Is price competitiveness favourable in Germany and the euro area?

The assessment of an economy's price competitiveness plays an important role in the economic policy debate. International organisations, such as the International Monetary Fund, issue policy recommendations based on such evaluations. The Bundesbank also regularly makes reference to these in its analyses. The robustness and informative value of price competitiveness indicators therefore hold key significance.

One basic indicator of price competitiveness is the real exchange rate, which is composed of the nominal exchange rate alongside domestic and foreign inflation rates. High rates of inflation at home compared with those abroad as well as nominal effective appreciations of the euro tend to adversely affect the price competitiveness of domestic producers. In 2022, a major factor weighing on Germany's price competitiveness was the – at times sharp – relative rise in energy prices. To ensure that this is also adequately reflected in an indicator of price competitiveness, a suitable price index must be factored into the calculation. The deflator of total sales – which, amongst other things, also includes the costs of imported intermediate inputs and the costs of energy – proves to be well suited for this purpose.

An indicator based on this price index shows that, in 2022, the price competitiveness of several euro area countries against the rest of the euro area saw the largest year-on-year shifts since the introduction of the single currency. This is due to the fact that the high rates of inflation last year also led to large inflation differentials between the individual countries of the euro area. Depending on their trade structures, countries with particularly high inflation rates saw their price competitiveness consequently deteriorate markedly, while that of other countries improved distinctly. However, Germany's price competitiveness was hardly impacted by these effects, while the price competitiveness of the euro area as a whole was weighed down by relatively high inflation rates ceteris paribus.

Alongside the real exchange rate, more refined indicators also take account of other determinants of price competitiveness, particularly the productivity of the domestic economy in relation to the economies of other countries. This article presents a new method used by the Bundesbank to estimate the price competitiveness of a number of countries based on their relative levels of productivity. This method avoids the distortions that are produced by other common estimation procedures. The analysis shows that, despite the exceptional economic burdens of the past few years, Germany and the euro area were in favourable positions with regard to their price competitiveness in 2022 and that their positions improved even further over the course of the year due to the sharp nominal effective depreciation of the euro. However, this no longer holds true if Germany is compared only to the other countries of the euro area: in this case, Germany's price competitiveness roughly corresponds to the value suggested by its fundamentals. Nevertheless, these results should not obscure the fact that the prevailing challenges, such as the persistently high energy prices compared with other countries, could negatively impact the price competitiveness of both Germany and the euro area.

Introduction

The issue of a country's competitiveness is a frequent topic in the economic policy debate. In this context, "competitiveness" refers to whether the businesses in the country as a whole – under fair and free market conditions – are able to compete with vendors from other countries. This comprises both price and non-price components. This article discusses competitiveness with regard to prices, focusing on various country-specific price developments, relative price developments, and exchange rate movements between currency areas. The analysis takes account of the fact that productivity can grow at different rates in different countries, which has an impact on the assessment of price competitiveness.

Given the period of high inflation since 2021, there has been much movement in relative price developments among both euro area and non-euro area countries. This is because the inflation rates in different countries were at different levels and also differed in how they developed. The nominal exchange rate, which is generally the key factor for the short-term development of price competitiveness during periods of stable prices, thus became less significant by comparison. Productivity developments remained a major explanatory factor during the period of high inflation, too.

This article discusses three core questions. First, how can price competitiveness be adequately measured? Second, what are its special features in the current phase of unusually high inflation? Third, how much can be explained by relative productivity developments? This article will primarily analyse the competitiveness of Germany and the euro area.

A basic indicator of price competitiveness for Germany and the euro area

How can price competitiveness be adequately measured?

Real effective exchange rate as a basic indicator of price competitiveness

The real effective exchange rate is a basic indicator of the price competitiveness of an economy. Indicators based on the real effective exchange rate for the euro area and its Member States are calculated by the European Central Bank and the Bundesbank according to a common methodology.[1] The indicators calculated using this methodology for the euro area are referred to as the "real effective exchange rates of the euro" and those for the individual Member States are referred to as the "harmonised competitiveness indicators".

Indicator reflects exchange rate between domestic and foreign baskets of goods

The calculation of these indicators of price competitiveness incorporate trade-weighted averages of bilateral nominal exchange rates (nominal effective exchange rates) and the price or cost ratios between a given country and other countries (weighted price differentials). Ultimately, the real effective exchange rate thus represents the exchange rate between a defined basket of goods in a given country and the trade-weighted average of its partner countries. On this basis, a real depreciation could result either from a nominal effective depreciation of the euro or from a decline in prices at home in relation to abroad. As this makes the domestic basket of goods cheaper overall in comparison to the foreign basket of goods, the price competitiveness of the domestic economy improves.

Representative indicator must fulfil a number of statistical and conceptual requirements

In order to produce a representative assessment of the price competitiveness of an economy, an indicator must fulfil – alongside a number of statistical criteria – the following requirements, in particular: it should summarise an

1 The methodology for calculating the effective exchange rates is described in Schmitz et al. (2012), European Central Bank (undated), and Deutsche Bundesbank (2019).

economy's price competitiveness against a wide range of trading partners, it should reflect the price and cost situation as comprehensively as possible, and, for purposes of comparison, it should extend as far back in time as possible. Depending on which of these criteria is at the focus, alternative indicators can be calculated for a given country to produce different information.[2]

Indicator for euro area calculated against 18 trading partners, indicator for Germany against 37

In this article, the real effective exchange rate of the euro is calculated against 18 trading partners.[3] The corresponding indicator of the German economy's price competitiveness comprises 37 trading partners – the 18 non-euro area trading partners mentioned above as well as the 19 remaining euro area countries.

Indicators based on deflators of total sales at the focus of analysis

When selecting suitable deflators, there is some scope for discretion, as the available price and cost indices are defined differently.[4] The Eurosystem uses consumer price indices, producer price indices, gross domestic product deflators (GDP deflators) or unit labour cost indices for the total economy.[5] In addition, the Bundesbank uses the same methodology to calculate competitiveness indicators based on deflators of total sales. These are at the focus of the present analysis and, on a case-by-case basis, are compared with indicators based on likewise broadly defined GDP deflators.

Indicators based on deflators of total sales take account of prices of imported goods and services

The difference between deflators of total sales and GDP deflators is that the former take account of the prices of imported goods and services, in addition to domestic value added, and therefore reflect the price and cost situation to an even broader extent than GDP deflators. For example, imported intermediate inputs represent a considerable cost component of domestic production.[6] Accordingly, the deflator of total sales reflects the average change in the prices of both domestically produced and imported goods. Here, it is especially important that, unlike the GDP deflator, it also captures the influence of international factors – particularly the impact of international trade – on general price developments, which should be reflected in an indicator of price competitiveness.

The real effective exchange rate of the euro against 18 trading partners

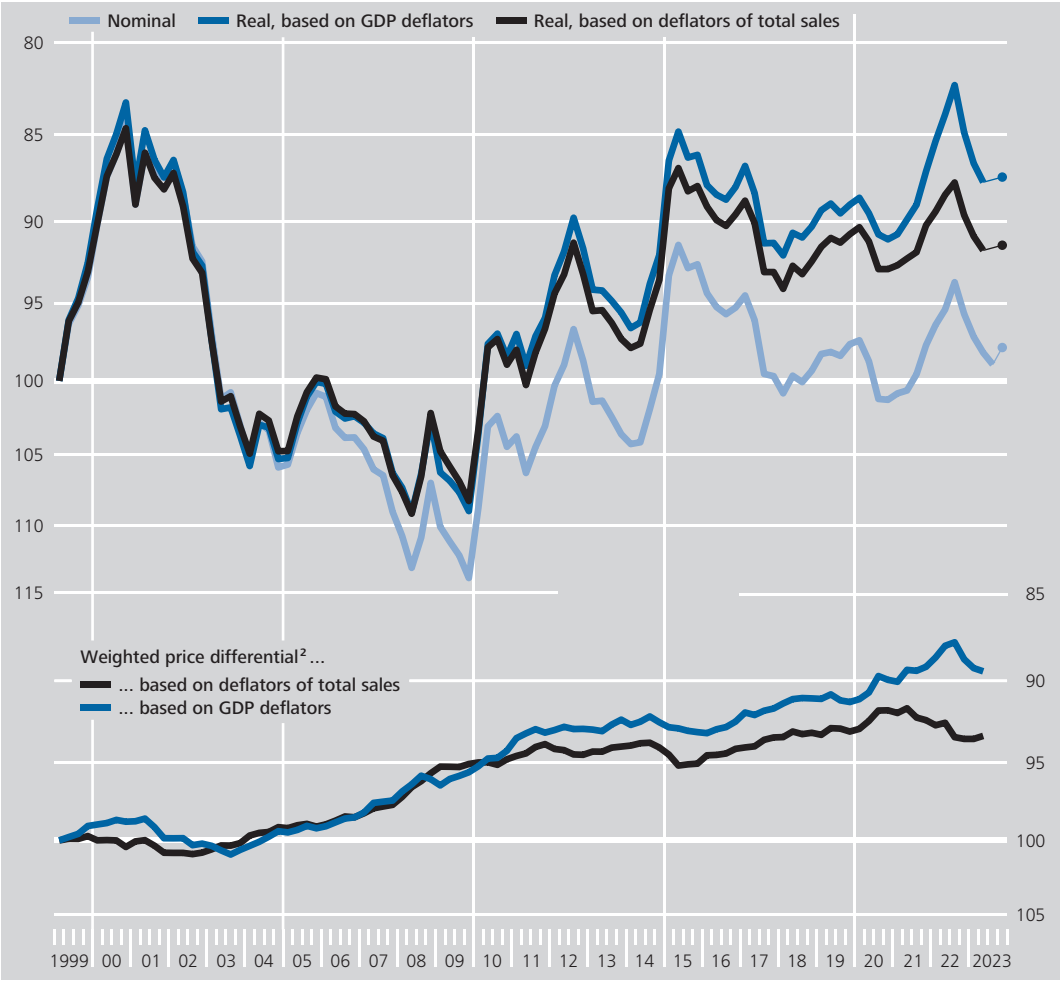
Price competitiveness of the euro area largely determined in recent years by the nominal effective exchange rate

First, the analysis looks at the real effective exchange rates of the euro against 18 trading partners calculated on the basis of either GDP deflators or deflators of total sales. To illustrate the concept of price competitiveness, the real exchange rates can be broken down into their components: the nominal effective exchange rates and the corresponding price differentials

2 A comprehensive empirical analysis of the characteristics of alternative indicators for price competitiveness is documented in Deutsche Bundesbank (2016).
3 Croatia's accession as the 20th member of the euro area on 1 January 2023 reduced the number of non-euro area trading partners from 19 to 18. The 18 non-euro area trading partners are Australia, Bulgaria, Canada, China, Czech Republic, Denmark, Hong Kong, Hungary, Japan, Norway, Poland, Romania, Singapore, South Korea, Sweden, Switzerland, the United Kingdom, and the United States.
4 Empirical evidence suggests that real effective exchange rates based on broadly defined price and cost indices have relatively high explanatory power for real goods exports and are thus suitable indicators of an economy's price competitiveness. See Deutsche Bundesbank (2016).
5 Consumer price indices exhibit the best data quality and comparability between countries, are available in real time, and are subject only to minor revisions. However, their main disadvantage is that they include neither capital goods nor intermediate inputs and thus do not fully capture the costs of production. By contrast, producer price indices include industrial goods and intermediate inputs, but do not cover retail trade turnover. The downsides of producer price indices, however, are that they do not include any services prices and that their composition varies significantly between countries, which impairs their comparability. Unit labour costs for the total economy are quite volatile and sometimes subject to considerable data revisions. GDP deflators are broadly defined and, like producer price indices, also reflect the costs of production. Furthermore, they also capture the domestic services sector, which has grown increasingly significant over recent years. Nevertheless, they are also subject to data revisions and are affected by the volatility of the quarterly GDP data series. See Deutsche Bundesbank (2016), European Central Bank (undated), and Schmitz et al. (2012).
6 One indication of the large and growing significance of intermediate inputs for value added in Germany and the euro area is provided by the considerable increase in the share of intermediate inputs in the total volume of trade, which saw particularly strong growth relative to total imports. In 2021, this share averaged more than 50% across all euro area Member States. By contrast, the average shares of imported capital and consumer goods were significantly lower at around one-fifth each. See Eurostat (2022).

Effective exchange rate of the euro*

Q1 1999 = 100, quarterly data, log scale[1]



Sources: Bundesbank for the ECB and Bundesbank calculations. * Calculated against 18 partner countries. **1** Inverted scale: a rise in the curve (fall in values) denotes an increase in price competitiveness. **2** Prices in the euro area relative to the weighted average of trading partners. Inverted scale: a rise in the curve (fall in values) denotes a smaller increase in prices in the euro area than among trading partners. Weighting scheme analogous to that for effective exchange rates. ● Latest figures: 18 October 2023, estimated for real effective exchange rates.

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(see the chart above). Initially, it should be noted that both of these indicators of euro area price competitiveness are highly correlated with one another. This is due mainly to the fact that these indicators are largely determined by the nominal effective exchange rate and that, in historical terms, the deflators exhibit comparatively minor variation over the short term. For example, between the final quarter of 2020 and the third quarter of 2022, the euro depreciated by around 7% against the partner currencies and has since recovered more than half of these losses. Here, the largest contributions to the nominal effective depreciation of the euro came from marked losses in value against the US dollar, the pound sterling and the Chinese renminbi.

Weighted price differentials based on GDP deflators and deflators of total sales have exhibited a divergent pattern since 2021

In light of the generally strong correlation between the two real effective exchange rates of the euro – based on deflators of total sales and GDP deflators, respectively – it is noteworthy that the two figures have increasingly been diverging from one another since 2021. The assessments of how price competitiveness in the euro area has changed therefore vary accordingly. For example, since 2021, the indicator based on GDP deflators has suggested a perceptibly stronger real effective depreciation of the euro and thus a greater improvement in

price competitiveness than the indicator based on deflators of total sales. As the nominal effective exchange rate developments are the same for both indicators, this increasing discrepancy is a reflection of the differences in the deflators over time.

For instance, the weighted price differentials based on these deflators have shown a striking trend by historical standards since 2021. While the weighted price differentials based on GDP deflators are characterised by a decline in domestic prices compared to those in other countries and a subsequent relative increase in prices up to the end of 2022, the weighted price differentials based on deflators of total sales indicate a continuous rise in relative prices vis-à-vis other countries since the second half of 2021. The latter is reflected in a less pronounced real decline in the corresponding indicator of price competitiveness.

The important role of relative energy price developments for price competitiveness in 2022 highlights the advantage of indicators based on deflators of total sales

The relative price developments in imported intermediate inputs since 2021 are, indeed, probably the main factor for the growing discrepancy between the series of price differentials based on the various deflators. This is because a marked increase in energy prices was observed from April 2021 to September 2022; this rise was considerably more pronounced in the euro area than other regions of the world due to the euro area's strong dependence on imports of natural gas from Russia.[7] Since that time, energy prices in the euro area have abated again in relation to those in other countries. As this has a direct impact on the indicator based on deflators of total sales (and the corresponding price differentials), but not on the indicator based on GDP deflators, the former indicator suggests a distinctly less favourable trend for euro area price competitiveness up until September 2022.[8] By contrast, the indicator based on GDP deflators does not provide a complete picture of price competitiveness during this period. This suggests that, at least for the past few years, an indicator based on the deflators of total sales would be preferable to one based on GDP deflators. For that reason, this analysis will focus on indicators of price competitiveness that were calculated using deflators of total sales.

How can the price competitiveness of the euro area be evaluated?

Benchmark value needed to assess the current competitiveness position of the euro area

The analysis has thus far looked at changes in the price competitiveness of the euro area over time. In order to reach a conclusion about the level of the indicator as well – i.e. whether the price competitiveness position of the euro area can be assessed as favourable or unfavourable – the indicator must be put in relation to a benchmark value that reflects the equilibrium (i.e. neutral) level of the real exchange rate. The price competitiveness position would be deemed to be favourable, for example, if the value of the indicator were considerably below a reference value defined in this way.

Long-term average of the indicator as a benchmark value

The equilibrium level of the real exchange rate is a long-term concept that must be derived from economic theory. Relative purchasing power parity theory, amongst others, can be drawn upon for this purpose.[9] This theory states that the indicator – in this case, the relative price of a basket of goods in a given country compared to that in other countries expressed in a common currency – should be constant over the long term. According to the theory, this holds true because the changes in the nominal exchange rate compensate for international differences in inflation rates over time due to arbitrage. Consequently, the long-

7 See Deutsche Bundesbank (2022a, 2022b).
8 Evidence suggests that, in particular, imports of intermediate inputs from countries that are less dependent on global energy production have temporarily replaced production in the more energy-intensive segments of the euro area manufacturing sector in some cases; see Chiacchio et al. (2023). However, since this development is reflected by the indicators of price competitiveness based on deflators of total sales but not those based on GDP deflators, the latter present a distorted picture of price competitiveness in the euro area.
9 Alternative theoretical and econometric approaches to determining the equilibrium level of the real exchange rate are described in Deutsche Bundesbank (2013a).

term average of the indicator reflects the equilibrium level of the real exchange rate and can thus be used as a benchmark value.[10] Due to its simplicity, this method is frequently used to obtain an initial assessment of an economy's price competitiveness position.

Indicator points to euro area's favourable price competitiveness position

If this long-term average of the real effective exchange rate is calculated based on deflators of total sales, the euro area's current competitiveness position is favourable overall. This has been the case for some time now, including for indicators based on GDP deflators. However, caution should be exercised when interpreting the euro area's competitiveness position, as the corresponding averages, such as those for the indicator based on deflators of total sales, are only available as of 1997.[11] In addition, the indicator for the euro area includes a non-negligible share of emerging market economies among the trading partners.[12] A comparison of the levels of these indicators with the respective series averages is therefore less meaningful than in the case of Germany, for example, where the indicators are available from 1975 onwards.

Indicators of Germany's price competitiveness

The indicator for Germany also signals a favourable price competitiveness position

For Germany, two indicators of price competitiveness based on deflators of total sales are considered (see the chart on p. 19): one against a group of 37 trading partners – corresponding to the indicator for the euro area – and the other against a smaller group of 27 trading partners. The latter excludes, amongst others, the central and eastern European countries and emerging market economies. This sub-indicator is useful because economic catching-up processes in the excluded countries are usually accompanied by higher inflation rates even if competitiveness remains unchanged, which distorts interpretations when measured against the benchmark. Overall, however, both indicators are highly correlated. Measured by the long-term average, the indicators have been signalling a favourable price competitiveness position for the German economy for some time.[13]

This holds when measured in terms of the long-term average against euro area partner countries as well as against non-euro area countries

Germany's current competitiveness position remains favourable in terms of the simple measure of long-term averages, even where a distinction is made between euro area partner countries and those outside the euro area. A comparison between the overall indicator against 27 countries and the sub-indicator against only the non-euro area partner countries in said 27 countries shows that the sub-indicator is markedly more volatile. It suggests that Germany's price competitiveness against partner countries outside the euro area is currently comparable to its position against all partner countries.

Sub-indicator against euro area partner countries represents a weighted price differential owing to the single currency

The sub-indicator against euro area partner countries also points to a favourable competitiveness position in Germany when measured against its long-term average. This has been the case since as early as 2002.[14] In addition, this sub-indicator is significantly less volatile than the indicator against non-euro area partner countries or the overall indicator. This is because the single currency means that no nominal exchange rate fluctuations between Germany and the other euro area countries are transmitted to the price competitiveness indica-

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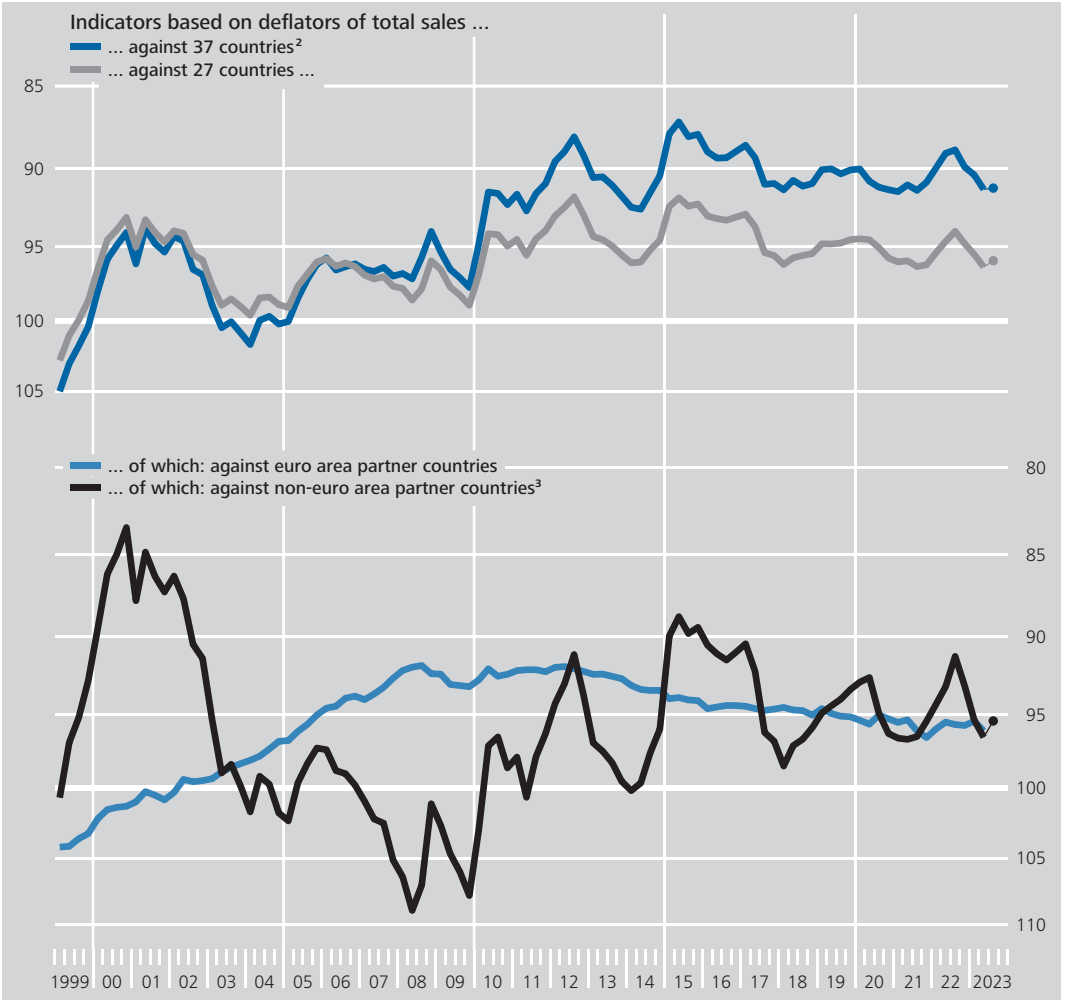
10 See MacDonald (2000) and Deutsche Bundesbank (2004).
11 Prior to the introduction of the euro in 1999, changes in the previous currencies of the eleven original euro area Member States are converted into hypothetical euro exchange rates using the irrevocably fixed euro exchange rates. The aggregation of these exchange rates is based on the shares of manufacturing trade in these countries out of total euro area foreign trade with non-euro area countries. See Schmitz et al. (2012).
12 The underlying problem is explained on p. 23 and p. 26.
13 For the German economy, the indicator of price competitiveness based on deflators of total sales against 27 trading partners is already available from the beginning of the 1960s. However, in order to exclude from the analysis the turbulence during the transition from the Bretton Woods system of fixed exchange rates to flexible exchange rates, only the period from 1975 onwards is actually used.
14 However, if additional information on relative price and productivity levels is taken into account, Germany's price competitiveness position compared with its euro area partner countries should not be regarded as favourable, but instead neutral. See p. 29.

Price competitiveness of the German economy

Average since 1975 = 100, quarterly, log scale[1]



1 Inverted scale: a rise in the curve (fall in values) denotes an improvement in price competitiveness. **2** The time series was chain-linked backwards between 1975 and 1996 using prior-quarter growth rates of the indicator against 27 advanced economies. **3** Canada, Denmark, Japan, Norway, Sweden, Switzerland, the United Kingdom and the United States. ● Last data point estiimated as at 18 October 2023.

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tor. Instead, this sub-indicator represents the weighted price differential against euro area partner countries, in which case only relative prices can provide for any necessary adjustment processes, which is usually a lengthy process owing to price stickiness. Accordingly, although Germany's relative prices have tended to rise slowly over the past decade compared with the rest of the euro area, the impact on its competitiveness position has remained rather small.

Impact of inflation differentials on price competitiveness in the euro area

What are the special features of the current phase of unusually high inflation?

Euro area inflation has risen sharply in the past three years …

Inflation in the euro area increased significantly between 2020 and 2022. Global factors such as the spread of COVID-19, the associated supply chain disruptions coupled with high demand for goods, and the energy crisis triggered by Russia's war of aggression against Ukraine all played their part. Euro area-specific causes

such as the response of fiscal and labour market policy to the pandemic-induced economic downturn in spring 2020 and the pace of Eurosystem monetary policy normalisation in 2022 also played a role.[15]

… reaching a historical peak in 2022 …

Euro area inflation as measured by the Harmonised Index of Consumer Prices (HICP) reached a historical peak in 2022 at 8.4% on the year. Such a figure is all the more striking as in previous years it had stood at 0.3% (2020) and 2.6% (2021). The same applies to the annual rate of change in the deflator of total sales, which is more relevant for price competitiveness. This likewise stood at 0.3% in 2020, rose to 4.1% in 2021, and reached its all-time high of 9.0% in 2022.

… accompanied by above-average inflation differentials between euro area Member States

The extraordinary inflation developments in the euro area in recent years have been accompanied by above-average inflation differentials between euro area Member States, particularly in 2022. Whilst annual HICP rates in 2020 ranged from -1.3% in Greece to 2.0% in Slovakia, they were positive for all countries in 2021, with the highest annual HICP rate being 4.6% in Lithuania. Measured by the deflator of total sales, inflation rates in 2020 ranged between -2.7% in Greece and 1.8% in France. In 2021, they rose in all countries, with the highest inflation rate being 8.3% in Lithuania. In 2022, inflation rates in all euro area Member States reached their highest levels since the introduction of the euro, with the exception of Slovakia (as measured by the HICP) and Ireland (as measured by the deflator of total sales). The Baltic states recorded the highest annual rates of change in terms of both the HICP and the deflator of total sales, which were above 15% in all cases and, in the extreme cases of Estonia and Lithuania, were at 19.4% (HICP) and 21.4% (deflator of total sales), respectively.[16] This contrasts with comparatively low values of 5.9% in France (HICP) and 4.5% in Ireland (deflator of total sales).

The deviation of the national inflation rate of an individual euro area Member State from that of the euro area provides an indication of the impact of such inflation differentials on the price competitiveness of that country compared with the rest of the euro area, especially where the deflator of total sales is used.[17] The chart on p. 21 shows these deviations for all euro area countries calculated on the basis of the HICP and the deflator of total sales for 2020, 2021 and 2022.[18] For a country with inflation above the euro area average, a white dot indicates the average level of positive deviations from current inflation in the euro area in the years following the introduction of the euro in that country until 2019. If, by contrast, a country's deviation from euro area inflation for the current year is negative (blue bar pointing to the left), the years in the aforementioned period during which deviations from current inflation in the euro area were negative are used to find the average level of negative deviation (black dot). For example, if the national inflation rate is higher than that of the euro area and also significantly higher than the value indicated by the dot, the inflation rate for that country is exceptionally high.

Deviations of national inflation rates from those in euro area …

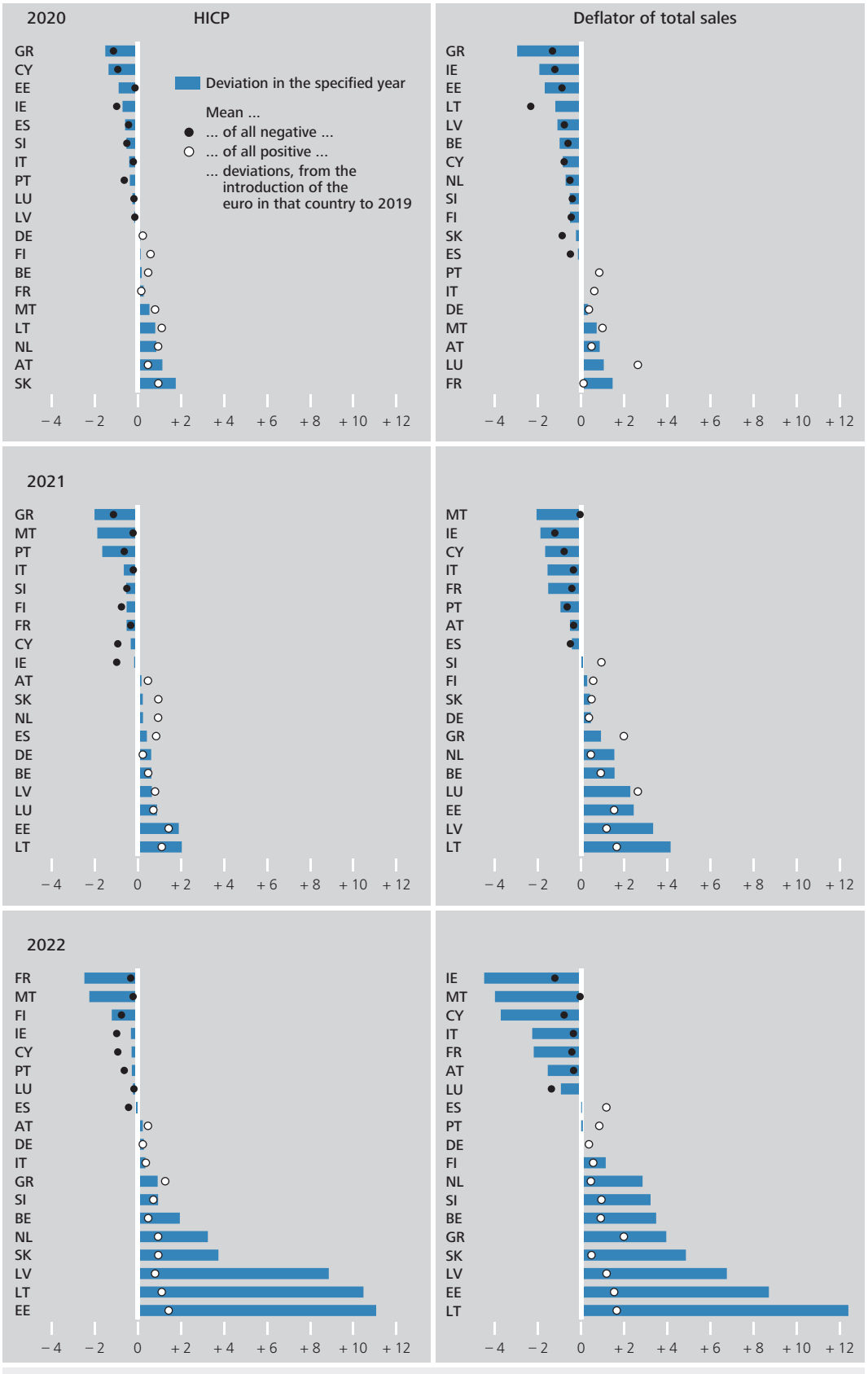
… exceptionally high in most euro area countries in 2022

The chart shows that, in 2020, the deviations of national inflation rates from those in the euro area were unremarkable, regardless of whether the HICP or the deflator of total sales is considered. Some countries had lower or somewhat higher deviations than in previous

15 See Deutsche Bundesbank (2022c).
16 Energy prices were a key factor in the sharp rise in inflation in the Baltic states. Before the war in Ukraine, these were lower in the Baltic states than for the other euro area countries on average. However, the percentage increase in energy prices as a result of the war was much higher in those countries. Differences in applicable energy price regulations, the energy mix and the support measures for households and firms initiated by euro area governments to cushion high prices also led to the observed inflation rate differentials. See Müller (2023) and European Central Bank (2023).
17 However, an exact value of the change in price competitiveness cannot be derived from such a metric. First, it does not take into account the fact that the weights of the partner countries differ for each base country, and, second, the inflation rates for the euro area also include developments in the base country.
18 Similar observations were also made for the HICP excluding administered prices, the HICP excluding energy and food, and the HICP at constant tax rates, none of which produced a fundamentally different picture.

Deviation of national inflation rates from euro area inflation in 2020, 2021 and 2022

Percentage points



Sources: Eurostat and Bundesbank calculations.
Deutsche Bundesbank

years. This changed fundamentally in 2021 and especially in 2022. For the HICP, in 2022 the deviations of national inflation rates from that of the euro area were many times higher for eight out of 19 countries than the average value in previous years. With regard to the deflator of total sales, which is more relevant for price competitiveness, the picture is even more striking. In this case, the deviations from 14 of the 19 euro area countries were at least twice as high as the average value in previous years.

Inflation differentials in 2022 with severe effects on the price competitiveness of many euro area countries …

This finding illustrates that the price competitiveness of most countries compared with the rest of the euro area changed considerably more severely in 2022 than had been observed so far in any year since they joined the euro area. France, Austria and Cyprus were among the countries with far below-average inflation and thus experienced a marked improvement in price competitiveness. Italy, too, was able to post marked gains in price competitiveness compared with the other euro area countries in 2022 owing to low inflation rates. The Baltic countries, Belgium, the Netherlands and Slovenia featured among those countries with far above-average inflation and thus experienced a marked deterioration in price competitiveness.

… which, unlike in other cases, has significantly weighed on or benefited producers competing internationally within a short period

These developments are also noteworthy in that relative price changes have traditionally only been able to significantly influence the price competitiveness of euro area and other advanced economies cumulatively over many years. In a year-on-year perspective, it was usually the nominal effective exchange rate that caused any marked changes in price competitiveness. This statement can be illustrated by the fact that the annual rate of change of the indicator of Germany's price competitiveness was largely determined by the movements of the sub-indicator against partner countries outside the euro area, in which the exchange rate component plays a major role – and not by the sub-indicator against partner countries within the euro area, which is driven only by the price component (see the chart on p. 19). In 2022, by contrast, this was fundamentally different for a number of euro area countries with particularly strong or comparatively weak inflation dynamics. The considerable price differential in these countries led to severe shifts in price competitiveness within a short period of time and considerably weighed on or benefited producers competing internationally.

By contrast, inflation differentials in Germany relative to euro area inflation rates rather small

Remarkably, Germany, of all countries, was not affected by a severe shift in its price competitiveness. Germany is indeed one of the few euro area countries where the inflation differential against the euro area as a whole was very small, not only in 2020 and 2021, but also in 2022. On balance, the weighted price differential between the German economy and those of euro area partner countries deteriorated only slightly in 2020 and 2021, and remained unchanged in 2022 (see the chart on p. 19). Thus, Germany's price competitiveness against this group of countries was not significantly influenced by relative price developments. Rather, in 2022 – in line with historical trends – the marked nominal effective depreciation of the euro against 18 partner currencies dominated the movements of the indicator. This depreciation led to an improvement in Germany's price competitiveness compared with the other countries. As a result, when discussing the impact of energy price increases or, more generally, high inflation on Germany's price competitiveness (see pp. 24 f.), it should be borne in mind that these developments have put a far greater strain on the macroeconomic price competitiveness of some other euro area countries in recent years.

Assessing price competitiveness using the productivity approach

How much can relative productivity developments explain?

Benchmarks for assessing an economy's price competitiveness position derived from purchas-

Valuation of price competitiveness position based on long-term averages only appropriate for homogeneous groups of countries

ing power parity theory can only provide a starting point. For example, relative purchasing power parity theory, from which the long-term average of a real exchange rate is derived as a benchmark, assumes that this benchmark is constant. Theories with less simplistic model assumptions, however, suggest that the equilibrium value of the real exchange rate, too, is not constant, but instead depends on fundamental factors, especially on relative productivity trends of the economy under consideration.[19] For this reason, a benchmark based on long-term averages is only appropriate for homogeneous groups of countries with similar productivity trends. For example, only advanced economies are taken into account as trading partners when calculating Germany's price competitiveness position using this method (see p. 18). Restricting the group of partner countries to a homogeneous group of countries increases the robustness of the results, but limits their representativeness.

Productivity approach allows emerging market economies and transition countries to be included in assessments …

In light of the great importance of emerging market economies and transition countries for foreign trade in Germany and the euro area, the Bundesbank has for some time now been using the productivity approach to determine the price competitiveness position of many economies.[20] By taking into account the impact of relative productivity on an economy's real effective exchange rate, this approach allows the price competitiveness of advanced economies to be correlated with emerging market economies and transition countries. For example, it takes into account the fact that the economic catching-up processes in emerging market economies and transition countries associated with strong productivity increases are usually accompanied by higher inflation rates, which lead to a real appreciation without seriously altering those countries' competitiveness positions. If this mechanism were not taken into account, the real appreciation would incorrectly be reflected in the assessment as a deterioration in price competitiveness.

… and represents a more robust equilibrium concept for assessing price competitiveness

In addition, theoretical considerations and empirical results alike suggest that level data play a key role in the relationship between productivity and the real exchange rate. Therefore, it is important to take into account not only the extent to which a relative increase in productivity in a given country leads to a real (equilibrium) appreciation in that country, but also the extent to which a higher relative productivity level is accompanied by a higher relative (equilibrium) price level in that country. Based on this measure, the productivity approach, which adjusts the real exchange rate for such productivity effects in the form of the relative price level, represents a more robust equilibrium concept for assessing price competitiveness. The resulting benchmark reflects the expected relative price level based on the given relative productivity level. If the actual relative price level falls below this benchmark, the price competitiveness position is deemed to be favourable.

In order to take into account that a higher relative productivity level is associated with a higher relative price level, a different body of data is used as part of the productivity approach

The Bundesbank's productivity approach allows price competitiveness to be determined in a consistent manner for a broad, representative group of economies. To allow real exchange rates to be used in the form of relative price levels rather than merely as indices, a different body of data is used than in earlier sections of this article. Relative price levels are calculated using purchasing power parities. Purchasing power parity expresses the domestic value of a broad basket of goods costing a fixed US dollar amount in the United States in the respective local currency of each economy under observation. The prices of the respective goods and services contained in the basket of goods are recorded by national statistical offices accord-

19 This is attributed, amongst other things, to the Balassa-Samuelson effect; see pp. 27 f.. Other frequently cited determinants of real equilibrium exchange rates include, for example, the net external position and relative government expenditure. However, evidence suggests that the addition of further determinants – on top of relative productivity trends – does not significantly improve the adequate calculation of the benchmark. See Deutsche Bundesbank (2013a).
20 See p. 17.

Energy prices and price competitiveness of the German economy – recent developments

Given the persistently high energy prices, questions arise concerning the extent to which they have weakened Germany's international price competitiveness and influenced decisions made by affected enterprises as to where to locate. When it comes to analysing the impact of factors such as the energy crisis on Germany's price competitiveness, the indicator based on deflators of total sales, which also contains the costs of imported intermediate inputs such as those for energy, is particularly well suited.[1] Judged by this indicator, the price competitiveness of Germany's economy relative to selected advanced economies improved by 2.1% between the first quarter of 2021 and the third quarter of 2022, but subsequently deteriorated by 2.7%.[2]

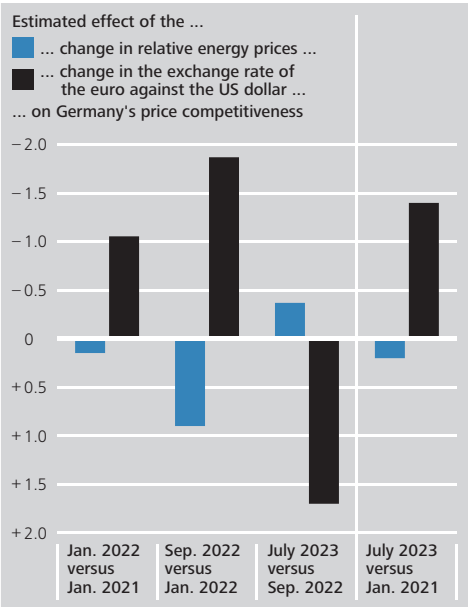
It has already been shown previously that at the exact period that Germany's price competitiveness underwent a marked improvement between January 2022 and September 2022, the relative energy price in Germany had actually risen sharply by just under 30% compared with other advanced economies.[3] This weighed down the German economy's price competitiveness by 0.9% over the period in question ceteris paribus, according to a rough calculation made by the Bundesbank at the time. At the same time, however, the euro depreciated against the US dollar, which, all else being equal, improved price competitiveness by an estimated 1.9%. As a result, the negative relative price effect was more than offset by the positive exchange rate effect, meaning that Germany's price competitiveness improved during this period.

Between October 2022 and July 2023 (after which no more data are currently available) however, the mirror image of these developments set in. During this period, Germany's relative energy costs fell by 22.1% and the euro appreciated against the US dollar by 11.7%. Working under the same assumptions as were used for the rough calculation mentioned earlier,[4] the decline in relative energy costs, all else unchanged, translates into a 0.4% improvement in Germany's price competitiveness and the appreciation of the euro produces a deterioration of 1.7%.

Taking into account developments in 2021, which were particularly characterised by the relative rise in energy prices occasioned by shortages in Russian gas supplies, we are left with an increase in Germany's relative energy prices of 5.0% over the entire period from the start of 2021 to July 2023. As a result, Germany's price competitiveness deteriorated by 0.2%. This was offset by an improvement of around 1.4% stemming from the euro's depreciation against the

Components of Germany's price competitiveness*

%, inverted scale



* Estimated against selected advanced economies. A positive value (downwards-pointing column) denotes a relative energy price rise in Germany or appreciation of the euro against the US dollar and thus a decrease in price competitiveness.

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1 See p. 17.
2 The indicator employed here covers 27 trading partners. This is because the rough calculation used to measure relative energy costs for the purposes of our analysis is based on an energy-specific producer price index that is unavailable for many countries.
3 See Deutsche Bundesbank (2022b). The article focuses on the relative increase in energy prices in 2022 in relation to Russia's war of aggression against Ukraine.
4 Specifically, we assume an energy cost share of just over 2% for the German economy as a whole and assign the United States a trade weight of 15% for Germany.

US dollar, which meant that, according to our calculations, the negative cost effect was more than absorbed when looking at the economy as a whole.

There is currently talk of a "bridge" electricity price. Subsidies of this kind would risk slowing down structural change, making such an arrangement unconducive to the transition to greener energy.[5] Nevertheless, an illustration of the – limited – effect that such a measure would have on price competitiveness in aggregate terms has been provided here. The following estimation is based on the proposal put forward by the Federal Ministry for Economic Affairs and Climate Action in spring 2023. The proposal suggests introducing a temporary cap on electricity prices for a certain set of energy-intensive firms for a transition period that would run up to 2030, according to the plans of the Federal Ministry for Economic Affairs and Climate Action.[6] The proposed bridge pricing of 6 cent (for the net "Arbeitspreis", or working price) per kilowatt hour would be well below the benchmark price of the current temporary electricity price brake of 13 cent (net working price) per kilowatt hour. Taking into account the relevant taxes and levies, the bridge electricity price would reduce the beneficiary companies' electricity costs by roughly 35%, compared to their bills under current regulations.[7] As electricity costs account for around 0.7% of total production costs on aggregate, the electricity subsidy would improve price competitiveness by an estimated 0.3% on the basis of the indicator considered.[8]

Overall, even without the bolstering effect of euro depreciation and further subsidies, the relative cost effect of high energy prices on the price competitiveness of the German economy appears to have been negligibly small of late. Nevertheless, when talking about indicators of price competitiveness, it should be borne in mind that we are dealing with a macroeconomic concept. Sectors with a higher share of energy costs than the average for the economy as a whole will be hit commensurately harder by a relative increase in energy prices in Germany. Examples include products from the chemical and paper industries, whose energy cost shares amount to an estimated 13% and 18%, respectively, according to input-output tables. The burdens arising from the relative increase in energy prices experienced by Germany are thus many times greater in those two sectors than they are for the economy at large.

Furthermore, energy costs in Germany have risen significantly over the period under review when compared against the energy costs of specific competitors. All other things being equal, then, incentives to invest in energy-intensive industrial plants in countries with comparatively low energy costs are likely to have grown. Productivity gains in Germany could act as a counterweight to such developments. Improvements to the framework conditions in Germany, with the goal – among other things – of fostering efficiency gains and securing the energy supply, would help here.[9] This would serve to support Germany's price competitiveness, which still remains in favourable shape overall.

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5 See Deutsche Bundesbank (2023), p. 29.
6 Specifically, the idea is that in years in which the average market price for electricity has been higher than 6 cent per kilowatt hour, certain energy-intensive firms will be reimbursed for the difference for 80% of their energy consumption. See Federal Ministry for Economic Affairs and Climate Action (2023).
7 According to data from the Federal Statistical Office, taxes and levies on electricity for non-households with somewhat higher consumption amounted to 7 cent per kilowatt hour in the first half of 2023. These must be added as additional electricity costs to the current electricity price brake and the proposed bridge electricity price. In purely arithmetical terms, the 7 cent per kilowatt hour mark-up results in a maximum limit for the working price including taxes and levies of 20 cent per kilowatt hour at present. Under the proposal submitted by the Federal Ministry for Economic Affairs and Climate Action, the corresponding price for electricity would work out at 13 cent per kilowatt hour, meaning that the electricity price would fall by 35% compared with current provisions as a result of the measure. For more information on the data source, see Federal Statistical Office (2023).
8 According to data from the Federal Statistical Office on the calculation of producer prices for industrial products, electricity accounts for around one-third of producer prices for energy, meaning that Germany's relative producer prices for energy would fall by around 12% compared with its partner countries. Assuming that energy costs account for around 2% of total costs, as mentioned above, Germany's price competitiveness would improve by roughly 0.26%. For more on what proportion of producer prices for energy is accounted for by electricity, see Federal Statistical Office (2022).
9 See Deutsche Bundesbank (2023).

ing to a uniform methodology.[21] That country's purchasing power parity is then measured at its currency's nominal exchange rate against the US dollar. This results in the relative price level, i.e. a real exchange rate at (relative) levels, which is then compared with a relative level of productivity. Productivity per hour worked (in purchasing power parities) is generally the preferred measure of the productivity level because it is arguably the closest proxy for total factor productivity.[22]

Hourly productivity in Germany and the United States noticeably higher than in Japan and more significantly higher still than in China

Two variables, then, are key to assessing price competitiveness using the productivity approach: hourly productivity and relative price levels. The following section shows, for illustrative purposes, how these two variables evolved for the largest economies, i.e. the United States, China, Japan, Germany and the euro area, between 1999 and 2022. Hourly productivity has been influenced by exceptional global factors, particularly in recent years, with both GDP and hours worked dropping markedly for a time in 2020 when the coronavirus spread across the countries under analysis. Germany was recording the highest level of hourly productivity prior to the global financial crisis of 2008-09, but the United States has since closed the gap. Hourly productivity in the euro area moved in a similar fashion to Germany's, but at a lower level. The past two years have seen this gap between German and euro area hourly productivity widen somewhat because euro area real GDP (measured in International Dollars) grew more slowly than hours worked in 2021 and 2022, which lowered labour productivity. Hourly productivity in Japan was significantly lower than in Germany and the euro area throughout the period under analysis, reaching just under two-thirds of the German level in 2022. China has experienced very dynamic growth since the global financial crisis in particular, and yet its hourly productivity level still lags significantly behind that of the other countries under analysis, coming in at around 20% of Germany's.

Relative price level highest in the United States in 2022 among the countries under analysis; much lower in Germany and the euro area

The highest relative price level between 1999 and 2015 was mostly to be found in Japan, even if the country's hourly productivity was comparatively low. Since then, however, the relative price level in the United States has been higher, which is consistent with that country recording the highest level of hourly productivity (alongside Germany).[23] The price levels of Germany and the euro area overlap with a small number of exceptions. Compared with the United States, Germany and the euro area experienced a real depreciation last year, with the relative price level in Germany coming in around 24%, and the relative price level in the euro area coming in around 28%, below that of the United States. Just as China has the lowest relative hourly productivity, so, too, is its relative price level the lowest. That said, China's real exchange rate against the euro area, much like that of the United States, has seen a marked real appreciation since 2015, visibly narrowing the price-level gap to other countries. For instance, the gap between China's price level and that of the United States has roughly halved since 1999, reaching just under 60% of the US price level, around 79% of Germany's price level and 83% of the euro area's price level in 2022. These percentages show that the stark differences in hourly productivity between the countries under analysis are reflected to a far lesser extent in relative price levels in 2022, with the exception of the United States.

The two factors described above – relative price levels and hourly productivity – can be used to compute productivity approach-based

21 The underlying methodology is described in detail in World Bank (2020).
22 See Fischer and Hossfeld (2014). An alternative measure used in some emerging market economies if hourly productivity data are not available is per-employee productivity (again in purchasing power parities).
23 The surging real appreciation observed in the United States in 2015 is due primarily to a significant and broadly based nominal depreciation of the euro and also to a nominal appreciation of the US dollar. It should also be borne in mind for the next section of this article that relative price levels are real exchange rates, meaning that they are partly driven by changes in nominal exchange rates, significantly so in some cases.

How to assess price competitiveness using productivity approach-based indicators

Economic theories may serve as a basis for deriving empirical benchmarks – namely equilibrium real exchange rates – that enable statements to be formulated on a national economy's price competitiveness. In relation to these benchmarks, a country's price competitiveness may be assessed as favourable or unfavourable. At the Bundesbank, the benchmarks are determined inter alia based on the productivity approach, which takes account of the differences in productivity between the countries in question.

A theoretical foundation for a benchmark based on the productivity approach is provided by the Balassa-Samuelson hypothesis.[1] According to this hypothesis, the relative price level of two national economies is determined by the different productivity levels of those countries in the traded and non-traded goods sectors. Using plausible assumptions, the statements can be applied to economy-wide productivities.[2] Hence, a positive relationship exists between the relative productivity of a country and its real exchange rate in the form of the relative price level. Accordingly, the benchmark for the relative price level of the country in question rises in line with its productivity relative to its partner countries (Balassa-Samuelson effect). The following mechanism is behind this: countries with a comparatively high productivity level pay comparatively high wages in the traded goods sector, without this impairing their price competitiveness. However, these relatively high wages are also paid in the non-traded goods sector because both sectors compete for labour. The higher wages are thus responsible for the comparatively high price level in the more productive national economy.[3] Because the productivity approach-based benchmarks take relative productivity levels into account, they can also express the price competitiveness of advanced economies relative to that of emerging market economies, which is not possible when long-term averages are used.

Price competitiveness indicators based on the productivity approach are calculated in three steps at the Bundesbank. In a first step, the Balassa-Samuelson effect is determined based on the assumption that the strength of the effect is uniform across all of the countries under analysis. In empirical terms, the strength of the effect is determined using a country panel regression approach in which the respective relative price level of a country is placed in a linear relationship to its relative productivity level. To ensure that the series are comparable with one another, the relative price and relative productivity levels of each country are included in the estimate as bilateral ratios standardised to a uniform base country.[4] In order to avoid interpretation difficulties, the base country is not part of the group of countries under analysis, seeing as no indicator of price competitiveness can be calcu-

1 See Deutsche Bundesbank (2013a).
2 Evidence of the theoretical and empirical validity of this relationship is presented in Fischer and Hossfeld (2014), for example. This applies both to the Balassa-Samuelson hypothesis as well as to the Balassa-Samuelson effect mentioned later in this paragraph. Macroeconomic instead of sectoral relative productivities are frequently used within the scope of empirical work on the Balassa-Samuelson effect. The empirically, regularly determined positive relationship between the relative macroeconomic productivity level and the relative macroeconomic price level is often also referred to as the "Penn effect"; see Bergstrand (1991) and Samuelson (1994).
3 See Balassa (1964) and Samuelson (1964).
4 Colombia serves as the base country in our analyses. See Fischer and Hossfeld (2014).

lated for the base country. In the process, the productivity level is approximated by labour productivity per hour worked and the price level is calculated by means of purchasing power parities.[5]

As part of the second step, country-specific effective multilateral benchmarks, i.e. values relating to a large group of 56 partner countries in each case, are calculated to determine neutral price competitiveness.[6] It is therefore determined which price level of a country is to be classified as neutral when taking account of the productivity of the relevant country along with the productivity and price levels of its trading partners and the strength of the Balassa-Samuelson effect. To this end, trade-weighted measures are calculated for each country as regards the relative price and productivity levels, with the trade weights used here matching those also used to calculate the effective exchange rates. Its trade-weighted equilibrium relative price level is then obtained from its relative productivity level multiplied by the estimated elasticity calculated uniformly across countries as part of the first step.

In the third step, a two-stage forecast method is used to calculate the daily current deviation from the benchmark. This is necessary because the annual frequency of the price and productivity levels used in the first step of the approach and their lagged publication mean that the final data point of the observation period is not current; at present, for example, it refers to the year 2022. To render the approach usable for economic policy purposes, a current forecast value is necessary. For this purpose, a quarterly forecast is first prepared using the productivity differential of the country under analysis in relation to its trading partners as well as the real effective exchange rate based on consumer price indices.[7] Next, a daily current value is forecast with the aid of the nominal effective exchange rate. Given this comparatively short period frequently amounting to merely a few months, it is assumed, for the sake of simplicity, that the relative productivity level is constant and that the inflation differential in relation to the trading partners is equal to zero.[8]

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5 In individual cases where the time series for hourly productivity is not available, an alternative option is to use an estimate of labour productivity per employee for the country under analysis.
6 While the broad group of countries uniformly determined in the Eurosystem comprises a total of 60 trading partners – see this report, Statistical Section, Table XII.11 – only the data records for 56 of these countries are used in our calculations. As already mentioned, Colombia serves as the base country in our analyses and therefore does not belong to the group of partner countries. In addition, Ukraine is not considered any longer due to its recent problematic data status. Moreover, Saudi Arabia and the United Arab Emirates are not included in our calculations either, since oil and gas production constitutes a key fundamental factor of macroeconomic development in these countries. However, as prices of such homogeneous goods are determined on the world market, the assessment of the price competitiveness of these countries using the productivity approach is less meaningful. For instance, productivity in oil-exporting countries is also largely determined by exogenous rather than endogenous factors. In this context, global economic activity and geopolitical events play an important part.
7 The weighted productivity differential in relation to 56 trading partners represents the index of real GDP per capita, which is placed in relation to the weighted geometric average of the relevant indices of the trading partners. The weighting system used here is the same one that is used for the effective exchange rates.
8 This assumption is based on the observation that both relative productivity levels as well as relative prices represent comparatively sluggish processes and therefore have rather limited impacts on the price competitiveness of a national economy in the short term. However, this assumption is likely to lose its validity during periods of high inflation differentials. For instance, the high inflation differentials observed in recent years have led to marked relative price level changes (see pp. 19-22). Against this backdrop, the present article does not make use of a daily current forecast of indicators of price competitiveness with the aid of the nominal effective exchange rate.

Productivity approach-based indicators show that German and euro area price competitiveness has been favourable for more than a decade now and improved further in 2022

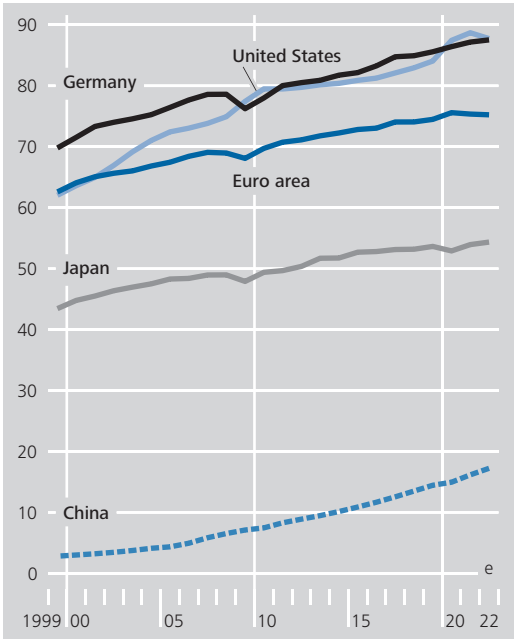
indicators of price competitiveness.[24] The calculation of these indicators has been switched to a new estimation method in an effort to eliminate distortions.[25] The first thing to note is that the price competitiveness of Germany and the euro area, as calculated using the productivity approach, has been regarded as favourable for around ten years now, and that it improved again significantly for both economies in 2022. This year, the actual relative price level was lower than the relative price level expected based on the given relative productivity level by 8% in Germany and by 15% in the euro area.

Yet, according to this measure, Germany's price competitiveness position in the euro area is currently neutral

Yet the euro area's price competitiveness position has mostly been more favourable than Germany's since 1999, except in the period around the global financial crisis. According to the latest data, Germany's price competitiveness position (according to this measure) can be considered neutral relative to the rest of the euro area in the sense that its relative price level compared with the countries of the euro area is slightly (around 1%) above the benchmark. This may seem surprising at first glance, given that the euro area's relative productivity level is lower than Germany's while their relative price levels are similarly high. It should be remembered, though, that the indicators for Germany and the euro area have a different trading partner structure altogether, if only because a number of euro area countries rank among Germany's most important trading partners.[26]

24 The results are presented with a focus on 2022, the last year of the estimation period. This article refrains from a projection using daily nominal exchange rate data as described on p. 28 because, given the currently high inflation differentials, there is no assurance that disregarding them in the short term will remain more or less without effect.
25 See pp. 31-34.
26 A productivity approach-based indicator that measures Germany's price competitiveness only relative to countries from outside the euro area is therefore more comparable with the indicator for the euro area because, in this case, the partner countries in question are identical and only their trade weights differ between the two indicators. An indicator of that kind developed for Germany broadly matches the indicator for the euro area in terms of both its path and its level in 2022.

Hourly labour productivity in selected countries*



Source: Conference Board – Total Economy Database (TED, April 2023 update). * Ratio of real gross domestic product (GDP) to total hours worked per year. Real GDP expressed in millions of International Dollars (base year 2022), converted using purchasing price parities.
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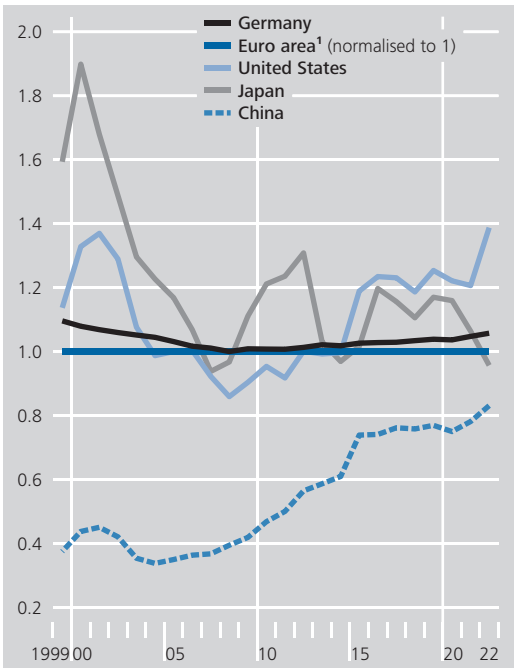
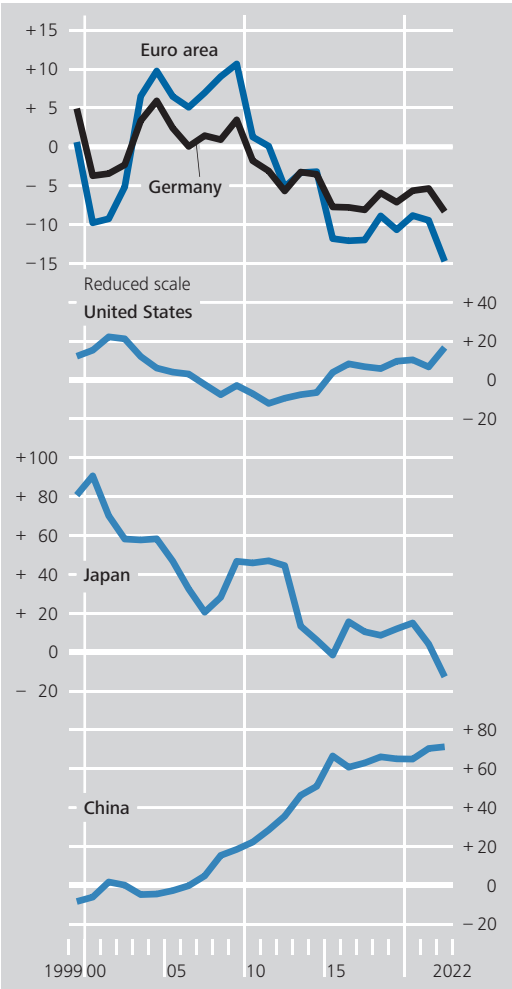
Price levels in selected countries*



Sources: IMF and World Economic Outlook Database (May 2023 update). * Relative price level (normalised relative to the euro area). 1 Average of the respective euro area Member States' time series, weighted on the basis of nominal household consumption expenditure.
Deutsche Bundesbank

Productivity approach-based indicators of price competitiveness*

Percentage deviation from benchmark



* A positive (negative) deviation implies that price competitiveness is unfavourable (favourable). Results based on an estimation using the correlated random effects model.

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Price competitiveness position in the United States, meanwhile, has been unfavourable since 2015 and deteriorated again distinctly in 2022

In the United States, meanwhile, the price competitiveness position as measured by the productivity approach has been unfavourable since 2015. As a result of the marked real appreciation of the US dollar in 2022, it deteriorated again sharply, exceeding its benchmark that year by 16%. Given that the productivity level there is fairly high, the only possible explanation for this outcome is the relative price level in the United States, as described above, which is likewise quite high and related to the pronounced strength of the US dollar in 2022. An exceptionally high relative price level was a long-standing feature of the Japanese economy in the wake of what has often been dubbed an "asset price bubble" at the beginning of the 1990s. However, Japan's price competitiveness has experienced strong trend growth over the years, mainly on the back of very low inflation rates. The past two years saw a strong nominal effective depreciation of the yen that provided tailwinds for this upturn. This is the backdrop against which Japan's price competitiveness stood well below the benchmark in 2022, by just over 12%. China's price competitiveness moved in the opposite direction to Japan's, deteriorating rapidly in the 2007-15 period in particular. The relative price level went from neutral in 2005 to around 70% above its benchmark in 2022. This also impacted distinctly on the competitiveness positions of China's trading partners, because a deterioration in the price competitiveness of a key trading partner like China for the countries under analysis will inevitably entail an improvement in their own price competitiveness.

Price competitiveness of individual euro area countries favourable for the most part in 2022

Many euro area countries' price competitiveness was relatively favourable in 2022, much like Germany's. Only in Finland was it unfavourable, whilst it was neutral in countries like Estonia, Ireland, Austria and Latvia. Italy, Spain and Lithuania, meanwhile, enjoyed the greatest competitive edge, each boasting values of around 15%. Italy's price competitiveness benefited most in this regard from the fact that the country's relative price level has been declining in relation to the average of the euro area countries for around a decade now, and currently stands distinctly below that average.[27]

27 In fact, current calculations indicate that Italy's relative price level has been below the euro area average ever since the euro area was established. Another reason why the current estimate sees Italy's price competitiveness as comparatively favourable is that the elasticity of the price level with respect to hourly productivity is now calculated as being somewhat lower. As a result, Italy's relatively low productivity no longer has as much of a bearing as in earlier estimates.

A new estimation method for the productivity approach

In order to empirically determine benchmark values for assessing a country's price competitiveness, panel estimation methods are generally used. Recent research suggests that the methods typically employed in practice produce distorted benchmarks and thus distorted estimates of competitiveness. This is because they make assumptions about the relationship between real exchange rates and their most important determinants that are generally not backed up by the data.[1] In order to avoid these distortions, the Bundesbank has changed its method for calculating these benchmarks and now uses a correlated random effects (CRE) approach. This panel estimation method and the way in which it is applied as part of the productivity approach are presented below.

In most of the applications, the benchmarks are calculated using a fixed effects estimator. The time series used are demeaned over time.[2] This type of adjustment is unavoidable if real exchange rates are only available as indices. Such indices lack level information on the underlying relative price level series. Thus, in this case, the time series do not contain any information that would allow for a comparison of individual data points across countries – i.e. a cross-sectional comparison – and must therefore be normalised through demeaning, as mentioned above. However, more recent research papers highlight the potential and actual high significance of the cross-sectional information contained in both the relative price levels and their corresponding explanatory variables for the estimated relationship.[3] If, however, these variables are used for the panel estimation, the question arises as to which method is optimal for determining the benchmarks – a question that was unresolved in the literature until recently.

In fact, it can be shown that the benchmarks calculated using conventional panel estimation methods – such as pooled OLS, fixed effects, random effects or between effects – are often significantly distorted. These distortions can be avoided by using a CRE model.[4] In this context, conventional panel estimation methods are restricted special cases of the CRE model. The key element of these restrictions is that the parameter estimated from the time series variation must be identical to the parameter estimated from the cross-sectional variation.[5] If, however, the assumed restrictions are violated by the actual data, the conventional methods produce distorted results for the benchmarks. It can thus be demonstrated that these restrictions are violated in several use cases, including the method for calculating the equilibrium rate that was previously used by the Bundesbank. The

1 For instance, the panel estimation methods that are typically used assume a priori that the real exchange rate is only materially influenced by how its explanatory variables vary over time, and not how they vary between countries. However, evidence suggests that this assumption is not empirically valid; see Fischer (2019). The method presented here is also based on this research paper.
2 Examples of this include one of the EBA estimation methods used by the International Monetary Fund, see Phillips et al. (2013); a method employed by the ECB, see Fidora et al. (2017); and the approach used by Couharde et al. (2018). In the previous applications used by the Bundesbank, too, the benchmarks were determined using a panel estimation method with fixed effects; see Deutsche Bundesbank (2013b) and Fischer and Hossfeld (2014). However, the previous method differs fundamentally from traditional applications of a fixed effects estimator in that level data are used, which allow the unobserved effect to be assigned to the deviation from the benchmark.
3 See Cheung et al. (2007), Fischer and Hossfeld (2014), Adler and Grisse (2017), International Monetary Fund (2017) and Berka et al. (2018).
4 The CRE model is based on Mundlak (1978).
5 Alternatively, it can be assumed that one of the two coefficients does not differ significantly from zero.

method for determining the benchmarks was therefore switched to using the CRE model.

The following panel regression is estimated:

$$\begin{aligned} q_{it} &= (x_{it} - \bar{x}_i)\beta_{1,CRE} + \bar{x}_i\beta_{2,CRE} \\ &\quad + \omega_{it,CRE} \\ &\quad \text{where } \omega_{it,CRE} \\ &\quad = \mu_{i,CRE} + \varepsilon_{it,CRE} \end{aligned}$$

or, analogously:

$$\begin{aligned} q_{it} &= x_{it}\beta_{1,CRE} + \bar{x}_i(\beta_{2,CRE} - \beta_{1,CRE}) \\ &\quad + \omega_{it,CRE} \\ &\quad \text{where } \omega_{it,CRE} \\ &\quad = \mu_{i,CRE} + \varepsilon_{it,CRE}, \end{aligned}$$

where q_{it} is the logarithmic price level (real exchange rate) of country i relative to the base country at time t and x_{it} represents the corresponding logarithmic relative productivity. The variable $\bar{x}_i$ is the time series average of x_{it}; $\mu_{i,CRE}$ is an unobserved country-specific effect and $\varepsilon_{it,CRE}$ is the error term.

While the estimated coefficient $\hat{\beta}_{1,CRE} = \hat{\beta}_{FE}$ captures the effect of the time series variation in the data and thus corresponds to the fixed effects estimator $\hat{\beta}_{FE}$, the coefficient $\hat{\beta}_{2,CRE} = \hat{\beta}_{BE}$ represents the effect of the cross-sectional variation in the data and thus corresponds to the between effects estimator $\hat{\beta}_{BE}$.[6] These coefficients can be interpreted as elasticities of the price level with respect to productivity because both the dependent and explanatory variables are logarithmic variables. Here, it is assumed that these elasticities are the same across all of the countries included in the panel.

The estimated elasticities are then used to adjust the relative price levels for the impact of relative productivity levels. However, in order to determine representative benchmarks, all of the variables must first be placed in a multilateral context. To this end, the weighted average of the partner countries is subtracted from the logarithmic relative price level of country i:

$$\tilde{q}_{it} = q_{it} - \sum_{j=1}^{N} w_{ij} q_{jt},$$

where $w_{ii} = 0$ and $\sum_{j=1}^{N} w_{ij} = 1$. The productivity level $\tilde{x}_{it}$ is analogous to the value of x_{it} normalised vis-à-vis the partner countries. The multilateral benchmark for the relative price level $\tilde{q}^*_{it}$ is then determined using the estimated elasticities as follows:

$$\tilde{q}^*_{it} = (\tilde{x}_{it} - \bar{\tilde{x}}_{it})\hat{\beta}_{1,CRE} + \bar{\tilde{x}}_{it}\hat{\beta}_{2,CRE}$$

or, analogously:

$$\tilde{q}^*_{it} = \tilde{x}_{it}\hat{\beta}_{1,CRE} + \bar{\tilde{x}}_{it}(\hat{\beta}_{2,CRE} - \hat{\beta}_{1,CRE}).$$

Finally, the deviation of the multilateral normalised price level $\tilde{q}_{it}$ from its benchmark $\tilde{q}^*_{it}$ is calculated as:

$$\tilde{d}_{it} = \tilde{q}_{it} - \tilde{q}^*_{it}.$$

If $\tilde{d}_{it}$ is equal (or close) to zero, the price level in country i relative to the price levels in its partner countries corresponds (roughly) to the equilibrium level that would be expected based on its level of relative productivity. This would mean that the price competitiveness position of that particular country would be considered neutral. By contrast, its price competitiveness position would be considered unfavourable in the case of positive deviations from the benchmark (meaning an excessively high relative price level) and favourable in the case of negative deviations.[7]

6 Specifically, the first coefficient $\hat{\beta}_{1,CRE} = \hat{\beta}_{FE}$ captures the within-group variation.
7 For the extrapolation in the third step of the productivity approach, it should be noted that logically only the coefficient $\hat{\beta}_{1,CRE}$ is used when employing the CRE approach.

Estimated values for coefficients and the price competitiveness of selected countries°

a) Estimated elasticity			
Estimator	$\widehat{\beta}_{1,CRE} = \widehat{\beta}_{FE}$	$\widehat{\beta}_{2,CRE} = \widehat{\beta}_{BE}$	$\widehat{\beta}_{2,CRE} - \widehat{\beta}_{1,CRE}$
Elasticity	0.20**	0.42***	0.22**
b) Hausman test	H_0: $\widehat{\beta}_{2,CRE} - \widehat{\beta}_{1,CRE} = 0$		
Hausman (χ^2_1)	5.39**		
c) Price competitiveness position calculated for 2022 (%)			
Estimation method	FE,ω	BE,ω	CRE,ω
Euro area	0.4	– 10.1	– 14.7
Germany	3.3	– 6.0	– 8.3
United States	35.9	18.9	16.8
Japan	– 0.8	– 7.0	– 12.7
China	18.0	55.4	71.3

° Notes: Panel estimators: CRE: Correlated random effects; FE: Fixed effects; BE: Between effects. *** denotes significance at the 1% level based on robust variances. ** denotes significance at the 5% level based on robust variances. Price competitiveness is shown as a percentage deviation from the respective benchmark value. The unobserved country-specific effect $\mu_{i,CRE}$ is considered part of the imbalance, i.e. part of the deviation from the benchmark value. A positive value corresponds to an unfavourable competitiveness position. A negative value corresponds to a favourable competitiveness position. A value close to zero corresponds to a neutral competitiveness position.

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The table above summarises the key results for the euro area, Germany, the United States, Japan and China obtained from the productivity approach using the CRE model. Section a) first documents the elasticities resulting from the estimation of the equations described above. The estimations are based on annual data for the period from 1980 to 2022.[8] The first coefficient of the CRE model $\widehat{\beta}_{1,CRE} = \widehat{\beta}_{BE}$ indicates an estimated elasticity of 0.20. The influence of relative productivity on the relative price level over time is thus relatively small for any given country.

The second coefficient of the CRE model $\widehat{\beta}_{2,CRE} = \widehat{\beta}_{BE}$ produces a fairly high elasticity of 0.42. The influence of relative productivity on the relative price level is therefore more than twice as large in a cross-country comparison as it is over time. Accordingly, the result of a Hausman test in section b) also suggests that the two coefficients $\widehat{\beta}_{1,CRE}$ and $\widehat{\beta}_{2,CRE}$ are significantly different. This means that the restrictions assumed when using conventional panel estimation methods are violated by the data, and the benchmarks calculated based on those estimators are correspondingly distorted.

Examples of the distortions resulting from the use of conventional panel estimation methods are shown in section c). The first column shows the price competitiveness position calculated for selected countries for 2022 on the basis of the fixed effects estimator (FE,ω) and the second column shows the results of the between effects

8 The data are not available for all of the countries under review from 1980 or, in some cases, are not taken into account until a later date for economic reasons. For instance, all of the post-communist transition countries are only included in the panel from 1995 onwards because market mechanisms in those countries were not relevant for price formation until the 1990s. Argentina, Brazil and Turkey, which had to contend with hyperinflation and the associated sharp depreciation of their national currencies in the 1980s, are also not included until 1995 onwards.

estimator (BE,ω).[9] The final column shows the results of the CRE model (CRE,ω) and thus the undistorted estimation results for the respective competitiveness positions.

Overall, it should be noted that, compared with the benchmarks calculated using the CRE model, the benchmarks from the fixed effects estimator are more distorted than those from the between effects estimator. The deviation of 53.3 percentage points from the result of the CRE model in the case of China is particularly large. By contrast, Germany exhibits the smallest deviations, followed by Japan. Furthermore, depending on the estimation method used, the calculated price competitiveness position may even be reversed. For example, the fixed effects model tends to consider Germany's price competitiveness position to be unfavourable, while the undistorted result of the CRE model suggests that Germany has a favourable competitiveness position.

The benchmarks calculated for China are especially striking. In particular, the use of the CRE model leads to an exceptionally unfavourable assessment of China's price competitiveness. However, if the countries under review have an important trading partner, such as China, with a particularly unfavourable price competitiveness position, this implies that those respective countries have a better competitiveness position. This is reflected in the results for the remaining countries.

9 ω indicates that the price competitiveness position is derived from the sum of the unobserved country-specific effect $\mu_{i,CRE}$ and the error term $\varepsilon_{it,CRE}$. Such an approach results when the equilibrium rate is defined as the expected value of the real exchange rate conditioned on the fundamental variables (relative productivity in this case).

Conclusion

Price competitiveness of Germany and euro area favourable at present and improved yet again in 2022

The existing body of analytical work shows that the price competitiveness position of Germany and the euro area can currently be regarded as favourable. That has been the case for more than a decade now. The year 2022 saw the price competitiveness of Germany and the euro area improve again noticeably, mainly because of the weakness of the effective euro. Conversely, the analyses suggest that the price competitiveness of major trading partners of Germany and the euro area, such as that of the United States and China, could be considered unfavourable in 2022.

Considerable shifts in price competitiveness in 2022 due to high inflation differentials across euro area countries

As far as individual euro area countries' price competitiveness relative to the rest of the euro area is concerned, quite a few countries experienced intra-year shifts in 2022 of a kind not seen since the euro was introduced. This is because the high inflation rates were also accompanied by high inflation differentials across euro area countries which impacted on their price competitiveness depending on the country's trade structure. For example, the price competitiveness of manufacturers from countries where inflation rates were low relative to their trading partners benefited, while that of relatively high-inflation countries was hurt, in some cases significantly. Germany's price competitiveness was affected only very marginally by shifts of that kind, though. Calculated only relative to the partner countries in the euro area, the indicator that takes relative productivity levels into account suggests that Germany's competitiveness position was neutral in 2022.

In an environment of highly volatile energy prices, price competitiveness indicators based on deflators of total sales are superior

Alongside movements in nominal exchange rates, changes in relative energy prices also played an important role in the aforementioned shifts in price competitiveness in 2022. In this context, a price competitiveness indicator calculated on the basis of deflators of total sales has proved superior to other indicators. This is because deflators of total sales also take prices

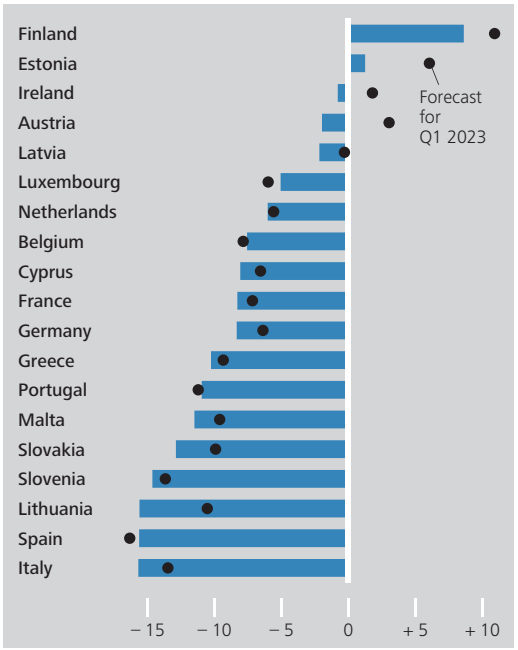
of imported intermediate inputs, which also include energy imports, into account.

Germany's international price competitiveness facing challenges

Despite what is currently a favourable assessment overall of Germany's price competitiveness position, the dislocations experienced notably last year in energy markets show that Germany's competitiveness position is also facing challenges. There are justified concerns that, all other things being equal, the persistently high relative energy prices are likely to have weakened Germany's international competitiveness in the energy-intensive production space, even if this has barely been reflected so far by changes in macroeconomic price competitiveness.[28] Whilst it is true that price competitiveness is just one of many factors that has a bearing on economic growth, an energy price persistently well above pre-crisis levels is likely to be an intermittent drag on the growth path of Germany's potential output. Higher energy costs weaken productivity because more expensive energy inputs are needed to produce the same value added. In addition, energy-intensive property, plant and equipment would need to be written down.[29] Overall, in that kind of scenario of energy prices persisting at high levels relative to abroad, it stands to reason that both the relative price level and the relative productivity level would shift to the detriment of Germany, potentially diminishing Germany's price competitiveness as a result. The price competitiveness of energy-intensive firms has already deteriorated significantly. Government policies can help maintain Germany's price competitiveness by creating the right framework conditions and thus, for example, promoting efficiency gains and security in the supply of energy.[30]

Productivity approach-based price competitiveness of euro area countries in 2022*

Percentage deviation from benchmark



* A positive (negative) deviation implies that price competitiveness is unfavourable (favourable). Results based on an estimation using the correlated random effects model.

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28 Thus, output in this sector was around 7% down on the previous year in real terms in 2022, and up by 1.1% in the non-energy-intensive sector. A detailed analysis of the structural implications of the energy crisis for the German economy can be found, for example, in Projektgruppe Gemeinschaftsdiagnose (2023).

29 High relative energy costs erode the profitability of energy-intensive capital investment. This generally depletes the capital stock and thus productivity growth. See Deutsche Bundesbank (2022d).

30 See Deutsche Bundesbank (2023).

List of references

Adler, K. and C. Grisse (2017), Thousands of BEERs: Take your pick, Review of International Economics, Vol. 25(5), pp. 1078-1104.

Balassa, B. (1964), The Purchasing-Power Parity Doctrine: A Reappraisal, Journal of Political Economy, Vol. 72(6), pp. 584-596.

Bergstrand, J. H. (1991), Structural Determinants of Real Exchange Rates and National Price Levels: Some Empirical Evidence, American Economic Review, Vol. 81(1), pp. 325-334.

Berka, M., M. B. Devereux and C. Engel (2018), Real exchange rates and sectoral productivity in the Eurozone, American Economic Review, Vol. 108(6), pp. 1543-1581.

Cheung, Y.-W., M. D. Chinn and E. Fujii (2007), The overvaluation of Renminbi undervaluation, Journal of International Money and Finance, Vol. 26, pp. 762-785.

Chiacchio F., R. A. De Santis, V. Gunnella and L. Lebastard (2023), How have higher energy prices affected industrial production and imports?, in European Central Bank, Economic Bulletin, Issue 1, 2023, pp. 40-46.

Couharde, C., A.-L. Delatte, C. Grekou, V. Mignon and F. Morvillier (2018), EQCHANGE: A world database on actual and equilibrium effective exchange rates, International Economics, Vol. 156, pp. 206-230.

Deutsche Bundesbank (2023), Germany as a business location: selected aspects of current dependencies and medium-term challenges, Monthly Report, September 2023, pp. 15-35.

Deutsche Bundesbank (2022a), The recent energy price shock in a historical comparison, Monthly Report, November 2022, pp. 15 f.

Deutsche Bundesbank (2022b), Rise in energy prices, the exchange rate of the euro and Germany's price competitiveness, Monthly Report, December 2022, pp. 45-54.

Deutsche Bundesbank (2022c), High inflation rates in the euro area and the United States: similarities and differences, Monthly Report, August 2022, pp. 14 f.

Deutsche Bundesbank (2022d), Impact of permanently higher energy costs on German potential output, Monthly Report, December 2022, pp. 29 f.

Deutsche Bundesbank (2019), Real effective exchange rates, price competitiveness indicators and concepts for their assessment, Monthly Report, January 2019, pp. 33-35.

Deutsche Bundesbank (2016), The impact of alternative indicators of price competitiveness on real exports of goods and services, Monthly Report, January 2016, pp. 13-30.

Deutsche Bundesbank (2013a), Macroeconomic approaches to assessing price competitiveness, Monthly Report, October 2013, pp. 31-46.

Deutsche Bundesbank (2013b), On estimating a benchmark for the real effective exchange rate based on the productivity approach, Monthly Report, October 2013, pp. 39-41.

Deutsche Bundesbank (2004), Purchasing power parity theory as a concept for evaluating price competitiveness, Monthly Report, June 2004, pp. 29-42.

European Central Bank (undated), Harmonised competitiveness indicators, available at https://www.ecb.europa.eu/stats/balance_of_payments_and_external/hci/html/index.en.html

European Central Bank (2023), Prices and costs, Economic Bulletin, Issue 1, 2023, pp. 20-24.

Eurostat (2022), International trade in goods by type of good, June 2022, available at https://ec.europa.eu/eurostat/statistics-explained/index.php?title=International_trade_in_goods_by_type_of_good

Federal Ministry for Economic Affairs and Climate Action (2023), Wettbewerbsfähige Strompreise für die energieintensiven Unternehmen in Deutschland und Europa sicherstellen, available at https://www.bmwk.de/Redaktion/DE/Downloads/W/wettbewerbsfaehige-strompreise-fuer-die-energieintensiven-unternehmen-in-deutschland-und-europa-sicherstellen.html

Federal Statistical Office (2023), Strompreise für Nicht-Haushalte: Deutschland, available at https://www-genesis.destatis.de/genesis/online?sequenz=tabelleErgebnis&selectionname=61243-0005&language=de#abreadcrumb

Federal Statistical Office (2022), Index Erzeugerpreise gewerblicher Produkte (Inlandsabsatz) – Wägungsschema für das Basisjahr 2015, available at https://www.destatis.de/DE/Themen/Wirtschaft/Preise/Erzeugerpreisindex-gewerbliche-Produkte/Methoden/Downloads/waegungsschema-erzeugerpreise-2015-pdf.pdf?__blob=publicationFile

Fidora, M., C. Giordano and M. Schmitz (2017), Real exchange rate misalignments in the euro area, ECB Working Paper Series, No 2108.

Fischer, C. (2019), Equilibrium real exchange rate estimates across time and space, Deutsche Bundesbank Discussion Paper, No 14/2019.

Fischer, C. and O. Hossfeld (2014), A consistent set of multilateral productivity approach-based indicators of price competitiveness – Results for Pacific Rim economies, Journal of International Money and Finance, Vol. 49(A), pp. 152-169.

International Monetary Fund (2017), Technical Background Note: 2015 Refinements to the External Balance Assessment (EBA) Methodology, available at https://www.imf.org/external/np/res/eba/pdf/Technical-Note_EBA%20Refinements072017.pdf

MacDonald, R. (2000), Concepts to Calculate Equilibrium Exchange Rates: An Overview, Deutsche Bundesbank Discussion Paper, No 3/00.

Müller, M. (2023), Why is inflation so high and so different in different euro area countries?, speech at the Bank of Slovenia, 3 March 2023.

Mundlak, Y. (1978), On the Pooling of Time Series and Cross Section Data, Econometrica, Vol. 46(1), pp. 69-85.

Phillips, S.T., L. Catão, L. Ricci, R. Bems, M. Das, J. Di Giovanni, D.F. Unsal, M. Castillo, J. Lee, J. Rodriguez and M. Vargas (2013), The External Balance Assessment (EBA) Methodology, IMF Working Paper, 13/272.

Projektgruppe Gemeinschaftsdiagnose (2023), Inflation im Kern hoch – Angebotskräfte jetzt stärken, Gemeinschaftsdiagnose Frühjahr 2023, Chapter 5.

Samuelson, P. (1994), Facets of Balassa-Samuelson Thirty Years Later, Review of International Economics, Vol. 2(3), pp. 201-226.

Samuelson, P. (1964), Theoretical Notes on Trade Problems, The Review of Economics and Statistics, Vol. 46(2), pp. 145-154.

Schmitz, M., M. De Clercq, M. Fidora, B. Lauro and C. Pinheiro (2012), Revisiting the Effective Exchange Rates of the Euro, ECB Occasional Paper Series, No 134.

World Bank (2020), Purchasing Power Parities and the Size of World Economies: Results from the 2017 International Comparison Program, World Bank Publications – Books, The World Bank Group, No 33623, December.