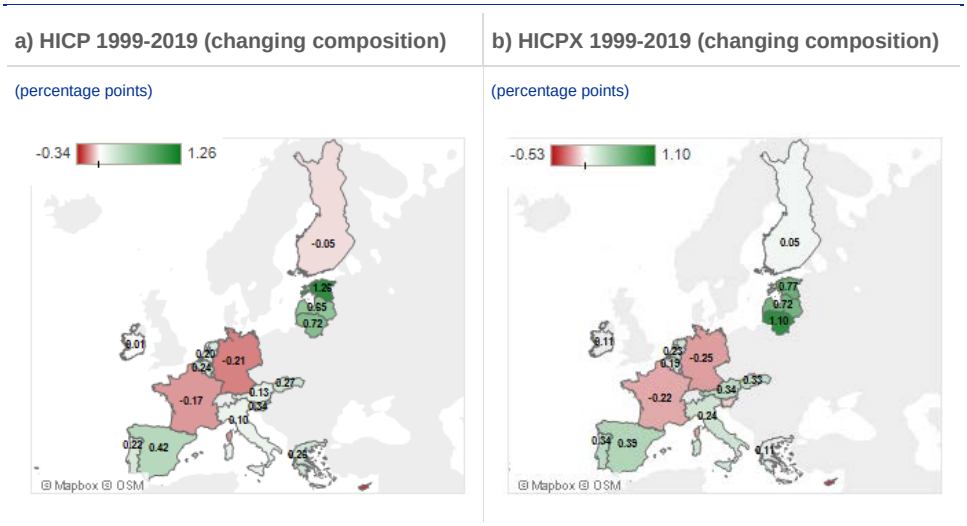
For inflation dispersion in the euro area, the dimension across countries has been more important that the dimension across regions, confirming that an inflation buffer might be especially important in a monetary union made up of different countries. Inflation dispersion in the euro area has been well above the dispersion of intra-country regional data (available for Germany, Spain, Italy. Portugal and Finland: see Chart 12b). Regional movements shows surprisingly little intra-country variation in inflation – even for countries with very substantial differences in economic structure across regions, like Italy. This supports the view that inflation differentials are mainly a phenomenon between euro area countries, not between regions within euro area countries. The implication is that national business cycles and differences in national economic and fiscal policies may be more important than the different levels of economic development and regional business cycle dynamics within individual euro area countries.[47]

Average inflation differentials in the euro area over the years 1999-2019 were relatively limited overall. In the 12 countries that joined the euro area first, average HICP inflation differentials compared to the euro area average in the period 1999-2019 range from just -0.21 percentage points in Germany (average HICP inflation of 1.5%) to 0.51 percentage points in Luxembourg (average HICP inflation of 2.2%; see Chart 13a). (See Box 3 for what has been happening since the start of the pandemic.) For HICPX inflation, the differentials vary from -0.25 percentage points in

47 See also Checherita et al. (2009) for further evidence on the differences in the role of regions and countries.

Germany (average HICPX inflation of 1.1%) to 0.41 percentage points in Luxembourg (average HICPX inflation of 1.8%; see Chart 13b). The maximum positive inflation differentials have been around twice as large as the maximum negative ones, and the difference between the highest average and the lowest average HICP and HICPX inflation rates has been a mere 0.7 percentage points in the euro area 12 countries. Including the other seven countries that joined later and have a far shorter membership period in the euro zone (from Slovenia in 2007 to Lithuania in 2015), the range of inflation differentials increases from 0.7 percentage points to around 1.6 pp for HICP and HICPX (see Chart 13). The pattern of maximum positive deviations being around twice as large as maximum negative deviations remains.

Chart 13
Average inflation differentials in the euro area



Sources: Eurostat and ECB calculations.
Notes: The inflation differential is calculated as the difference between the average inflation in the specific country from the time it joined the euro area until 2019 and the average inflation in the EA changing composition for the same period. Monthly data. Latest observation: December 2019.

Box 3
Inflation differentials since the start of the COVID 19 pandemic

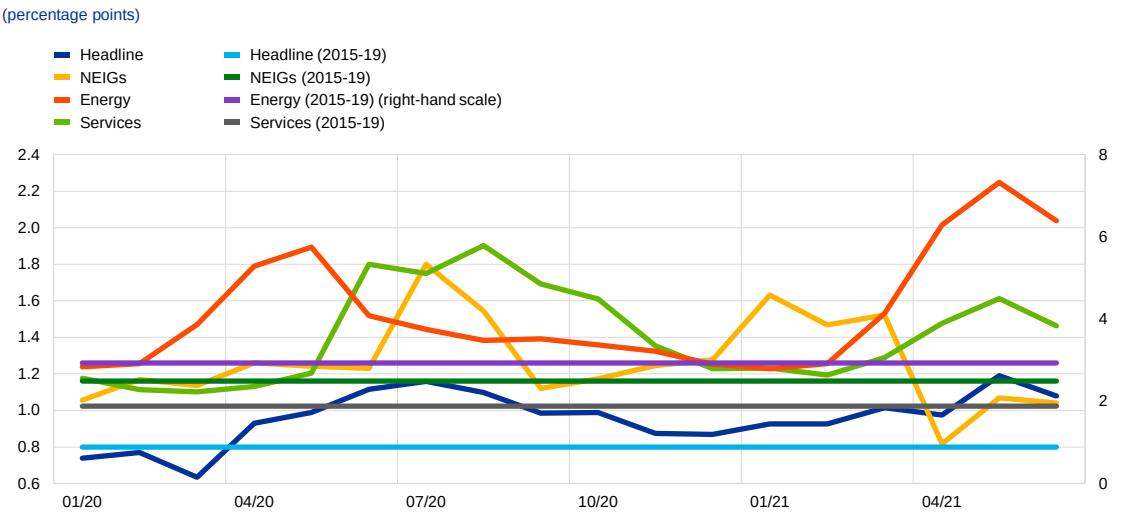
Most parts of this paper analyse changes in inflation over the period 1999-2019. The choice is motivated by both an interest in the longer-term drivers of inflation differentials in the euro area and the fact that from spring 2020 onwards inflation has been strongly affected by the COVID-19 pandemic and related measures. This box provides some insights into how the pandemic has affected inflation differentials across euro area countries.

Since the start of the pandemic (i.e. spring 2020), dispersion in headline inflation has been higher than the average over 2015-2019 (the longest sample which includes all 19 current euro area countries; see Chart A). However, the increase as measured by the standard deviation is not massive compared to an average standard deviation of 0.8 for the period 2015-2019, and peaked at 1.2 in May 2021. Looking at the main components, energy inflation dispersion was pushed up at the time of the trough in euro area energy inflation in May 2020 resulting from the COVID-19 shock and the subsequent base effect one year later. Dispersion in services inflation increased over the

summer of 2020 due to transport and tourism services and their differing performance in countries with very different exposures to the tourism sector.[48] The increased dispersion of non-energy industrial goods inflation was related to the volatility associated with a postponement of seasonal sales in some countries in summer 2020 and the first months of 2021.

Chart A

Standard deviation of HICP inflation (and its main components) since the start of the pandemic



Source: Eurostat and ECB calculations.
Notes: Monthly data. Latest observations: June 2021.

Looking at inflation differentials across countries, the size of differentials increased somewhat for headline, services and NEIG inflation compared to the period 2015-2019. The overall change in the relative position of euro area countries was relatively limited. Headline inflation differentials changed sign only in Estonia, Latvia, Malta and Finland (see Chart B). In services inflation, substantial negative differentials were observed in countries with large tourism sectors such as Greece, Italy, Cyprus, Spain and Portugal; this was likely linked to restrictions on tourism and travel.

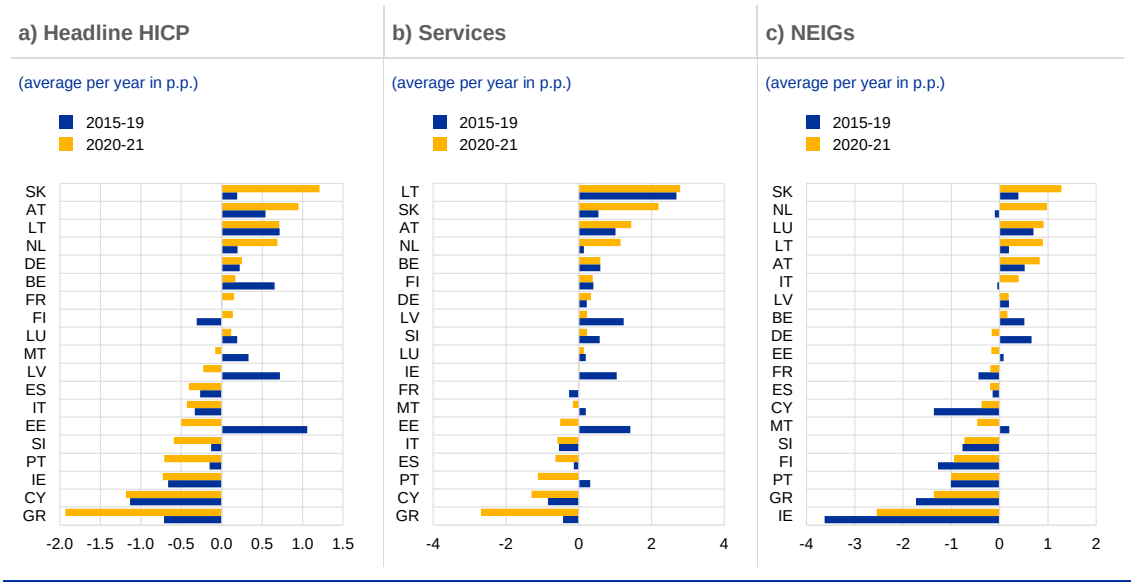
A general caveat to the analysis shown here is that the pandemic has affected the collection of price data (and the role of price imputations), changed consumption habits and triggered extraordinarily large changes to HICP weights in 2021. This has affected inflation trends and differentials across countries and complicated the interpretation and reliability of inflation data since the start of the pandemic.[49]

[48] For more details see ECB (2021).

[49] For more details see ECB (2020) and ECB (2021).

Chart B

Inflation differentials in 2020-2021 compared to 2015-2019



Source: Eurostat and ECB calculations.
Notes: Monthly data. Latest observations: June 2021.

3.2 Avoiding periods of excessively low or negative inflation rates in euro area countries since the start of the euro: an assessment

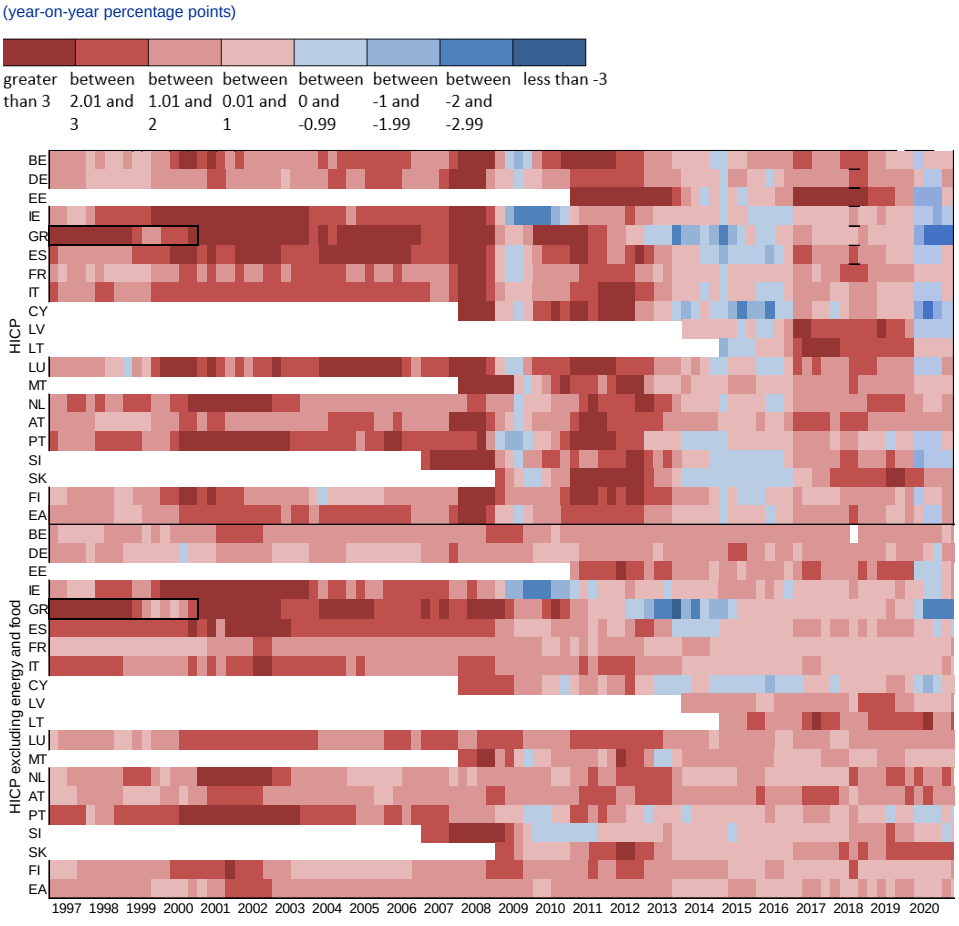
While average headline inflation differentials in the period 1999-2019 were relatively small and average headline inflation was between 1.5% and 2.2% in each of the first 12 countries that were members of the euro area, this did not guarantee that periods of excessively low inflation rates were avoided. Low overall average inflation differentials might conceal substantial differences in inflation over time, which could also include periods of excessively low inflation. We define excessively low inflation as negative inflation and distinguish between transitory periods up to three consecutive quarters and prolonged periods of four or more. We examine whether periods of excessively low inflation were avoided for headline HICP (which is used in the ECB's definition of price stability) and HICP excluding energy and food (HICPX, which is more strongly driven by domestic trends than headline inflation).

HICP and HICPX in euro area countries reveal that in the first decade of the euro the 2% buffer for headline inflation did indeed prove sufficient to prevent countries from having to live with excessively low inflation (see Chart 14). From 1999 to 2008 only two members of the euro area experienced negative inflation rates for HICP (Luxembourg in 1999 and Finland in 2004, both for just one quarter) and only Germany for the more domestically determined HICPX (in 2000, again for just one quarter).

During the second decade of the euro however (2009-2019), the picture changed and episodes of negative HICP and even negative HICPX inflation rates occurred (see Chart 15). First, headline inflation turned negative in the euro area as a whole and in most constituent countries on occasions in 2009, 2015 and 2016, mainly due to collapsing oil prices. Second, and more concerning, while HICPX never turned negative in the euro area as a whole, there were extended periods of excessively low HICPX inflation in some countries. Over the period from 2009 to 2019 HICPX remained negative for more than four consecutive quarters in Ireland and Slovenia (between 2009 and 2011), Greece (between 2012 and 2015), Spain (2014) and Cyprus (2014 and 2017). These periods of negative inflation occurred in an environment of low inflation for the entire euro area,[50] with headline inflation substantially below 2% and HICPX below the average level for the pre-crisis period (up to 2008) of 1.6%.

Chart 14

Heatmap of HICP and HICPX in euro area countries (changing composition)



Source: Eurostat and ECB calculations.
Notes: Quarterly data. White fields reflect time prior to joining EMU. Latest observations: second quarter 2021.

Stripping out the effects of indirect tax changes on inflation reveals a substantially higher prevalence of longer periods with negative HICPX in euro

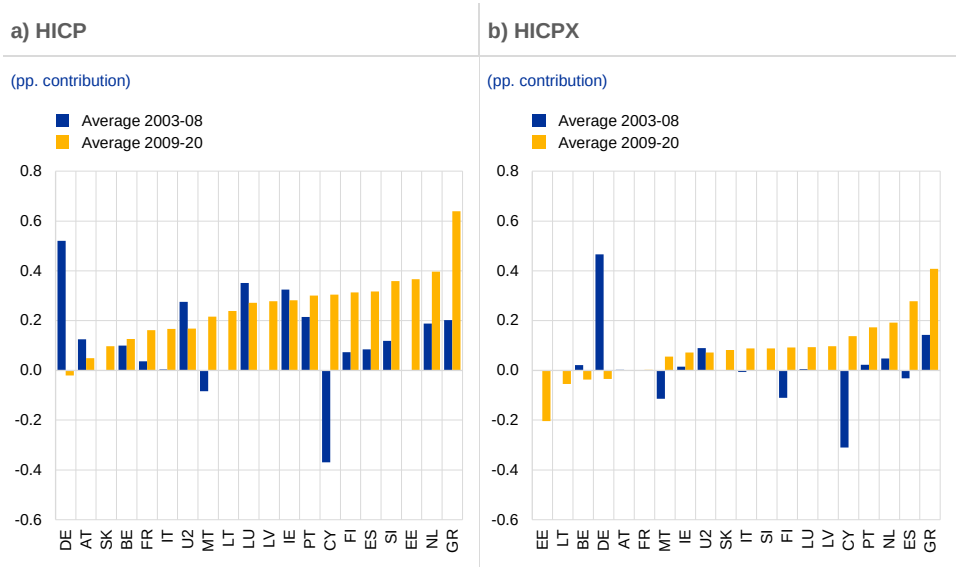
[50] See also the discussion in Koester et al. (2021).

area countries in the second decade of the euro. Changes in indirect taxation can have a direct influence on inflation and should be taken into account when assessing whether the 2% target provided a sufficient buffer to avoid periods of negative inflation, especially in HICPX. This is because inflation net of indirect tax changes reflects price changes from the perspective of companies, and so has implications for the need to adjust input costs, including wages. If HICPX excluding indirect taxes had been negative, this would have implied the need to cut input costs in the form of labour costs.[51] In the event of low productivity growth, this could also require cuts in nominal wages (see Sections 2.2 and 2.3 for a discussion of downward nominal wage rigidities and their effects). An estimate of the impact of indirect tax measures on inflation is possible, because Eurostat has published HICP at constant tax rates since 2002. These indexes are estimated excluding the impact of changes in indirect taxes and assuming full pass-through to consumer prices. They can hence be seen as an upper limit to the possible effects of changes in indirect taxes on inflation. Indirect tax changes played an especially important role in the second decade of the euro (from 2009 on; see Chart 15), when inflation overall was already low in most countries (see Chart 13). In Greece for example, HICP inflation would have been around 0.7 percentage points lower and HICPX inflation 0.5 percentage points lower in the second decade when the effects of indirect taxes are stripped out (see Chart 15). Stripping out the impact of indirect taxes tends to prolong the periods of negative HICPX inflation in Ireland, Greece, Spain, Cyprus and Slovenia (see Chart 16a). In Spain the period of low or negative HICPX inflation would have started in the last quarter of 2012 without the large increase in VAT rates which pushed up HICPX by 2.2 percentage points from September 2012 to August 2013. Net of the impact of indirect taxes, Greece experienced negative HICPX inflation throughout the years 2011-2017 (with the exception of the third quarter 2017, when it was zero).

[51] Sometimes reductions in labour costs took place via cuts in social security contributions as part of a fiscal devaluation combining increases in indirect taxes with reductions in labour tax or social contribution rates.

Chart 15

Impact of indirect tax changes on inflation rates



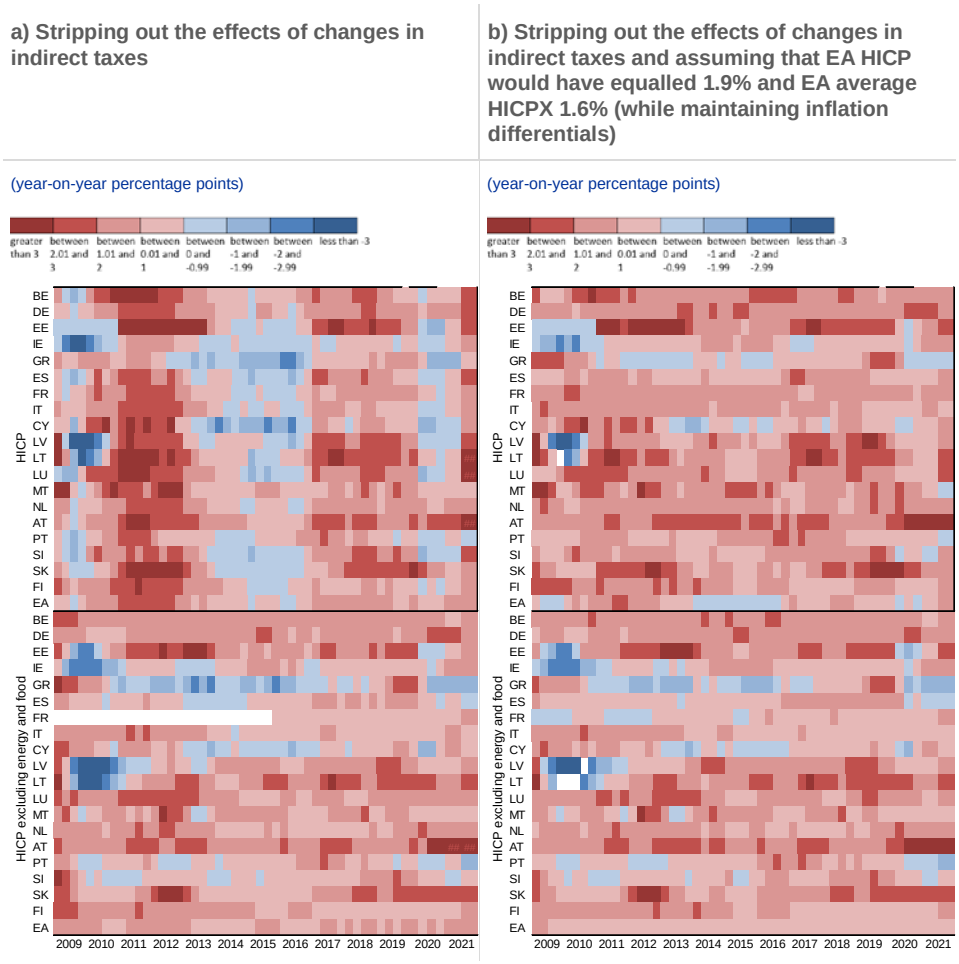
Source: Eurostat, NSIs and ECB calculations.
Note: Latest observations: July 2020. Data available from 2003 on; from December 2015 on for HICPX FR.

Purely mechanical counterfactual analyses indicate that deflationary periods would have been less pronounced during the second decade of the euro if the euro area-wide inflation target had been reached, but they would not have been avoided entirely.[52] Purely mechanical counterfactual calculations assuming euro area headline inflation was kept up at 1.9% (or HICPX at its pre-crisis average of 1.6%) from 2009 while maintaining inflation differentials and not taking the endogenous reactions of economic agents to a counterfactually higher inflation rate into account still indicate periods of negative HICPX in Ireland, Greece, Cyprus, Portugal and Slovenia over 2009-2019 (see Chart 16b). However, under this scenario only Greece and Ireland experienced prolonged periods of negative HICPX for more than four consecutive quarters.

[52] There were calls to increase the inflation target; see for example Blanchard et al. (2010).

Chart 16

Counterfactual heatmap of headline HICP and HICPX in euro area countries (changing composition) from 2009 to the first half of 2021



Source: Eurostat, NSIs and ECB calculations.
Notes: Quarterly data. White fields reflect time prior to joining EMU.

The inflation target of below but close to 2% ex post provided a sufficient margin to prevent long periods of excessively low or even negative inflation rates in all countries in the first decade of the euro – but not fully in the second decade. After the financial crisis, there were not only periods with negative headline inflation in all countries (and the euro area as a whole), but also times when inflation was low or HICPX negative in 7 out of the 19 euro area countries. Even more substantial and widespread experiences of low or negative HICPX inflation across countries result if the substantial increases in indirect taxes related to fiscal adjustments are stripped out. Counterfactual analyses (again stripping out the effects of indirect taxes) show that deflationary periods would have been less pronounced during the second decade of the euro if the area-wide inflation target had been reached over 2009-2019, but they would not have been avoided entirely. In this scenario Greece and Ireland would still have experienced prolonged periods of negative HICPX inflation (stripping out the upward impact of indirect taxes) for more than four consecutive quarters.

By and large, the inflation objective of close to but below 2% therefore seems to have provided a sufficient margin to prevent countries from having to live with excessively low or even negative inflation rates. However, when euro area-wide inflation remained persistently below the objective, periods of excessively low or even negative inflation did occur in some countries. These periods might have been more pronounced if nominal rigidities had not implied a stronger adjustment in quantities than prices during some phases (see the discussion in Chapter 2).

3.3 Drivers of structural differences in national inflation

Understanding the drivers of structural differences in inflation in euro area countries is also important for forming a view on future trends and challenges for monetary policy. In this section we assess three important such drivers: first, convergence in price levels; second, different starting positions and structural change in the composition of consumption baskets; third, the build-up and correction of macroeconomic imbalances.

3.3.1 Price level convergence

Countries entered the euro area at quite different levels of real GDP per capita and prices, with lower GDP per capita being strongly correlated with lower price levels (see Chart 17).[53] In 1999, real GDP per capita in Portugal started from a level 43% lower than the euro area average, while the corresponding figure was 12% higher than the average in Finland (the country with the highest price level) and 149% higher in Luxembourg. In the same year, price levels ranged from 23% below the average in Portugal to 19% above in Finland.

Given the different starting positions, one would have expected price level convergence to be an important driver of inflation differentials. Following the removal of intra-area exchange rates, which should have helped to foster an increase in intra-euro area trade, one might have expected to see convergence in levels of real GDP per capita, hand in hand with a convergence of price levels. Countries with a lower price level are likely to face higher than average demand for their tradable goods and services, which then translates into higher than average inflation.

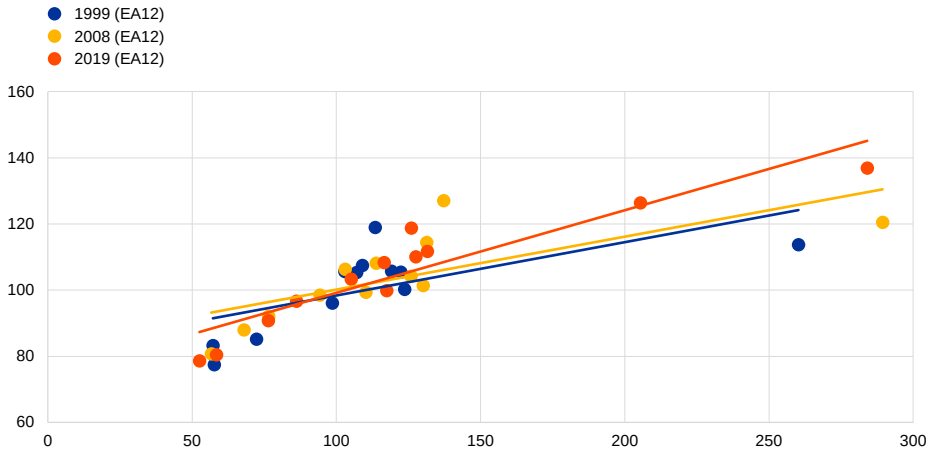
[53] See also the discussion in Diaz del Hoyo et al. (2017).

Chart 17

Real and nominal convergence

Relationship between GDP per capita (x-axis) and price levels (y-axis) in 1999, 2008 and 2019

(index values)



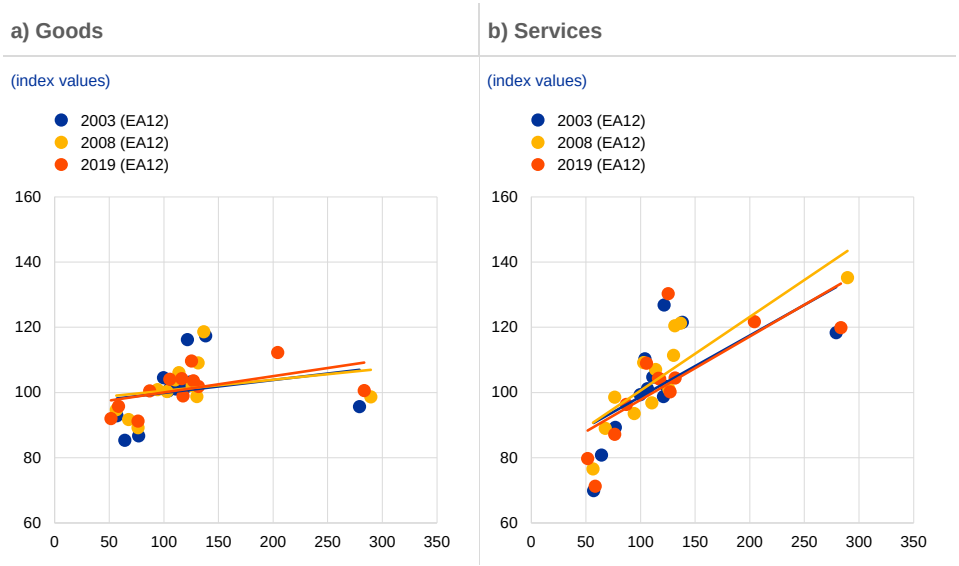
Sources: Eurostat and ECB calculations.
Note: Annual data. Latest observations: 2019.

With price levels one would expect the convergence process to be started by prices of tradables, followed by non-tradables, based on the Balassa-Samuelson effect. The evidence shows, however, that there was no such automatic convergence process or sequencing.

There has not been much progress in nominal convergence in EMU since 1999. Real GDP per capita levels in the euro area 12 have not converged significantly and sustainably, nor have price levels (see Chart 17). In 2020 (the latest year for which price level indices from Eurostat are currently available), differences in price levels had actually increased since 1999, with Luxembourg recording a price level 42% above the average and Greece 23% below. Contrary to expectations, overall inflation rates tended on average to be higher in countries that started from a high price level and lower in countries that started from a low price level. Looking at sectoral developments, there has been no strong convergence in either goods or services prices (Charts 18a and b).

Chart 18

Relationship between GDP per capita (x-axis) and price levels (y-axis)

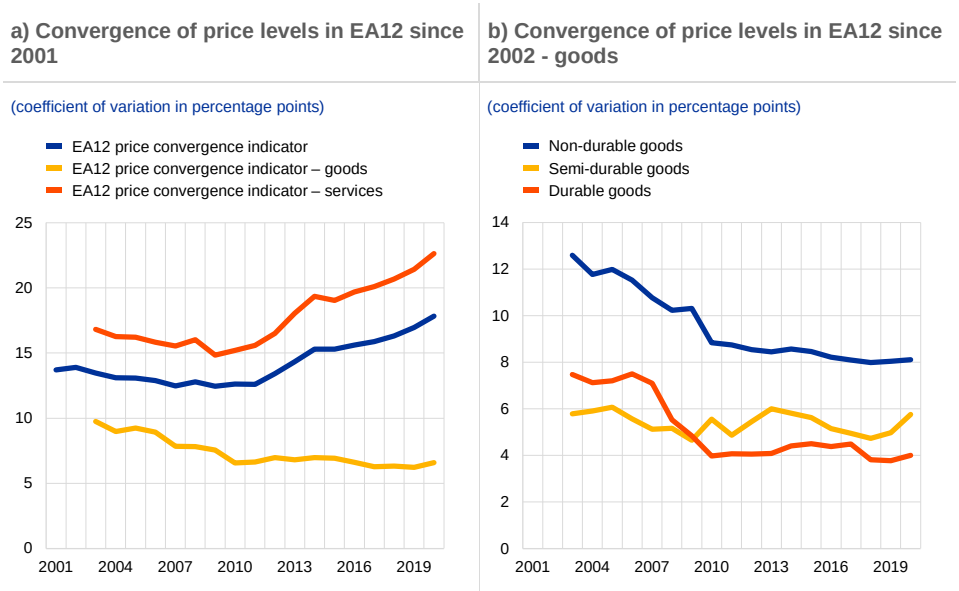


Sources: Eurostat and ECB calculations.

After the start of the euro, price levels first converged slightly, driven by goods prices; but the process was then reversed after 2010, driven by services prices. As shown in Chart 19a, between 1999 and 2010 price levels converged slightly (as measured by a lower coefficient of variation). This was driven by goods prices, in line with the general working of Balassa-Samuelson effects. The convergence of goods prices was driven by both durable and non-durable (but not semi-durable) goods (see Chart 20b). After 2010, however, price levels did not converge any further for goods and a rise in the dispersion of services prices led to an overall gradual increase in price level dispersion, more than reversing the previous convergence (see Chart 19a).

Chart 19

Convergence in price levels in the euro area 12



Sources: Eurostat and ECB calculations.
Notes: The Eurostat convergence indicator is defined as the coefficient of variation of the price level indices (PLIs) and per capita volume indices (VIs) of gross domestic product (GDP), actual individual consumption (AIC) and household final consumption expenditure (HFCE). It measures price and volume convergence across countries, which is associated with a decrease in the indicator.

It seems the Balassa-Samuelson effects discussed prominently in the 2003 strategy review were only a minor factor for changes in inflation differentials in the euro area. This finding is supported by other studies. Using an estimate of the elasticity of relative CPI changes to relative GDP per capita changes, it is possible to estimate the impact of the Balassa-Samuelson effect on inflation differentials. These estimates suggest that the effect was important, especially in the first decade of the euro, for the Baltic countries, Slovenia and Slovakia in particular during the years before they joined the euro area, but not so much for countries inside the area. The importance of these effects also seems to have declined in the second decade.[54] Overall, the effects are found to be rather small and not decisive drivers of inflation differentials in the euro area. It should be noted, however, that these estimates are surrounded by substantial uncertainty. This is also demonstrated by pronounced differences in the findings in the literature, depending on the estimation methodology applied.[55]

Summing up, structural convergence in price levels has not yet taken place in the euro area, and looking at the euro area 12 countries only, the latest data indicates that price level dispersion is higher than it was in 1999. This could partly be the result of rebalancing effects (see the discussion in the next section). If a genuine process of sustainable real and nominal convergence were to start, this

54 See Table 1 in Fidora et al. (2017), where this elasticity is also estimated controlling for other variables like short-term interest rates, openness and fiscal position.

55 Estimates (up to 2007) for euro area countries vary from zero to two percentage points per annum. For the non-euro area EU countries the range widens from zero to three percentage points per annum; see for example Mihaljek and Klau (2008) and Égert (2010). A study by Berka et al. (2018) using detailed data for sub-categories of the price level index and sectoral total factor productivity for euro area countries finds a relatively large role for Balassa-Samuelson effects.

would become a source of inflation differentials, with higher inflation in countries catching-up and lower inflation in countries starting from higher price levels. The process would be justified by economic fundamentals, as it would originate from the productivity growth differentials that played a prominent role in the 2003 strategy review discussion of the inflation buffer.

3.3.2 Effects of differences in the composition of consumption baskets on inflation differentials

Structural differences and changes in consumption baskets across euro area countries are one potential source of inflation differentials in a monetary union. This follows from heterogeneous inflation dynamics for different categories of goods and services, which then lead to differences in overall inflation rates due to the different weights these categories have in the consumption baskets of the different countries.

Counterfactual calculations show that since the start of the euro, differences in the composition of consumption baskets across countries have played only a limited role in inflation differentials in the euro area (see Box 4). An analysis of counterfactual inflation rates applying the same common weights for the main HICP components to all countries, which can be taken as a measure for the contribution the compositional effect makes to inflation differentials, points to only a very small impact (below 0.1 percentage points on average per year over the period 1999-2019), with the main exceptions being Ireland and Latvia. However, even in these countries the effects are not overly large.

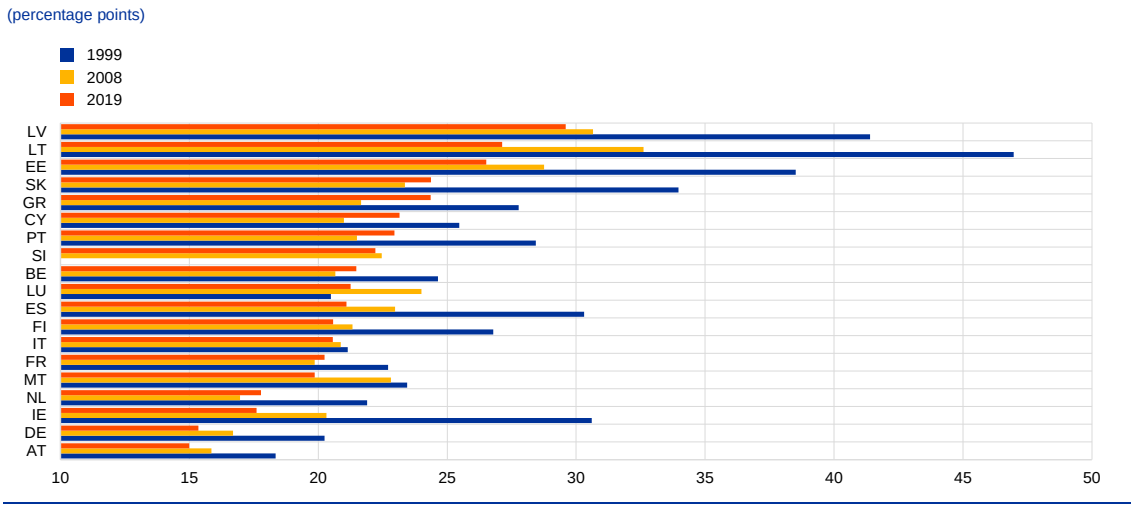
Box 4

The importance of differences in national consumption baskets for inflation differentials in the euro area

Consumption baskets underlying the HICP have long been heterogenous across euro area countries. At the start of euro in 1999 for example, the weight of food in national baskets ranged from 18% in Austria to 31% in Ireland. Since then, the weight of food has decreased in all euro area 19 countries except Luxembourg. In 2019 it ranged from 15% in Austria to 30% in Latvia (see Chart A). Similar cross-country differences are also observable in the other main categories. In services, the weight in 2019 varied from 28% in Lithuania to 52% in Ireland; in non-energy industrial goods from 19% in Greece to 32% in Lithuania; and in energy from 6% in Malta to 16% in Slovakia.

Chart A

Weight of food in the HICP basket by country



Sources: Eurostat and ECB calculations.

One way to evaluate the extent to which inflation differentials are driven by these differences in consumption patterns is to calculate counterfactual inflation rates applying the same common weight to all countries. The difference between the actual headline inflation rate and these counterfactual rates can be seen as a measure for the contribution the “composition effect” makes to inflation differentials. It cannot, however, capture any endogeneity between consumption weights and the way they change and trends in prices.

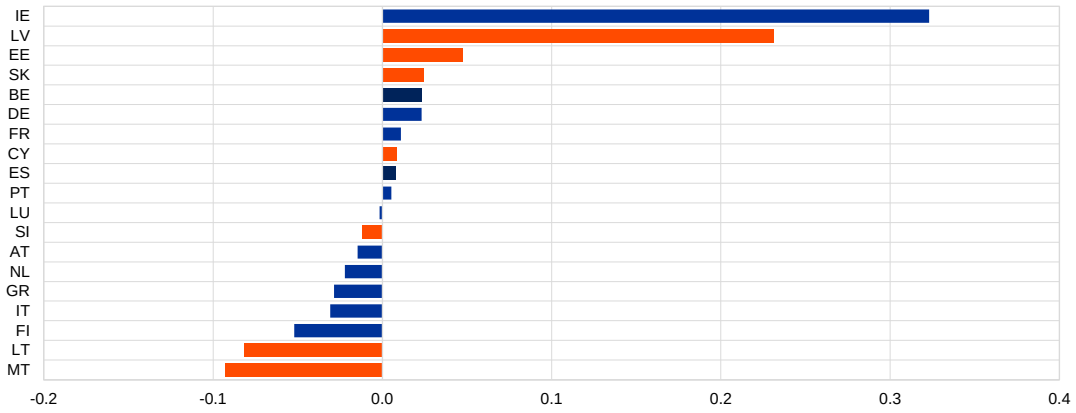
Compositional effects result from the interplay of differences in weights and inflation rates. Even when the inflation rates for subcomponents are the same in all countries and the euro area, differences in the weights of these subcomponents in the consumption basket can lead to inflation differentials. If both weights and inflation rates for subcomponents differ across countries, the compositional effect will reflect the differential weight multiplied by the differential inflation rate compared to the euro area.

As illustrated in Chart B below, compositional effects are generally small (below 0.1 percentage points and often close to zero on average per year over the period 1999-2019), with the exceptions of Ireland and Latvia. In Ireland these compositional effects are linked to a relatively high share of services with a comparatively high inflation rate and a relatively low share of non-energy industrial goods with a comparatively lower inflation rate. In the absence of such compositional effects, average inflation in Ireland would have been around 0.3 percentage points lower on average between 1999 and 2019 (adjusted average headline inflation rate: 1.4%; unadjusted rate: 1.7%).

Chart B

Average compositional effects

(percentage points; blue bars = EA 12; red bars = countries joining afterwards)



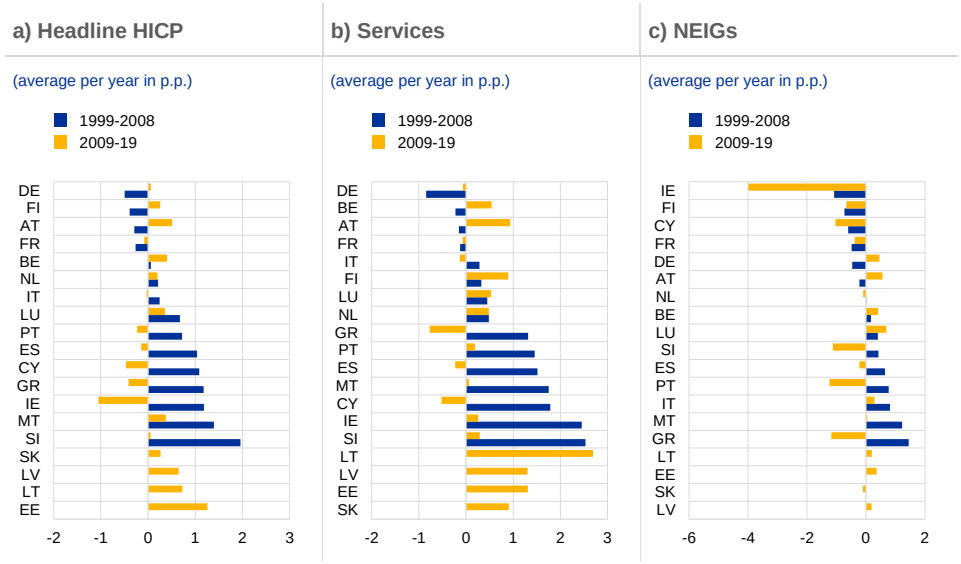
Sources: Eurostat and ECB calculations.
Notes: Bars show the difference between the actual average headline inflation rate in 1999-2019 and counterfactual average headline inflation using for the aggregation the euro area 19 (changing composition) weights of the five special aggregates: unprocessed food, processed food, energy, services and non-energy industrial goods.

3.3.3 Rebalancing for inflation differentials in the euro area[56]

While overall average inflation differentials in the euro area since 1999 have been quite small (see Section 3.1), they were substantially more pronounced when looking at the first and the second decades of the euro separately.
Chart 20a shows that inflation differentials (measured here as the average difference between national HICP inflation and EA 19 changing composition inflation) were substantial in the first decade. Annual average inflation differentials in the EA 12 ranged from -0.5 percentage points in Germany to 1.2 percentage points in Ireland and Greece. This was more than twice as large as the range around the average inflation rates from 1999 onwards. Some Member States, in particular Ireland, Portugal, Greece, Spain and Cyprus, experienced inflation persistently above the average. Looking at components, overall headline differentials were driven primarily by services (see Chart 20b), while non-energy industrial goods (NEIGs) played a less important role (see Chart 20c). One special case is Ireland, which recorded the highest positive differential in services inflation and the highest negative inflation differential in NEIG. In Ireland, Greece, Spain and Cyprus the increase in differentials was coupled with above-average growth in GDP per capita; however this turned out to have been unsustainable, as discussed below.

[56] See the chapter “Nominal Side” in Sondermann et al. (2019) for an in-depth discussion of the build-up and subsequent rebalancing process in euro area countries; also Pierluigi and Sondermann (2018).

Chart 20
Inflation differentials



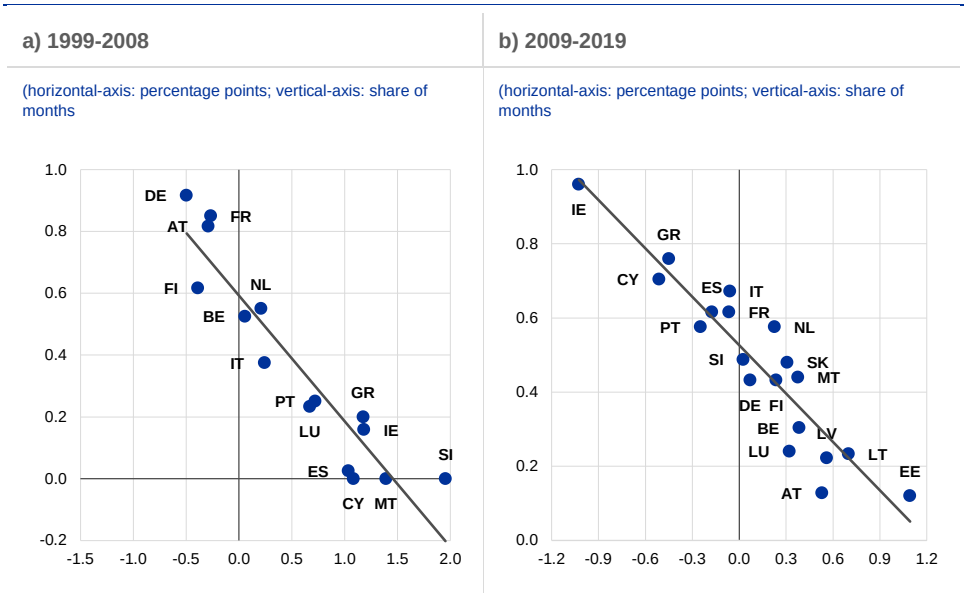
Source: Eurostat and ECB calculations.
Notes: annual data. Data for countries included only for years of EA membership.

In the second decade of the euro, which was characterised by rebalancing, average inflation differentials changed sign in most euro area (EA 12) countries (see Chart 20). This holds both for Member States that recorded higher than average inflation in the first decade (in particular Ireland, Portugal, Greece, Cyprus and Spain), and those where it was lower, like Finland, Austria and Germany (where the shift is more marginal given a very small positive differential in the second decade). With the financial crisis and EU/IMF macroeconomic adjustment programmes, countries like Ireland, Portugal, Greece, Cyprus and Spain underwent significant macroeconomic adjustment. This was reflected in negative inflation differentials, amongst other things.

The finding that inflation differentials between groups of countries are relatively persistent remains robust even when outliers or extreme movements in some sub-periods are taken into account. One way of doing this is to look at the share of months during a decade in which a country's HICP inflation was below the euro area average rather than at the average. Countries with a negative inflation differential on the former measure (see Chart 20a) mostly also recorded one according to the share of months measure (see Charts 21a and 21b), e.g. Germany, France, Finland and Austria in the first decade. In the second decade, countries experiencing a negative inflation differential again remained below euro area inflation for a large share of this period (e.g. Portugal, Italy, Greece, Cyprus and Ireland).

Chart 21

Relationship between inflation differentials (x-axis) and share of months when country HICP inflation was lower than euro area HICP inflation (y-axis) in the first and the second decades of the euro



Sources: Eurostat and ECB calculations.
Note: Latest observation: December 2019.

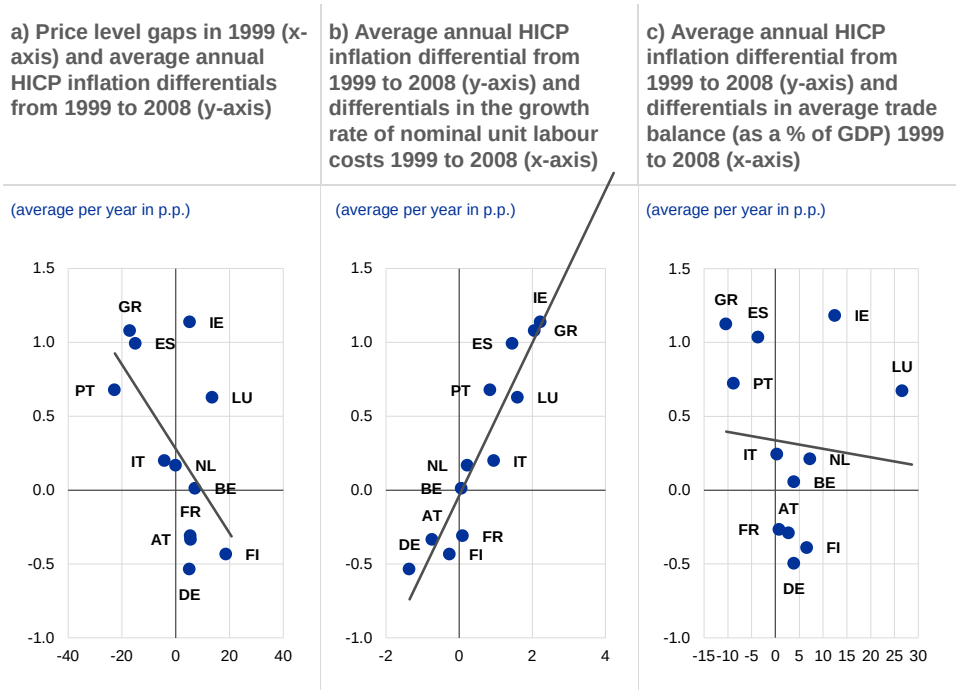
Matching inflation to price level data shows that inflation differentials in 1999-2008 led to some convergence in price levels, but this was at least partly built on unsustainable booms. Chart 22a indicates that inflation differentials were indeed in line with a convergence in price levels, but this did not reflect a lasting situation. It was mainly a by-product of an unsustainable catch-up in low income economies which, given the high nominal wage growth and comparatively weak productivity dynamics, led to a loss in competitiveness in some countries. This is shown, for example, in the strong correlation between inflation differentials and differentials in the growth of unit labour costs (which were often even higher than inflation differentials: see Chart 22b). The economic booms in these countries were mainly driven by very strong domestic demand, not price convergence effects via tradable goods and services.[57] This in turn was a side-effect of a credit-driven boom associated with (depending on the country) the accumulation of large external imbalances, fiscal profligacy, capital misallocation, and insufficient diffusion of technology coupled with an overestimation of growth potential. It is also supported by the fact that the link between increases in unit labour costs and inflation rates was substantially stronger in the more domestically oriented services sector than in industry excluding construction (where tradable goods played a way more important role). Inflation differentials were associated with trade balances: persistent current account deficits indicated unsustainably strong demand, leading to the build-up of

[57] See Pierluigi and Sondermann (2018) for an in-depth discussion of the build-up and subsequent rebalancing process in euro area countries.

imbalances in some countries in the first decade (Chart 22c).[58] When the strong domestic demand turned out to be unsustainable, adjustments to competitiveness were needed. This, in conjunction with nominal rigidities and the financial crisis, explains the subsequent costly adjustment, including increases in unemployment.

Chart 22

Inflation differentials



Source: Eurostat and ECB calculations.

In the second decade of the euro, rebalancing played a dominant role and led to an increase in the dispersion of price levels. Chart 23a indicates that in the period 2009-19 price level convergence disappeared, as inflation increased more in those countries with higher than average price levels and decreased in countries where these were lower than average. This demonstrates the importance of rebalancing; price levels fell in Greece, Spain, Portugal and Ireland. These reductions in price levels went hand in hand with (partial) unwinding of the current account imbalances (Chart 23c) and a reduction of the differentials in unit labour cost growth in these countries (Chart 23b). It was also linked to structural reforms in product and labour markets.

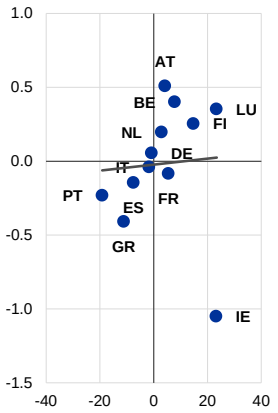
[58] There is also evidence suggesting that the persistent current account surplus of the euro area has been a low-frequency contributor to the decline in inflation outcomes over the last decade; see Galstyan (2019) and Eser et al. (2020).

Chart 23

Inflation differentials

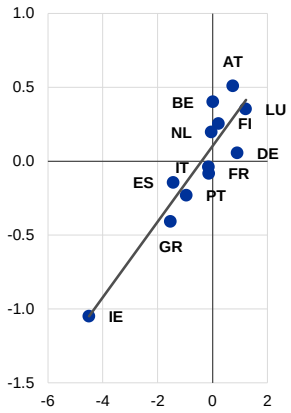
a) Price level gaps in 2009 (x-axis) and average annual HICP inflation differentials from 2009 to 2019 (y-axis)

(average per year in p.p.)



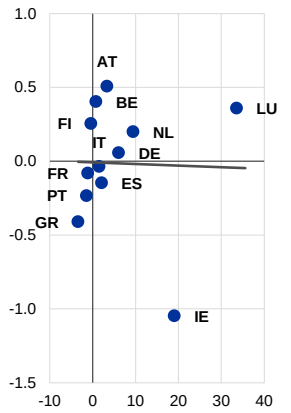
b) Average annual HICP inflation differential from 2009 to 2019 (y-axis) and differentials in the growth rate of nominal unit labour costs 2009 to 2019 (x-axis)

(average per year in p.p.)



c) Average annual HICP inflation differential from 2009 to 2019 (y-axis) and differentials in average trade balance (as a % of GDP) 2009 to 2019 (x-axis)s

(average per year in p.p.)



Source: Eurostat and ECB calculations.

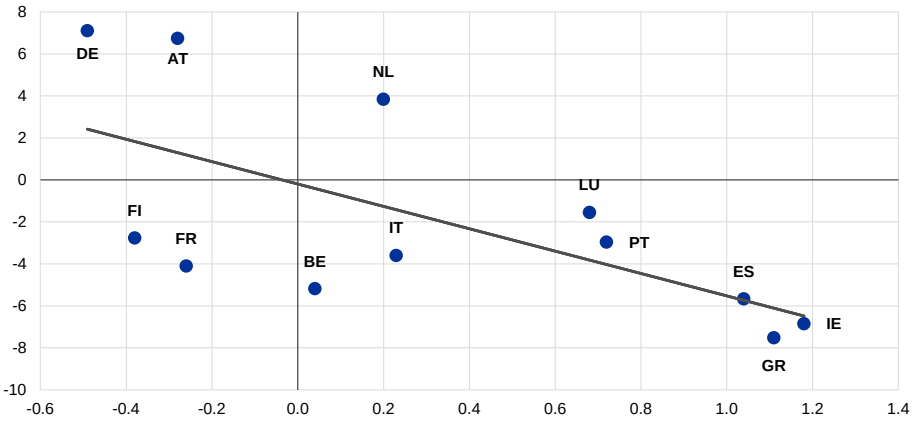
The large costs of rebalancing were also linked to downward nominal wage rigidities, and can be illustrated very clearly for the adjustment period running from 2009 to the peak of unemployment in 2013 (see Chart 24). Countries that experienced unsustainable booms in the first decade of the euro, as reflected in large and unsustainable current account deficits and inflation rates above the euro area average (see Chart 24a), had to adjust strongly over 2009-2013. This was also reflected in lower than average inflation rates (see Chart 24b). However, the adjustments in prices and wages in these countries were not sufficient – partly because of downward wage rigidities (see Section 2.3) – to prevent a massive increase in unemployment, which reflected an adjustment in quantities instead of prices (see Chart 24c).

Chart 24

Competitiveness, adjustment costs and the process of rebalancing 2009-2013

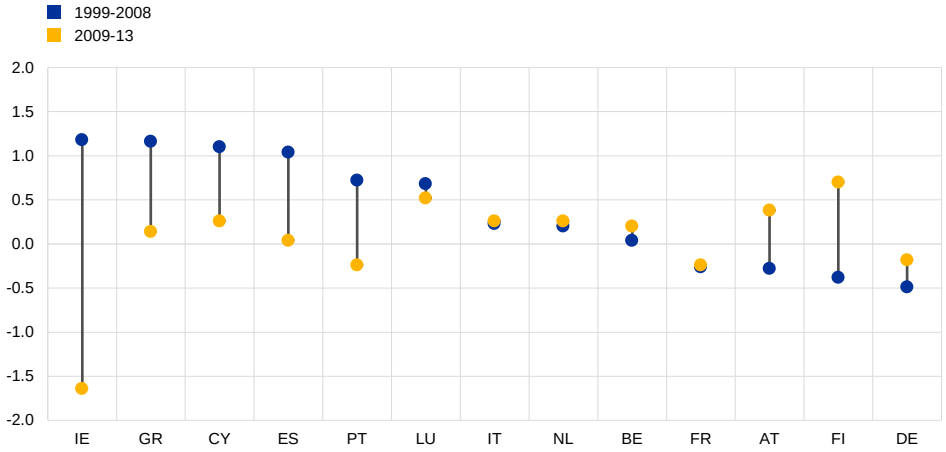
a) Change in current account between 1999 and 2008 (y-axis) and inflation differentials 1999-2008 (x-axis)

(y-axis: change in current account; x-axis: average inflation differential; percentages points)



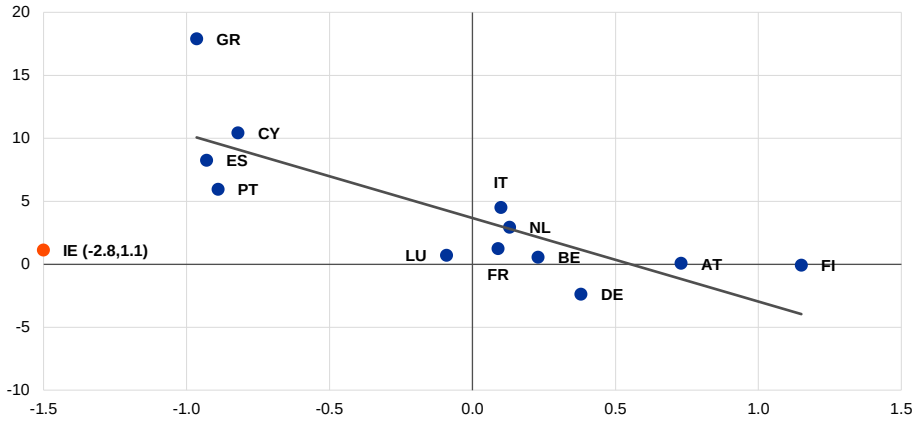
b) Inflation differentials

(y axis: average inflation differential in percentage points)



c) Change in unemployment rate between 2009-13 (y-axis) and change in inflation differentials between 1999-2008 and 2009-13 (x-axis)

(y-axis: change in unemployment rate; x-axis: change in average inflation differential; percentage points)



Sources: Eurostat and ECB staff calculations.
Notes: The sample includes all countries in EA12; countries are included from the time they joined EMU. Current account is calculated as a percentage of GDP on a four-quarter moving average. Belgium is included from 2000 onwards (due to availability of data). the unemployment rate is calculated as a percentage of the labour force. The change in the current account refers to the period 1999-2008; the change in the unemployment rate refers to the period 2009-2013. Inflation differentials are calculated from the euro area weighted mean. The inflation differential refers to the average inflation differential 1999-2008 in Chart a and the difference between the average inflation differentials in 1999-2008 and 2009-2013 for Charts b and c. Ireland is excluded from the trend line in Chart c and its true values are shown in brackets.

4 Summary and conclusion

This paper discusses two of the main rationales for an inflation buffer in a monetary union where monetary policy is oriented towards an area-wide inflation objective: nominal rigidities and inflation differentials. While the 2003 strategy review focused mainly on the conceptual aspects of these as arguments for a positive inflation buffer, considerable empirical evidence has been gathered since then.

Evidence accumulated since 2003 suggests that nominal rigidities remain a prevalent feature of the euro area, but with differences as regards prices and wages.

Price setting may have become more flexible and there is no evidence for especially strong downward rigidities. According to the Inflation Persistence Network (IPN, 2005) and the ECB Corporate Telephone Survey (CTS, 2019), consumer prices on average remain unchanged for several quarters; however, there is significant sectoral heterogeneity around this average, with more frequent changes for energy and unprocessed food and less frequent ones for non-energy industrial goods and services. Results from the PRISMA network over 2011-2017 indicate that the frequency of price changes has increased compared to the IPN results, possibly substantially for non-energy industrial goods but less so for services. While the share of decreases in overall price changes remains lower than the share of increases in both PRISMA and IPN analyses, the average size of decreases tends to be somewhat larger in the latest PRISMA analysis. Nevertheless, given that relative prices of goods tend to decrease over the life cycle of the product, the overall frequency of price changes may still be considered relatively low, implying the continued need for a positive inflation buffer to minimise misallocations over time. A recent study of PRISMA data (Adam et al., 2021) estimates that the positive inflation buffer needed to account for these effects of price stickiness might be well above 1% in the euro area.

Nominal wage rigidities across euro area countries have remained high compared with the most flexible advanced OECD economies, and evidence gathered during the sovereign debt crisis suggests DWR remain prevalent. The Wage Dynamic Network (WDN, 2007-2015) finds that wage contracts in the euro area are staggered and sticky and DWR is found to be important across euro area countries, including during the period 2010-2013. Nominal wages are often frozen during a crisis, but very rarely cut. Adjustments thus led to nominal wage changes clustering at zero. At the same time, the WDN results point to adjustments in firms' wage bills during the financial and sovereign debt crises via other labour market margins such as variable pay, more flexible types of contracts and hours worked.

Structural policies implemented to support economic resilience and higher economic growth have contributed to increasing labour market flexibility – but may have made DWR more binding. For instance, the introduction of more flexible types of employment contract since 2003 has helped firms in the euro area to adjust

their labour costs depending on profitability and the overall economic situation. However, the same reforms that improved labour market flexibility may also have made DWR more binding. By way of example, during the financial crisis firms reduced wages and set them closer to the minimum level in collective agreements – limiting the space for further cuts in subsequent downturns. Also, in some countries the level of minimum wages has increased relative to average wages. These two factors may lead to larger output losses, as downward nominal wage rigidity has become more binding.

DWR provides a strong argument for a positive inflation buffer in the euro area. The large costs in terms of unemployment following the rebalancing needed after the financial and sovereign debt crises emphasise the risk that macroeconomic adjustments are managed in terms of quantities (unemployment) rather than prices when DWR is binding – which is a strong argument for why a positive inflation buffer is required in the euro area. When assessing whether DWR should be treated as a given for the purposes of monetary policy strategy, it is worth noting that microeconomic and survey evidence suggests nominal rigidities are deeply related to firms' and workers' bargaining preferences as well as firms' cost-effectiveness, and do not necessarily reflect equilibrium inefficiencies.

The argument for a positive inflation buffer is reinforced in a persistent low-inflation and low-productivity environment with DWR. In such an environment, nominal wage growth is likely to be low, leaving very little room for nominal adjustments if DWR prevails and hence increasing the risks of an adjustment in terms of quantities. Limited adjustment to real wages in such an environment has an impact on firms' profitability, with persistently negative effects on hiring and investment and hysteresis effects on output and unemployment. The effect on output and unemployment is also related to the joint degree of flexibility in prices and wages. If prices become more flexible than wages, protracted adjustment in real wages could lead to hysteresis effects on output and unemployment.

Average inflation differentials have been relatively small across euro area countries, with an average standard deviation of below 1 percentage point. The difference between the highest average and lowest average for both HICP and HICPX inflation was a mere 0.7 percentage points in the euro area 12 countries over the period 1999-2019. Including the other seven countries that joined later and have a far shorter membership period increases the range to around 1.6 percentage points. While cyclical developments have played a key role in inflation dispersion in the euro area, a substantial part of this can be linked to dispersion in more persistent inflation trends (as shown in five-year moving averages). It is the dimension across countries that has been key, rather than across regions, confirming that an inflation buffer may be especially important in a monetary union of different countries. Overall inflation dispersion across euro area countries has been only slightly higher than across US regions, which is remarkable given that one might expect larger differences in a currency union with national business cycles and, for example, largely national fiscal and economic policies.

By and large, the ECB's inflation objective seems to have provided sufficient margin to prevent countries from having to live with excessively low or even

negative inflation rates in the period 1999-2019. On average, the largest negative average deviation of headline inflation in any country from the euro area average was -1.5% over the years 1999 to 2019, indicating that a positive buffer of 2% for euro area headline inflation should be largely sufficient to avoid prolonged periods of negative inflation. In the first decade of the euro the 2% buffer proved sufficient to prevent countries from having to live with negative inflation rates for prolonged periods (defined here as four or more consecutive quarters). However, this was based around average headline inflation of 2.2%. During the second decade the picture changed, and episodes of negative HICP and even negative HICPX inflation rates occurred in the aftermath of the financial and sovereign debt crises. While HICPX never turned negative in the euro area as a whole, there were considerable periods of negative HICPX rates recorded in some countries. Correcting for the upward effects of indirect taxes would expand and prolong most of these periods. The periods of negative inflation in individual countries emerged in an environment of low inflation for the euro area as a whole. Simple counterfactual analysis suggests that the periods with negative inflation in euro area countries during the second decade of the euro would have been less pronounced if the euro area-wide inflation objective of close but below 2% had been reached, but would not have been completely avoided. These episodes underline the importance of maintaining the inflation buffer as much as possible in the face of asymmetric shocks, implying both negative and positive deviations from the inflation target across countries.

Inflation differentials have remained persistent and only changed sign in many countries between the first and the second decades due to the build-up and subsequent partial correction of imbalances. In the first decade of the euro, inflation differentials were in line with convergence in price levels, but were only in a few countries accompanied by a lasting convergence in income levels. The Balassa-Samuelson argument discussed prominently in the 2003 strategy review were only a minor factors for inflation differentials actually observed. Rather, these were mainly a by-product of unsustainable growth in lower income economies, which, in the presence of high nominal wage growth and comparatively weak productivity dynamics, led to a loss in competitiveness and high current account deficits in some of those countries. In the second decade of the euro, the need to unwind these unsustainable imbalances and regain competitiveness led to a reversal of inflation differentials. Countries with lower price levels recorded lower than average inflation rates, but typically at a high cost in terms of unemployment. Structural differences in the composition of consumption baskets across euro area countries played only a limited role in inflation differentials in the euro area (see Box 4).

Inflation differentials have remained a prevalent feature of the euro area, but their nature did not correspond to the original motivation for an inflation buffer. The 2020/2021 strategy review has found that inflation differentials have been essentially due to the rise of economic and financial imbalances in the first decade and the subsequent need for adjustment, not to Balassa-Samuelson effects and a convergence in price levels across euro area countries.

Inflation differentials that imply negative inflation rates for some countries are particularly harmful if they are combined with high nominal downward wage

rigidity. An inflation buffer limits the risk of long-lasting adjustment processes from asymmetric shocks (or from common shocks that affect euro area countries asymmetrically) leading to deflationary outcomes.

However it should be noted that the different reasons for an inflation buffer – e.g. nominal rigidities and inflation differentials – cannot simply be added up to define the appropriate size of the buffer. This requires a holistic assessment of the different rationales for such a buffer, including a possible, systematically positive error in the measurement of inflation and the need to reduce the likelihood of nominal interest rates reaching the effective lower bound (see Work stream on inflation measurement, 2021; Work stream on the price stability objective, 2021).

The COVID-19 pandemic is an example of a common shock which may have different effects across countries and therefore requires relative price adjustment and a positive inflation buffer. The pandemic has had a substantial impact on inflation differentials in the euro area and the dispersion in headline inflation across countries has increased. Services inflation played an important role here, partly reflecting differences in the importance of the tourism sector, which was hit especially hard by pandemic-related restrictions (see Box 3).

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